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Textbook for CBSE Class XII

# Essentials of PHYSICAL EDUCATION

## Teacher's Manual

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CHAPTER 1

# Management of Sporting Events

B. 1. This is the first step in holding an event where goals are defined, budget is estimated and the theme, branding, uniforms, guest list, logistics, invitations, sponsorship, awards and other event-related aspects are defined.

2. This is a method of ranking players and teams on the basis of their past performances. The seedings, of course, will change based on the form and performance, but the general idea is to keep the seeded players in separate groups so that they do not meet early in the tournament.

3. This is the commonest format for most tournaments as a large number of teams can take part in a relatively short time. Here, all contestants get eliminated one by one till only the winner is left. Once defeated, the team or the individual does not get a second chance.

4. In case the number of byes to be given is an even number, they are divided equally between the upper and lower half. The process to be followed starts with writing numbers 1 to 13 on a slip of paper. Each team picks a number which represents their team number in the tournament. Then, they are divided into two lots. Thereafter, the number of byes to be given is calculated as:

   (a) The last team of lower half gets the first bye.

   (b) The first team of upper half gets the second bye.

   (c) The first team of the lower half gets the third bye.

   (d) The last team of the upper half gets the fourth bye.

5. Special Seeding is a method for the top performers to start the event not from the first game but directly in the quarter-finals or even in the semi-finals.

6. A league or Round Robin tournament (or all-play-all tournament) is a competition in which each contestant meets all other contestants. This is also called the Berger system, named after the person who first proposed it. A league tournament contrasts with an elimination tournament in which participants are eliminated after a certain number of losses. There are two types of league tournaments:

   (a) **Single League Tournament:** Here, each team plays the other team at least once.

   (b) **Double League Tournament:** Here, every team plays the other teams twice.

7. Medical Committee is a committee consisting of qualified doctors and paramedical staff to attend to any medical exigencies. Setting up first-aid centres and ensuring transport to reach the nearest hospital in case of any serious injury is the primary function of this committee.

8. In case the number of byes to be given is an even number, teams are divided equally between the upper and lower half. The process to be followed starts with writing numbers on a slip of paper. Each team picks a number which represents their team number in the tournament. Thereafter, the number of byes to be given is calculated as:

   (a) The last team of lower half gets the first bye.

   (b) The first team of upper half gets the second bye.

   (c) The first team of the lower half gets the third bye.

   (d) The last team of the upper half gets the fourth bye.

9. Most schools worldwide have sporting tournaments as part of the school curriculum. This allows every student to be physically active and expose their talent on the sports field. A few advantages of tournaments for students are:

   (a) They help develop mental, physical and social aspects of the students.

   (b) They teach ethics of competition, while encouraging a healthy lifestyle and help train future sports stars.

10. A league or Round Robin tournament (or all-play-all tournament) is a competition in which each contestant meets all other contestants. This is also called the Berger system, named after the person who first proposed it. There are two types of league tournaments:
    (a) **Single League Tournament:** Here, each team plays the other team at least once.
    (b) **Double League Tournament:** Here, every team plays the other teams twice.
11. Planning is an important step in sports management that helps develop a roadmap for the future—predefined steps—to accomplish organisational goals. Errors of the past can be eliminated and resources available presently—both internal like people, time, and cost and external like policies and general business environment—help plan better.
12. The idea behind these runs is to foster peace and unity among people. People of different ages, religions and backgrounds get together and aim at spreading unity. People may run in relays or the whole distance. Many countries organise unity runs to celebrate their independence days. After violence in a city, a run for unity aims at enhancing peace and brotherhood.
13. In extramural tournaments, outside schools participate as schools now tend to encourage friendly competition amongst each other in order to assess their strengths and weaknesses as well as foster talent. Extramurals are also called inter-school competitions. Today, these are organised at regional and national levels in India by bodies such as the School Games Federation of India, CBSE as well as various inter-university boards. Extramural competitions are scheduled much in advance so that all possible teams can participate.

**C.** 1. The team that gets the maximum points is the winner of the tournament. The winner gets two points, the loser gets no point and, in case of a draw, the teams get one point each. In case of a tie at the top on the basis of points, a rematch is held between the top two teams. If it again results in a draw, then the team that has won most matches is declared the winner. Sometimes, the winners are decided by tossing a coin.

Other methods that are used to determine the winners are: the British Method, where the total points won are divided by the maximum possible points and the American Method, where the number of matches won is divided by the total number of matches played. The team with the highest percentage is declared the winner.

2. A league or Round Robin tournament is a competition in which each contestant meets all other contestants. There are two types of league tournaments: Single League Tournament, where each team plays the other team at least once and Double League Tournament, where every team plays the other teams twice.

The advantages offered by league tournaments are as follows:

(a) Every team has an opportunity to play against every other team at least once and since each team gets to play multiple matches, the players have a great opportunity to showcase their talent. Also, the best team has the highest chance of winning the tournament so it is easier to correctly rank the teams.

(b) Demerits of league tournaments include them being time-consuming as a large number of games are played. These tournaments tend to cost more money to the organisers as large-scale facilities for accommodation, food, transport and other logistics are necessary.

3. A disadvantage of the knockout system is that a weak team may be pitted against a very strong team. It is also possible that all strong teams get grouped together and the weak teams get grouped together. This causes a strong team to get eliminated while a weak team may move ahead. Seeding method avoids this pitfall. Here, by default, the strong teams get placed appropriately in the schedule of play. Strength of the teams generally depends on their past performance. So, the seeding tends to change after each event and depends on the performance in the preceding tournament. Special Seeding allows for the top performers to start the event not from the first game but as late as the quarter-finals or even the semi-finals.

4. Tournaments are important as they help develop mental, physical and social aspects of the students. Also, they teach ethics of competition besides developing skills and encouraging a healthy lifestyle. Tournaments develop stamina, coordination and skills in students besides teaching and develop leadership skills. Tournaments help in the following:
   (a) Providing equal and uniform opportunities to all students is the primary aim of encouraging tournaments. The higher the level of the tournament, the lesser the number of people that can take part, so initiating them at an early age allows for mass involvement in sports. Also, since it is possible to participate in many sports before settling on one particular sport, they also help locate talent.
   (b) They help develop leadership qualities in students; we can certainly develop first and second-line leadership skills on the sports fields. Students also learn organisational skills when organising tournaments.
   (c) Students not only get skilled at one game but in many games and activities.
5. Procedure of placement of team in upper half and lower half is that if number of team is even then equal number of team is divided into the upper half and lower half which is n/2 and here "n'' indicating the number of team. If number in a team is odd then the number of team in upper half will be (n+1)/2 and number of team in lower half will be (n-1)/2 and in both cases "n'' is the number of teams.
6. We need to give byes because we want to have only top four teams in the semi-finals of the event. This way, the players or teams who get a bye do not have to play in the very first round. This is done to ensure that the top players do not have any advantage of extra rest over other participants in between the games. We need to give byes because we want to have only top four teams in the semi-finals of the event. This way, the players or teams who get a bye do not have to play in the very first round. This is done to ensure that the top players do not have any advantage of extra rest over other participants in between the games.

   In case the number of byes to be given is an even number, they are divided equally between the upper and lower half. The process to be followed starts with writing numbers on a slip of paper. Each team picks a number which represents their team number in the tournament. Then, they are divided into two lots. Thereafter, the number of byes to be given is calculated as:
   (a) The last team of lower half gets the first bye.
   (b) The first team of upper half gets the second bye.
   (c) The first team of the lower half gets the third bye.
   (d) The last team of the upper half gets the fourth bye.
7. The committees to organise a tournament include:
   (a) Pre-tournament Committees: Organising committee, Finance Committee, Technical Committee, Purchase Committee, Publicity Committee
   (b) During-tournament Committees: Reception Committee, Transportation Committee, Boarding and Lodging Committee, Medical Committee, Tournament Committee, Ceremonies Committee, Officials Committee and Announcement Committee

   There is also a Post-tournment Committee which helps wind up the event and is responsible for the smooth return of sportspersons to their respective home countries by ensuring proper post-event transport facilities. The Official Committee is responsible for the selection of various sports officials such as umpires, referees, record keepers, track marshals and timekeeper as per the requirements of the event.
8. Special Seeding is for the top performers to start the event not from the first game but as late as the quarter-finals or even the semi-finals. This allows the stronger players to start the tournament later based on the past performances. This allows to place the stronger team/s at appropriate places in the fixture and to avoid the elimination of such teams in the first round.

9. Cyclic Method is a part of the Round Robin or league method of organising tournaments. Here, the process in case of even number of teams is that we place team 1 on the top and other teams are placed consecutively downwards in an ascending order to move upside on the other side of the columns. The number of rounds here is (N–1) where N is the number of teams. On the other hand, if the number of teams is odd, the number of rounds equals the number of teams. Bye is placed at the top of the right side when odd number of teams are there. The rest of the steps are the same as before. The teams are rotated in a clockwise direction.
10. The team that gets the maximum points is the winner of the tournament. The winner gets two points, the loser gets no point and, in case of a draw, the teams get one point each. In case of a tie at the top on the basis of points, a rematch is held between the top two teams. If it again results in a draw, then the team that has won most matches is declared the winner. Sometimes, the winners are decided by tossing a coin.

    Other methods that are used to determine the winners are:

    **British Method:** Here, the total points won are divided by the maximum possible points. Thus, if any team playing a ten-match tournament wins seven and draws three matches, the percentage of wins is simply calculated as—

    Total points = 7 × 2 + 3 × 1 = 17 points

    Possible maximum points = 10 × 2 = 20 points

    Percentage points won = Total points won × 100 divided by total possible points

    So, 17 × 100 = 1700 divided by 20 = 85%

    **American Method:** Here, the number of matches won is divided by the total number of matches played. Suppose a team has won seven out of possible ten wins. To calculate the percentage, we use the following formula:

    Total matches won × 100 divided by total matches played. Here, 7 × 100 divided by 10 = 70%.

    Since this calculation is applied to all the teams, the winner will be the team with the highest percentage.
11. Physical education and sports play a vital role in promoting the social values among the youth such as fairness, self-discipline, solidarity, team spirit, tolerance and fair play. There are different social values promoted through sporting activities in our day-to-day life and activity which include:
    (a) **Equality:** Equality is promoted in sport as a core value which makes everyone to be equal to each other no matter the race, gender and economic background, everyone is equal in sports and performance is the only criterion.
    (b) **Fairness:** Transparency is also one of the core values promoted in sport, with being fair to everyone taking part in a particular sport event.
    (c) **Community:** Sports also serve as an activity for the feeling of belonging to a community, and with the sense of belonging to something, it gives the positive value of being counted as someone that is important.
12. The Pre-tournament Committees include:
    (a) **Organising Committee:** This committee is headed by a Chairman who has the overall responsibility of organising, running and wrapping up the event.
    (b) **Finance Committee:** The finance committee takes care of the budget, plans spending and prevents wasteful expenditure.
    (c) **Publicity Committee:** The dates, venues and timing of the events are brought to the notice of the people through media advertising, press meets and publicity through newspapers, hoardings, etc.
    (d) **Technical Committee:** This committee ensures that the equipment, playing area, courts and grounds meet the required specifications.

(e) **Purchase Committee:** Sports equipment and other items that will be used in the event are acquired by this committee.

During-tournament Committees are set up during the tournaments. These include:

(a) **Reception Committee:** Welcoming the athletes on their arrival in the city or at the venue, and also welcoming the chief guests at the opening and closing ceremonies.

(b) **Transportation Committee:** Transporting the sportspersons and the attending staff to the venues and stadia on time.

(c) **Boarding and Lodging Committee:** This committee is responsible for boarding and lodging of the players, teams and officials.

(d) **Medical Committee:** This committee consists of qualified doctors and paramedical staff to attend to any medical exigencies.

(e) **Tournament Committee:** The task of receiving entries, drawing up fixtures and making arrangements for standard sporting facilities is handled by members of this committee.

(f) **Ceremonies Committee:** The opening and closing ceremony as well as arranging trophies, medals and certificates to be given are arranged by this committee.

(g) **Officials Committee:** This committee is responsible for the selection of various sports officials such as umpires, referees, record keepers, starters, track marshals and timekeepers.

(h) **Announcement Committee:** This committee sets up facilities for making announcements during the events.

Post-tournament Committees are responsible for the smooth return of sportspersons to their respective homes and countries by ensuring proper post-event transport facilities.

13. **Fixtures for even number of teams**

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| A | | 1 | 2 | 3 | 4 | 5 |
| B | | | 3 | 4 | 5 | 2 |
| C | | | | 5 | 1 | 4 |
| D | | | | | 2 | 1 |
| E | | | | | | 3 |
| F | | | | | | |

**Fixtures for odd number of teams**

| | A | B | C | D | E | Bye |
|---|---|---|---|---|---|---|
| A | | 1 | 2 | 3 | 4 | 5 |
| B | | | 3 | 4 | 5 | 2 |
| C | | | | 5 | 1 | 4 |
| D | | | | | 2 | 1 |
| E | | | | | | 3 |
| Bye | | | | | | |

14. Combination Tournaments are used to conduct matches on a group or zonal basis. Among the variables that determine the suitability of this method include the number of teams, the distance from which they commute and the games involved. Thus, if any activity involves a large country or region, the said area is divided into smaller areas where the players meet at a central place. After the zonal or regional winners are decided, they meet to compete at the national level. Among the possible combinations are:

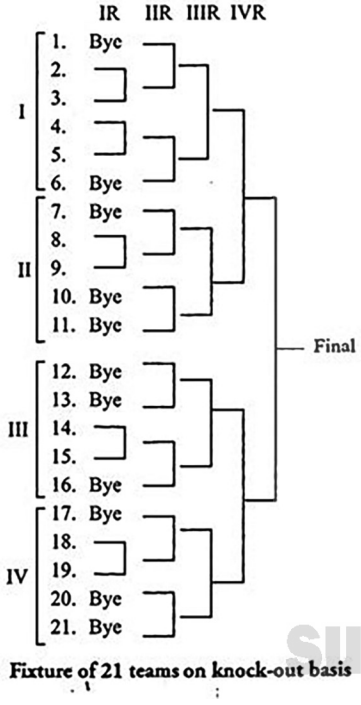
(a) **Knockout-cum-knockout:** All teams here get divided into four distinct zones. Every zone organises knockout tournaments. Then, the winners of all zones play on a knockout basis till a winner is established.

(b) **League-cum-league:** Here also, while the teams are divided into zones across a geographical area, they play in their zones on a league basis. Since one team from each zone is declared a winner, the four teams meet each other in the final round where they follow the league method to find out the national winner.

(c) **Knockout-cum-league:** Once the teams are divided into four groups or zones, they play the first round using the knockout method. Once the zonal winners are decided, the zonal winners play each other using a league basis and ultimately the winner is decided.

(d) **League-cum-knockout:** The initial games between the four zones are played on a league basis to decide the zonal winner. Once the four zones find their respective winners, they enter the next round at the national level and compete on a knockout basis to decide the winner.

**D.** 1. This is the commonest format for most tournaments as a large number of teams can take part in a relatively short time. Here, all contestants get eliminated one by one till only the winner is left. Once defeated, the team or the individual does not get a second chance. Tennis, badminton and basketball tournaments are organised on a knockout basis.



Fixture of 21 teams on knock-out basis

2. A league or round robin tournament is a competition in which each contestant meets all other contestants. This is also called the Berger system, named after the person who first proposed it. A league tournament contrasts with an elimination tournament in which participants are eliminated after a certain number of losses.

There are two types of league tournaments:

(a) **Single League Tournament:** Here, each team plays the other team at least once. A set formula that helps determine the number of games being played.

(b) **Double League Tournament:** Here, every team plays the other teams twice.

Advantages of League Tournaments include:

(i) Every team has an opportunity to play against every other team at least once.

(ii) Since each team gets to play multiple matches, the players have a great opportunity to showcase their talent.

(iii) The overall best team has the highest chance of winning the tournament.

(iv) Participants have an opportunity to improve their skills as they can be spectators at many other games.

(v) It is easier to correctly rank the teams in the order of sustained performances.

(vi) Everyone maintains enthusiasm and skill sets till the end of the tournament.

(vii) Spectators get an opportunity to watch their stars in action many times over a short period of time.

Disadvantages of League Tournaments are:

(i) These are time-consuming as a large number of games are played.

(ii) A lot of organisational skills are needed to organise these tournaments.

(iii) Such tournaments tend to cost more money to the organisers.

(iv) Large-scale facilities for accommodation, food, transport and other logistics are necessary.

(v) Teams that repeatedly display poor performance tend to suffer from low morale.

3. A tournament is a sports competition in which players who win a match continue to play further matches in the competition until just one person or team is left.

**Fixture of 9 teams**
**Staircase Method** Total teams = 9

Number of matches = $\frac{9(9-1)}{2} = \frac{9 \times 8}{2} = \frac{72}{2} = 36$ matches

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1-2 | | | | | | | |
| 1-3 | 2-3 | | | | | | |
| 1-4 | 2-4 | 3-4 | | | | | |
| 1-5 | 2-5 | 3-5 | 4-5 | | | | |
| 1-6 | 2-6 | 3-6 | 4-6 | 5-6 | | | |
| 1-7 | 2-7 | 3-7 | 4-7 | 5-7 | 6-7 | | |
| 1-8 | 2-8 | 3-8 | 4-8 | 5-8 | 6-8 | 7-8 | |
| 1-9 | 2-9 | 3-9 | 4-9 | 5-9 | 6-9 | 7-9 | 8-9 |

4. (a) **Organising Committee:** Headed by a Chairman who has the overall responsibility of organising, running and wrapping up the event.

(b) **Finance Committee:** The finance committee takes care of the budget plans and prevents wasteful expenditure.

(c) **Publicity Committee:** The dates, venues and timing of the events are brought to the notice of the people through media advertising, press meets and publicity through newspapers, hoardings, etc.

(d) **Technical Committee:** This ensures that the equipment, playing area, courts and grounds meet the required specifications.

(e) **Purchase Committee:** Sports equipment and other items that will be used in the event are acquired by this committee.

During-tournament Committees are set up during the tournaments. These include:

(a) **Reception Committee:** Welcoming the athletes on their arrival in the city or at the venue, and also welcoming the chief guests at the opening and closing ceremonies.

(b) **Transportation Committee:** Transporting the sportspersons and the attending staff to the venues and stadia on time.

(c) **Boarding and Lodging Committee:** This committee is responsible for boarding and lodging of the players, teams and officials.

(d) **Medical Committee:** This committee consists of qualified doctors and paramedical staff to attend to any medical exigencies.

(e) **Tournament Committee:** The task of receiving entries, drawing up fixtures and making arrangements for standard sporting facilities is handled by members of this committee.

(f) **Ceremonies Committee:** The opening and closing ceremony as well as arranging trophies, medals and certificates to be given are arranged by this committee.

(g) **Officials Committee:** This committee is responsible for the selection of various sports officials such as umpires, referees, record keepers, starters, track marshals and timekeepers.

(h) **Announcement Committee:** This committee sets up facilities for making announcements during the events.

5. No. of teams = 17

Total no. of matches = N – 1 = 17 – 1 = 16

No. of teams in upper half = $\frac{N+1}{2} = \frac{17+1}{2} = \frac{18}{2} = 9$

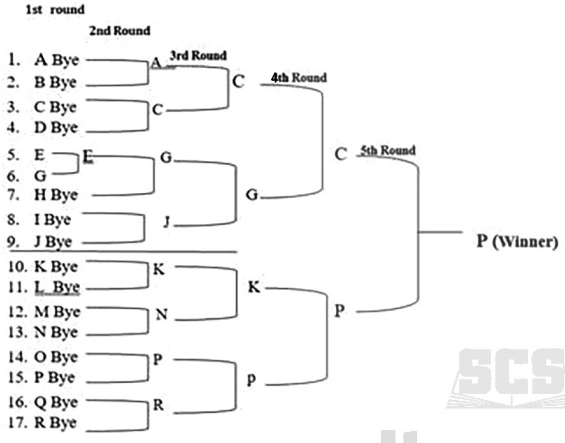
No. of teams in lower half = $\frac{N-1}{2} = \frac{17-1}{2} = \frac{16}{2} = 8$

Total no. of byes = 32 – 17 = 15 byes

No. of byes in upper half = $\frac{NB-1}{2} = \frac{15-1}{2} = \frac{14}{2} = 7$

No. of byes in lower half = $\frac{NB+1}{2} = \frac{15+1}{2} = \frac{16}{2} = 8$

Total rounds = 5




6. In the Staircase method, fixtures run according to a ladder. The teams are assigned a number each. These numbers are then arranged in a tabular form using vertical and horizontal columns. The number of columns is one less than the number of teams in the tournament. So, if seven teams are to take part, we draw six columns only and place the numbers as illustrated in the diagram below.

| | | | | | |
|---|---|---|---|---|---|
| 1 - 2 | | | | | |
| 1 - 3 | 2 - 3 | | | | |
| 1 - 4 | 2 - 4 | 3 - 4 | | | |
| 1 - 5 | 2 - 5 | 3 - 5 | 4 - 5 | | |
| 1 - 6 | 2 - 6 | 3 - 6 | 4 - 6 | 5 - 6 | |
| 1 - 7 | 2 - 7 | 3 - 7 | 4 - 7 | 5 - 7 | 6 - 7 |

$$\text{Total matches} = \frac{N(N-1)}{2} = \frac{7(7-1)}{2}$$

$$= \frac{7 \times 6}{2} = \frac{42}{2} = 21 \text{ matches}$$

7. Planning is an important function of management that helps develop a roadmap for the future—predefined steps to accomplish organisational goals. Errors of the past can be eliminated and resources available presently—both internal like people, time and cost, and external like policies and general business environment—help plan better. One of the primary objectives of planning is to improve the efficiency of sports officials in conducting sporting events/competitions. Sports officials become more efficient and perform their duties more effectively and efficiently with the help of proper planning.

Planning also helps to keep control over all activities which suggests that planning & control are connected with each other. It also helps in keeping a good control in organising a tournament. With proper planning, tasks can be performed effectively. It also will reduce unnecessary pressure. Planning also facilitates coordination among various members of committees and helps reduce mistakes to a minimum. Planning helps officials to do their assigned work more efficiently and effectively as well as enhances creativity, and enhances the performance of officials, sportsmen, etc. who are engaged in tournaments or any kind of activity. Proper planning ensures that all work is done in a controlled manner as well as improving the quality of work.

8. In extramural tournaments, outside schools participate as schools now tend to encourage friendly competitions amongst each other in order to assess their strengths and weaknesses as well as foster talent. Extramurals are also called inter-school competitions. Today, these are organised at regional and national levels in India by bodies such as the School Games Federation of India, CBSE as well as various inter-university boards. Extramural competitions are scheduled much in advance so that all possible teams can participate.

   Advantages of Extramural Tournaments:

   (a) Such tournaments allow students to share their skills and knowledge with each other. Continuous participation leads to gaining experience.

   (b) Extramural competitions encourage sportsmanship as well as a feeling of fraternity and brotherhood.

   (c) Motivation from participating schools encourages the not-so-active schools and this can set off a chain reaction leading to all schools in that area or locality becoming active.

   (d) A major objective of extramural tournaments is allowing participants to learn new rules and regulations of the games and sports.

   (e) Extramural competitions are a perfect opportunity for schools to showcase their talent. The disadvantage of extramural competitions is that only a selective number of players participate in these events. Some potential players miss the chance to showcase their talent as only a limited number of slots are available. Also, extramural tournaments tend to be time consuming because of travel and may interfere with the academic schedules.

CHAPTER 2

# Children & Women in Sports

**B.** 1. For children, sports offer a myriad of benefits. Participating in team sports teaches them the importance of cooperation, communication and teamwork. They learn to set goals, manage their time effectively and develop discipline. Sports provide an outlet for their boundless energy, promoting physical fitness and reducing the risk of obesity and related health issues. Moreover, sports help children develop social skills, build friendships and learn to cope with success and failure, preparing them for the challenges they may face in life.

2. Female athlete triad was recognised as three separated but interrelated entities — eating disorders/low energy availability, menstrual disturbance/amenorrhoea and bone mass loss/osteoporosis.

   Female athlete triad is most common in sports that have subjective scoring based on the athlete's performance, endurance sports, sports that lay stress on low body weight and which require the athlete to wear revealing or skintight clothes. These conditions often manifest clinically as disordered eating behaviour, menstrual irregularity and stress fractures. An individual may suffer from one or two or all of the triad components simultaneously.

3. Bowlegs is a condition in which knees stay apart too much when the person is standing with feet together. This deformity is also visible from a distance when the person walks or runs. It can be seen in certain diseases like Blount's Disease and Paget's Disease and after bone injuries, but it is the commonest in deficiency diseases such as rickets. Bow legs do not typically cause any pain. During adolescence, however, persistent bowing can lead to discomfort in the hips, knees and ankles because of the abnormal stress that the curved legs cause on these joints.

4. Osteoporosis is weakening of the bones due to loss of bone density and improper bone formation. This condition can lead to stress fractures and other injuries, which can end an athlete's career. Usually, teen years are a time when girls build up their bone mass to their highest levels—called peak bone mass. Not getting enough calcium can also have a lasting effect on how strong a woman's bones are later in life.

5. This is when the normal curvature of the feet is missing and the feet fall fully flat on the ground. Our feet support the whole weight-bearing process while standing, running or jumping. When the arch is lost, weight distribution becomes altered and causes premature tiring of feet. This, in turn, leads to strain on knees, hip and spine. To find out if one has flat foot, just wet the feet and take an imprint on dry floor. One can see if the arch exists or not. Flat feet need treatment only if they cause discomfort, indicate an underlying disorder or lead to pain elsewhere in the body.

6. It is an eating disorder characterised by an abnormally low body weight, intense fear of gaining weight and a distorted perception of weight. Sufferers of this condition focus on controlling their weight and shape mostly by taking extreme steps that tend to significantly interfere with their lives.

7. Depending on the curve the spine deforms into, deformities are of three main types—Lordosis, Kyphosis and Scoliosis. Lordosis is defined as "an abnormal curvature of spine at the front". Here, the hips tend to stand out and the front of the pelvis tilts forward. Gait is peculiarly stiff and standing and walking is tiring and energy-sapping. When the spine, especially the thoracic (middle) spine, has an outward curve it is called Kyphosis. A sideways curve in the spine is called Scoliosis.

8. Postural deformities most often are a result of problems with either the spine or the limbs. The deformities from the spine are kyphosis, lordosis and scoliosis. The deformities originating from the limbs include flat foot, knock knees, bowlegs and rounded shoulders.

9. The advantages of a good posture include increased confidence as correcting the posture can impact the way you feel about yourself. Poor posture can negatively affect energy levels. Increased self-esteem leads to a better mood, easier breathing, reduced risk of injury and a significant boost in productivity. Good posture decreases the stress on the ligaments holding the joints of the spine

together and so prevents the spine from becoming fixed in abnormal positions. Good posture prevents fatigue because muscles are used more efficiently thus preventing backache and muscular pain.

10. Although scoliosis is tough to treat with corrective exercises, there are some that help in reducing discomfort. Braces used while working may prove helpful. Exercise and physical rehabilitation are important to give some relief and prevent further deterioration. Slow cardio exercises are known to benefit in scoliosis. Corrective exercises include hanging from a horizontal bar as long as possible, bending in the direction of the curve. It is also suggested to lie on rolled towels, one under your neck and the other under the lower back.
11. Menarche is the beginning of menstrual periods in females while amenorrhoea is the cessation of the menstrual periods.
12. Females usually try to lose weight as a way to improve their athletic performance. Eating disorder can range from not taking enough calories to keep up with energy demands to avoid certain types of food the athlete thinks are "bad" (such as foods containing fat) or serious eating disorders like Anorexia nervosa which is characterised by an abnormally low body weight, intense fear of gaining weight and a distorted perception of weight and body image. Bulimia nervosa which is an eating disorder characterised by bingeing or overeating, followed by purging, often either by vomiting or using laxatives.
13. A side-to-side curve in the spine is called scoliosis. Some helpful remedies for scoliosis can be the Braces used while working may prove helpful. Exercise and physical rehabilitation are important to give some relief and prevent further deterioration. Slow cardio exercises are known to benefit in scoliosis. It is also suggested that hanging from a horizontal bar as long as possible, bending in the direction of your curve, is relieving. It is helpful to lie on rolled towels, placed under the neck as well as under the lower back. Standing and stretching arms out to the sides with the palms of the hands facing outward is also helpful.
14. Postural deformities most often are a result of problems with either the spine or the limbs. Prevention is possible if early care is taken. For example, to prevent knock knees, taking care of the nutritional needs of a growing child, ensuring adequate calcium and vitamin D in diet, and exposure to sunlight are essential. Exercises suggested to improve flat foot include walking barefoot on uneven ground or wet sand. Similarly, for rounded shoulders, proper postures, adequate and proper exercise including shoulder rotation exercises, pull-up on horizontal bars and Yogasanas such as Chakrasana and Dhanurasana can be helpful in the prevention of postural deformities.

**C.** 1. Lordosis is defined as an abnormal curvature of spine at the front. Here, the hips tend to stand out and the front of the pelvis tilts forward. Gait is peculiarly stiff and standing and walking is tiring and energy-sapping. Besides poor diet, obesity and diseases of the vertebrae and muscles of the spine are some major causes. Lack of physical activity and having a protuberant abdomen contribute as well. Persistent lordosis causes awkward posture and is also responsible for chronic backaches.

Causes of lordosis include:

- Bad posture in early childhood—a readily correctible cause of lordosis.
- Bone-weakening diseases
- Lax abdominal muscles
- Obesity and lack of muscle tone

Corrective measures include exercises that focus on stretching the lower part of paraspinal muscles as well as the abdominal muscles. Paying attention to nutrition intake is important. Breathing exercises to strengthen the abdominal muscles are vital. Yogasanas, particularly Halasana, is suggested. Toe-touching exercises also help. Abdominal muscles strengthening exercises and sitting pelvic tilts on an exercise ball are also beneficial.

2. Menarche is the onset of menstrual bleeding in the young females. Most girls start to menstruate between the ages of 10 and 15 years. The average age is 12, but every girl's body has its own schedule. Although there's no fixed age for a girl to get her period, there are some clues that menstruation will start soon. This heralds the onset of puberty in females. The female reproductive system is sensitive to stress—physical and physiological. Some sports like gymnastics and ballet tend to delay menarche.

   Amenorrhea is defined as no menstruation for more than 3 months, despite normal secondary sexual development. Secondary amenorrhoea is the loss of menses after menarche. It can be caused both by anatomical and endocrinal dysfunction. The type of amenorrhoea resulting from changes in energy availability is Functional Hypothalamic Amenorrhoea (FHA). It is common in female athletes.

3. Bulimia is an eating disorder characterised by bingeing or overeating, followed by purging, often either by vomiting or using laxatives. Thus, it involves episodes of bingeing on food, followed by purging, to compensate for overeating. Causes of Bulimia are not really known. But genetics, biological factors, long-term dieting and psychological issues increase the risk. Binge-eating disorder is more common in women than in men. Although people of any age can have binge-eating disorder, it often begins in the late teens or early 20s. Symptoms of bulimia may not be so obvious. A person with bulimia nervosa is most likely of normal weight or slightly overweight. Behavioural symptoms of bulimia include an obsession with eating, compulsive exercising and constantly complaining about being overweight. Physical signs include severe dehydration, poor health, changing body weight and irregular menstruation.

4. This is a condition in which the shoulders become rounded and appear bent forward. Rounded shoulders are an unnatural posture characterised by an exaggerated curvature of the upper back, often a forward positioning of the head where the shoulder girdle is protracted and a thoracic kyphosis. Over time, this postural adaptation causes the muscles and fascia to get shorter in the front of the chest. Round shoulders can be usually corrected with exercises. Simple exercises, like the bench press, are useful. Active downwards shrugging of the shoulders also helps. A series of exercises called 'Bruegger's Postural exercise' is beneficial for correcting rounded shoulders. Lifting up a horizontal bar for a long time is also a corrective measure.

5. Most girls lose weight as a way to improve their athletic performance. Eating disorder can range from not taking enough calories to keeping up with energy demands to avoid certain types of food the athlete thinks are "bad" (such as foods containing fat) to serious eating disorders like anorexia nervosa or bulimia nervosa. As a result, they develop brittle hair or nails, dental cavities and become very sensitive to cold. One can also notice a low heart rate, blood pressure, heart irregularities and chest pain. Bulimia is an eating disorder characterized by bingeing or overeating, followed by purging, often either by vomiting or using laxatives. Anorexia is characterised by a total loss of appetite, leading to abnormally low body weight, intense fear of gaining weight and a distorted perception of weight and body image.

6. Bad posture can occur by things like the day-to-day effects of gravity on our bodies. Bad posture may also occur due to an injury, an illness or because of genetics. A combination of these factors is also quite common. After an injury, muscles can limit movements and cause pain. When certain muscle groups are weak or tense, your posture can be affected. Muscle weakness or tension can develop when you hold a prolonged position every day or when you do routine tasks and chores in a way that places tension on your muscles or use them unequally. The use of technology, like sitting at a computer all day or using a tablet or cell phone, will slowly take the body out of alignment. Stress may contribute to shallow breathing or overly-contracted muscles, which cause body posture. Clothing, especially shoes, can affect posture. High heels throw the body weight forward, which can easily lead to postural misalignment.

7. The biggest challenge in treating anorexia, since it also comes under the category of mental well-being, is helping the person recognise and accept that they have an illness. Many people with anorexia deny that they have an eating disorder. They often seek medical treatment only when their condition becomes serious or life-threatening, Thus, it is important to diagnose and treat anorexia in

its initial stages. Treatments include stabilising weight loss, starting nutrition rehabilitation to restore weight, eliminating binge eating and/or purging behaviours and other problematic eating patterns. Treating psychological issues such as low self-esteem and distorted thinking patterns and developing long-term behavioural changes are important too. Treatment options will vary, depending on the individual's needs. A person may receive treatment through residential care or hospitalisation, depending on their medical and mental health state. Treatment for anorexia most often involves a combination of psychotherapy, medication, nutrition counselling, group and family therapy, and in extreme cases, hospitalisation.

8. Osteoporosis is the weakening of bones due to loss of bone density and improper bone formation. This condition can lead to stress fractures and other injuries. Factors leading to osteoporosis include age, race, sex, family history and body frame size. As we grow older, bones become osteoporotic. White people, Asians and mostly women are at higher risk. Smaller body frames are also prone to osteoporosis. Lowering of estrogen in females and testosterone in males makes them prone to osteoporosis. Excess of thyroid hormone and parathormone also leads to osteoporosis. Amongst dietary factors, lower intake of calcium, eating disorders that restrict food intake as well as surgery of the gastrointestinal tract contribute to osteoporosis. Medications such as steroids and drugs used in the treatment of cancer, acidity and seizures, and medical conditions like lupus, celiac diseases, kidney or liver diseases and certain types of cancers predispose one to osteoporosis. A sedentary lifestyle, smoking and excessive alcohol consumption also lead to osteoporosis.
9. Menstrual function ranges from eumenorrhoea (normal menstruation) to amenorrhoea (no menstruation for more than 3 months). To maintain eumenorrhoea, females need to consume approximately 45kcal/kg Fat-free Mass (FFM) per day. Oligomenorrhoea is described as menstrual cycle lasting more than 35 days and can occur in females consuming less than 30kcal/kg FFM. Amenorrhoea is described as menstrual cycle lasting more than 90 days. Amenorrhoea can be primary or secondary. Primary amenorrhoea refers to delay in the age of menarche (no menses till the age of 15 despite normal secondary sexual development). Secondary amenorrhoea is the loss of menses after menarche. It can be caused both by anatomical and endocrinal dysfunction.

   The type of amenorrhoea resulting from changes in energy availability is Functional Hypothalamic Amenorrhoea (FHA). It is common in female athletes.
10. Exercising a lot and not eating enough calories can cause problems like a decrease in the hormones (such as estrogen) that help control a girl's monthly cycle. Low estrogen levels, poor nutrition and not enough calcium or vitamin D in the diet cause bone mass loss. Women with the triad also have a decreased immune function and impaired skeletal muscle oxidative metabolism. Many athletes with low bone density and/or menstrual irregularity suffer from stress fractures. The first step in the prevention of female athlete triad is educating athletes, coaches, trainers and parents. Athletes should be educated about basic nutrition concepts, burn out and overtraining, rest and recovery, healthy weight management, energy levels and bone health. Female athletes, especially those who play sports that prefer lean bodies, such as dancing, gymnastics, cheerleading, figure skating, distance running and rowing are more likely to have the triad. Other things that make someone more likely to have the triad include focusing on one sport at a young age. When the athlete suffers from exhaustion, lack of muscle mass, diminished energy and repeated injuries because of poor muscle and bone mass sports, performance will surely suffer.
11. Exercise, in the form of sports participation, works on bones much like it works on muscles—it makes them stronger. Exercise is important for building strong bones when we are younger and it is essential for maintaining bone strength when we are older. Because bones are living tissues, they change over time in response to the forces placed upon them. Exercising regularly lets bones adapt by making them denser. This improvement in bones require good nutrition, including adequate calcium and Vitamin D and, of course, regular participation in sports and exercising to improve balance and coordination. Vitamin D, calcium and hormones play vital roles in ensuring optimal bone health. When there is an imbalance between exercise and nutrition, as seen in the female athlete triad, bone health is compromised and can lead to bone stress injuries and early osteoporosis. Both of

these can lead to morbidity and lesser time for training and competition. Thus, sports and exercising play a vital role in improving bone health in women.

12. The psychological benefits for women that play sports are:
    - Playing sports improves mood. The release of endorphins lowers stress and reduces anxiety levels.
    - Exercise boosts brain power and help prevent cognitive degeneration. In people with dementia, exercise improves cognitive function and has a positive effect on the brain.
    - A positive relationship exists between athletics and body esteem. Women who participate in sports are better at organising and time management, skills that are essential for success in life.
    - Female athletes become less obsessed about their looks. Also, women find participation in sports a way to break gender stereotypes.
    - Sports and physical activity are linked to a decreased likelihood of symptoms related to stress and depression. Women who participate in sports are less likely to be suicidal than women who don't.
13. Women that indulge in sports develop leadership skills due to various reasons. Playing sports enhances team-building skills because of the bonding and communication in the team environment. Playing sports develops the ability to work in a team, which is an essential leadership skill called Teamwork. It further helps motivate participants to do their part, assisting the team to reach its ultimate goal. Teamwork also involves delegation of tasks, which is what successful leaders do every day. Communication skills are vital for leaders to motivate, recognise and appreciate the great work of their departments and teams. On an individual level, sports can give participants self-discipline and understanding. Self-discipline from sports can teach players what they need to practice, whether it is perfecting a softball batting stance or getting more endurance to run up and down the soccer field. Sports brings different challenges to each of the participants but can also allow them to recognise the challenge at hand, their contributions to the team and make necessary individual improvements. Same is true in the workplace. Lastly, sports teaches effective communication with team members and other teams too.

**D.** 1. (a) Lordosis is an abnormal curvature of the spine at the front. Poor diet, obesity and diseases of the vertebrae muscles of the spine cause this. Other causes of lordosis include a bad posture in early childhood, bone-weakening diseases, lax abdominal muscles, obesity and lack of muscle tone.

(b) Bowlegs, a postural deformity, is visible from afar when the person walks or runs. It can be seen in certain diseases and after bony injuries, but is the commonest in deficiency diseases such as rickets. It is caused due to…?

(c) Rounded shoulders is a postural deformity which, besides being hereditary, is made worse by sitting on improperly designed furniture, wearing very tight clothes and poor sleeping postures. Rounded shoulders are also caused by poor postures, muscle imbalances and stressing on certain exercises, such as too much focus on chest strength while neglecting the upper back. Lack of adequate and proper exercise also leads to rounded shoulders.

(d) Knock knees may be a sign of an underlying bone disease, such as osteomalacia or rickets. Obesity can contribute to knock knees. The condition can occasionally result from an injury to the growing end of the leg bone, which may result in just one knocked knee. Knock knees can also develop in young children that are forced to labour by lifting very heavy weights; due to this, the alignment of their legs gets altered. Asking very young children to walk and run also leads to altered knee shape and knock knees.

(e) Kyphosis of the spine is caused by spine infections, bone diseases such as rickets and osteomalacia. Besides, lack of muscles accompanied by lifting heavy loads and injuries causing spinal collapse can also lead to Kyphosis.

2. Scoliosis is the side-to-side curve in the spine. The causes of scoliosis, depending on age of appearance, are classified as:
   - Congenital: A form of scoliosis present at birth
   - Infantile: Scoliosis that occurs in 0-3 years olds
   - Juvenile: Scoliosis that occurs in 4-10 years olds
   - Adolescent: Scoliosis that occurs in 11-18 years olds
   - Adult: Adult scoliosis may be idiopathic or degenerative in cause

   Most people respond well to a series of supervised exercises to correct the curve by strengthening the muscles around the spine. Surgery is rarely needed. Preventive steps include good diet, correct posture while sitting or standing and being conscious of the need to self-correct the posture while awake. Braces used while working may prove helpful. Exercise and physical rehabilitation are important to give some relief and prevent further deterioration. Slow cardio exercises are known to benefit in Scoliosis. Hanging from a horizontal bar as long as possible, bending in the direction of the curve can be helpful. An exercise that is beneficial is to lie on rolled towels, one under your neck and the other under the lower back to permit spinal molding. Lastly, standing and stretching arms out to your sides with the palms of your hands facing outward is also relieving in scoliosis.
3. The triad was recognised as three separated but interrelated entities: eating disorders/low energy availability, menstrual disturbance/amenorrhoea and bone mass loss/osteoporosis. Menstrual dysfunction is especially focused on amenorrhoea (no menstruation for more than 3 months). Amenorrhoea can be primary or secondary.

   **Low energy availability:** Energy availability is the amount of dietary energy for all physiological functions after accounting for energy expenditure from exercise. There is a wide range of disordered eating among athletes that ranges from simple dieting to clinically defined eating disorders such as anorexia nervosa, bulimia nervosa and eating disorders not otherwise specified.

   **Low bone density:** Bone loss usually occurs later with menopause and ageing; in young female athletes with triad, a compromise on bone strength, including bone mineral density, may occur at a much younger age.

   Owing to the complex nature of the triad, treatment is challenging and requires a multidisciplinary approach. Team members often include a physician, psychologist or psychiatrist, nutritionist or dietician, physical therapist, athletic trainer, coach and most importantly, family members. Treatment of triad includes adequate calorie consumption to restore a positive energy balance; this is often the first step in the successful management of triad. In addition, determining the cause of Menstrual Dysfunction (MD) and resumption of menses is very important.

   The first step in the prevention of female athlete triad is educating athletes, coaches, trainers and parents. Athletes should be educated about basic nutrition concepts, burn out and overtraining, rest and recovery, healthy weight management, energy levels and bone health. They should be encouraged to eat a nutrient-rich and well-balanced diet, exercise in moderation, get plenty of rest and find ways to reduce stress. And lastly, medication under medical supervision is important.
4. Lordosis is one of the three deformities of spinal curvature. Corrective measures include exercises that focus on stretching the lower part of paraspinal muscles as well as the abdominal muscles. Paying attention to nutrition intake is important. Breathing exercises to strengthen the abdominal muscles are vital. Yogasanas, particularly the Halasana, is suggested. Toe-touching exercises also help. Abdominal muscles play an important role in maintaining our posture, so there is a need to do abdominal muscle-strengthening exercises that help in strengthening the spine and reducing the inward curve.

   Kyphosis is the second spinal curvature deformity. Correction is done by exercises such as:

   (a) **Head Retraction:** This exercise is done lying on the floor and is great for the muscles of the neck that are often stretched out and weak. Pull your chin back towards the floor as if you are trying to make a double chin and hold it there for 15 seconds. Repeating this for 5 to 10 times can prove beneficial.

(b) **Thoracic Spine Foam Rolling:**

Lie on the floor with a foam roller under you, across your mid-back. Gently roll up and down on the foam roller, massaging the muscles of your back and thoracic spine. You can try this with your arms extended over your head in the extension position described above. Do this for at least 30 seconds to 1 minute.

(c) **Yoga:** Kyphosis can be corrected by practising the Bhujangasana (Cobra Pose) and the Adho Mukha Svanasana.

Scoliosis is the third spinal deformity. It is much tougher to treat with corrective exercises. Braces used while working may prove helpful. Exercise and physical rehabilitation are important to give some relief and prevent further deterioration. Slow cardio exercises are known to benefit in scoliosis. Hang from a horizontal bar as long as possible while bending in the direction of your curve is beneficial. Also helpful is to lie on rolled towels, one under your neck and the other under the lower back (spinal molding). Static chest stretch is also recommended—stand and stretch arms out to your sides with the palms of your hands facing outward.

5. Besides being hereditary, it is made worse by sitting on improperly designed furniture, wearing very tight clothes and poor sleeping postures. Round shoulders are also caused by poor postures, muscle imbalances and stressing on certain exercises, such as too much focus on chest strength while neglecting the upper back. Lack of adequate and proper exercise also leads to rounded shoulders. Remedies include shoulder rotation exercises, pull-up on horizontal bars and Yogaasanas such as the Chakrasana and the Dhanurasana. Round shoulders can be quite often corrected with exercises. Simple exercises, like the bench press, are useful. Active downwards shrugging of the shoulders also helps.

   A series of exercises called 'Bruegger's Postural exercise' is beneficial for correcting rounded shoulders. Lifting up a horizontal bar for a long time is also a corrective measure.

6. Angular deformities of the knee are common during childhood and are usually variations in the normal growth pattern. Angular deformity of the knee is a part of normal growth and development during early childhood. Physiologic angular deformities vary with age. There are two main types of knee joint deformities—**knock knees** where the knees touch each other even while standing and **bowlegs** where the knees are far apart while standing even. Both these can be crippling, if not attended to. In severe cases, there is severe pain, even when not bearing weight. The knee buckles, clicks or locks and the deformed or misshapen knee and leg can cause crippling. Since the person cannot flex the knee and has trouble straightening it all the way out, gait is awkward and slow.

7. Knock knees is a condition in which the knees touch each other before the feet can close together in a fully erect posture. As a result, the knees strike each other. Individuals with severe deformities are not able to touch their feet together while simultaneously straightening the legs. Running and walking fast is impaired and stumbling is quite common. Knock knees are grounds for being medically unfit for many jobs, especially the army, and in participative sports. In early ages, knock knees are usually part of the normal growth and development of the lower extremities. In the course of developing normal alignment of their lower extremities, all young children have knock knees to some degree for a period of time. By the age of 7, only 1 per cent children have this gap.

   Some knock knees may be a sign of an underlying bone disease, such as osteomalacia or rickets. Obesity contributes to knock knees. The condition also results from an injury to the growing end of the leg bone, which may result in just one knocked knee. Knock knees can also develop in young children that are forced to lift very heavy weights. Asking very young children to walk and run also leads to altered knee shape and knock knees.

   Measures to prevent knock knees include taking care of the nutritional needs of the growing child, and ensuring adequate calcium and Vitamin D in diet and exposure to sunlight. Once knock knee is established, surgical correction may be warranted in later ages. Yoga recommends Padmasana and Gomukhasana regularly for knock knees. Knock knees can be prevented rather than corrected. Since this deformity is skeletal in origin, in most cases, correction is difficult with increasing age. Horse-riding is suggested as a good corrective exercise. Side leg raises and plank exercises are also helpful.

8. Adolescence is the age for exercising for a prolonged period of time. Competitive athletes and winners of championship events are produced at this age. This is the age to improve muscle strength, bulk, flexibility and endurance. Running, gymnastics, weightlifting, push-ups, hockey, football, tennis and squash are desirable and must be promoted at this age. The spirit of winning, competitiveness and aiming for gold is inculcated in this age group. A combination of aerobic, anaerobic and resistance exercises is enforced for higher performance.
9. Exercise has to be age-appropriate if it has to lead to development and prevent damage. Exercise is important at all ages and the intensity and duration should be tailored to the stage of growth and development. Although infants have little control over their muscles, they still enjoy the feeling of their limbs flexing, extending, twisting and moving through space. At the age of one month, parents can begin exercising their newborn. Exercises designed to develop head control, crawling and sitting up should be encouraged by the family. The infant should be encouraged to handle soft toys and objects. Carrying the infant in laps or putting them in high chairs or walkers should be avoided as these delay motor development as well as balance and coordination. Avoiding exposure to electronic media is also key.
10. Early Childhood is the age for rapid development of motor and sensory skills. Daily physical activity is necessary for building strong bones and muscles as well as strengthening the heart and lungs. Exercise also helps improve gross motor skills such as running, kicking, throwing and swinging. As a result of promoting healthy growth and development, physical activity helps achieve and maintain a healthy weight besides building strong bones and muscles. Mental development also occurs.

    This is an age to participate and not compete. It is recommended that the child spends at least an hour daily being physically active. The aim should be to increase muscle strength as per body weight and height. At this age, the activity should be enjoyable and fun. Allowing for experimentation and exploration will strengthen mental development.

CHAPTER 3

# Yoga as Preventive Measure for Lifestyle Diseases

**B.** 1. Health benefits of performing Vajrasana include:

- Good for our digestive system
- Relieves low back pain
- Keeps blood sugar levels under control
- Relieves rheumatic pain
- Strengthens pelvic floor muscles
- Helps calm our mind
- Treatment of high blood pressure
- Improves sleep

2. The three asanas known to prevent obesity include Tadasana, Katichakrasana and Pawanmuktasana.

   To do Tadasana, stand erect and place legs slightly apart, with hands hanging alongside your body. Make thigh muscles firm. Strengthen the inner arches of your inner ankles as you lift them. Elongate the tailbone such that it is towards the floor. Lift the pubis such that it is closer to the navel. Look slightly upward and breathe in and stretch your shoulders, arms and chest upwards. Raise your heels, making sure your body weight is on your toes.

3. Bhujangasana is a gentle backbend, practised in a face-down position that warms and strengthens the spine while opening the chest. Bhujangasana is also referred to as the cobra pose.

   **Benefits:**

   - Stretches muscles in the shoulders, chest and abdomen
   - Decreases stiffness in the lower back
   - Strengthens arms and shoulders
   - Increases flexibility
   - Improves menstrual irregularities
   - Elevates mood
   - Firms and tones up the buttocks
   - Invigorates the heart

   It is one of the best asanas to increase height naturally because it strengthens the back and increases flexibility of the spine.

4. Obesity is defined as the state of being extremely fat or overweight. While there are many ways to define obesity scientifically, the most compact term, especially in the Indian context, is the fat percentage in an adult. In an adult male, if the total body fat percentage is greater than 30% and in an adult female, if it is over 35%, the person is considered obese irrespective of body weight. The simplest method for assessing obesity is Body Mass Index (BMI). BMI is calculated by taking into consideration a person's height and weight, although many other factors such as lifestyle are ignored. A BMI of 25 or less is considered as not obese, while a higher range might indicate obesity. Nevertheless, it is essential to consult a professional healthcare provider to know for sure.

5. Diabetes today is the biggest silent killer in the world besides high blood pressure. It occurs because body cells fail to utilise sugar from food resulting in increased sugar levels in the blood. Data from several studies suggest that Yoga can reduce stress-related hyperglycemia and have a positive effect on blood glucose control.

   Many asanas help in alleviating diabetes. These include Katichakrasana, Pawanmuktasana, Bhujangasana, Shalabhasana, Dhanurasana, Supta-Vajarasana, Paschimottanasana, Ardha-Matsyendrasana, Mandukasana, Gomukhasana, Yogmudra, Ushtrasana and Kapalbhati. Yoga practices such as cleansing processes, asanas, pranayama, mudras, bandha, meditation, mindfulness and relaxation are known to reduce blood glucose levels.

6. Sit in a cross-legged posture. Bring right foot on top of the left thigh and slide it as close to the left hip as possible. Bring left ankle by the side of the right hip. Make sure that one knee is over the other. Slide both feet far behind, keeping the spine straight and vertical and the head facing forward. Raise right arm and bring it over shoulder. Wrap left arm behind the back and reach to grasp left hand with the right hand behind the back, clasping the fingers together. Stay in the final pose for about 10-12 breaths.
7. Avoid doing Trikonasana if you are suffering from migraine, diarrhoea, low or high blood pressure, or neck and back injuries. Those with high blood pressure may do this pose without raising their hand overhead, which may further raise the blood pressure. Individuals having cervical spondylosis should not perform this asana.
8. This pose is used to tone the arms and legs and also stimulate the reproductive organs by massaging these areas. It helps improve the strength of these areas and promotes sexual health. The Pawanmuktasana benefits conditions of mental illness such as anxiety, insomnia and depression by relieving stress. It acts on the stress areas and relieves the tension.
9. This asana stretches the hips and
   - Provides power to ankles, thighs, shoulders, armpits, chest, deltoid and triceps
   - Relieves chronic knee pain
   - Strengthens the spine and abdominal muscles
   - Helps decompress lower spine (during folded variation)
   - Strengthens the hip joint
10. The purpose of Sitali pranayama is to reduce the body temperature, which in turn calms the mind and lowers stress levels. This pranayama gives control over hunger and thirst. It has a calming effect on the entire nervous system, especially stimulating the parasympathetic nervous system, which induces muscular relaxation and is very effective in stress management.

**C.** 1. Yoga has eight separate stages, namely:

- **Yama**—Restraints, moral disciplines or moral vows
- **Niyama**—Positive duties or observances
- **Asana**—Posture
- **Pranayama**—Breathing techniques
- **Pratyahara**—Sense of withdrawal
- **Dharana**—Focused concentration
- **Dhyana**—Meditative absorption
- **Samadhi**—Bliss or enlightenment

Asana is a Sanskrit word meaning "posture," "seat" or "place." Asanas are the physical positions we assume during a Hatha Yoga practice. Each pose has its own Sanskrit and English name. Asana practice is considered important since it helps to keep the physical body healthy. Asana postures help to increase flexibility and strength whilst stimulating physiological systems of the body, such as the circulatory, immune, digestive and nervous systems. Regular asana practice develops mindfulness, discipline and concentration, preparing the mind for pranayama and meditation. On a subtle level, asana can help to stimulate the energetic body, opening the Chakras and Nadis in order to allow Prana to flow freely.

2. The breath aspect of Yoga is known as pranayama in Sanskrit. "Prana" means life force, while "ayama" means stretching. Yoga uses the breath to calm the mind and the physical postures to focus on the breath. While there are many types of pranayama one of the prominent one is Suryabhedana Pranayama which is a warming pranayama or breath work focused on the right nostril.

To perform this, sit in a comfortable position with a straight spine and neck. Close your eyes to focus on the point between the eyebrows. Proceed to breathe for several counts deeply, allowing the air to fill the lungs deeply, expanding the abdomen on the inhale and contracting it on the exhale. Then, allow the left arm to relax by the side. Using the right hand, block the left nostril with the ring finger. Inhale slowly and deeply through the right nostril. Retain the breath for a few seconds. Open the left nostril and close the right nostril with the thumb, exhaling slowly. Repeat it for one to three minutes.

3. Obesity is defined as the state of being extremely fat or overweight. While there are many ways to define obesity scientifically, the most compact term, especially in the Indian context, is the fat percentage in an adult. In an adult male, if the total body fat percentage is greater than 30% and in adult female, if it is over 35%, the person is considered obese irrespective of body weight. Yoga helps in curbing obesity. The following yogasanas are of particular use: Tadasana, Katichakrasana, Pawanmuktasana, Matsayasana, Halasana, Paschimottansana, Ardha-Matsyendrasana, Dhanurasana, Ushtrasana and Suryabedhana Pranayama. There is enough research to support the fact that Yoga helps manage stress, improve mood, curb emotional eating and create a community of support, all of which can help with weight loss and maintenance. Yoga can also help burn calories and increase muscle mass and tone.
4. The beginning of yoga can be traced back to the Indus-Saraswati civilisation in northern India over 5,000 years ago. The word 'Yoga' was first mentioned in the oldest sacred text, the Rig Veda. The Vedas are a collection of texts containing hymns, mantras and rituals to be used by the priests. Classical Yoga is defined by Patanjali's Yoga-Sûtras, the first systematic presentation of Yoga. Written in the second century, this text describes the path of Raja Yoga, often called "classical Yoga". Patanjali organised the practice of Yoga into an eight-limbed path containing 8 steps. A few centuries after Patanjali, Yoga masters created a system of practices designed to rejuvenate the body and prolong life. They developed Tantric Yoga. In the 1920s and 1930s, Hatha Yoga was strongly promoted. Hatha Yoga now has many different schools or styles.
5. High blood pressure is a common condition in which the long-term force of blood against the artery walls eventually causes health problems such as heart disease.

   Tadasana or Mountain Pose is considered as the mother of all asanas from which all other asanas emerge. Most of the other standing poses are shifts in a certain part of your body or an individual joint that spring from Tadasana, while the other parts remain neutral. It is not mandatory to practice this asana on an empty stomach. But if you are preceding or following it up with other Yogasanas, it is best to take your meals at least four to six hours before you practise this asana. Also, make sure that your bowels are clear.

   Ardha Halasana is also known as the half–plough pose. In Sanskrit, 'ardha' means half and 'hala' means plough. The half–plough pose is a beginner-level posture and is often used as a warm-up Yoga pose for more intense yoga poses. Both are helpful in high blood pressure.
6. Anuloma Viloma pranayama, also known as Nadi-Shodhana pranayama, is a breathing technique that helps clear the blocked energy channels, thus calming the mind. This ensures the proper supply of oxygen and that carbon dioxide is effectively removed. So, more oxygen is made available per breath, making breathing most efficient. This helps in purifying the blood of toxins. It is very effective for stress management as well and helps in reducing anxiety, depression and other mental illnesses. Thus, it also reduces hyperactive disorders related to the mind. If discomfort is felt while doing this, it is vital to reduce the ratio of breathing. Under no circumstances should the proportion of breathing be forced. Those who have undergone abdominal, heart or brain surgeries should consult a medical expert before performing this pranayama.
7. Yoga helps with weight loss, blood circulation, increasing insulin sensitivity and reducing stress. Yoga can help patients maintain an optimal weight and combat insulin resistance. It is considered to be a cost-effective option in the treatment and prevention of diabetes. Several studies suggest that Yoga and other mind-body therapies can reduce stress-related hyperglycemia and have a positive effect on control. Certain asanas such as Ardha Matsyendrasana (half-twist pose) combined with Dhanurasana

(bow pose), Vakrasana (twisted pose), Matsyendrasana (half-spinal twist) and Halasana (plough pose) squeeze and compress the abdomen and help stimulate pancreatic secretions. Surya Namaskar is proven to be a helpful practice for diabetes patients. Using controlled breathing techniques, meditation, Yoga and other mindfulness-based programmes train participants to invoke a relaxation response. This response helps regulate cortisol and other stress hormones. Both play a big role in the development of type 2 diabetes and related complications.

8. Asthma is a condition in which the airways become narrow and swell and produce extra mucus. This can trigger coughing and wheezing, often accompanied with a shortness of breath. Adding regular Yoga practice to an asthma treatment plan strengthens the muscles, increases flexibility and builds a connection between the body and breath. Of the many asanas that help, some are Tadasana, Urdhwa Hastottanasana, Uttana-Mandukasana, Bhujangasana, Dhanurasana, Ushtrasana, Vakrasana, Kapalbhati, Gomukhasana, Matsyasana and Anuloma Viloma. Pranayama is a set of breathing exercises that reduces stress levels and improves lung function. One effective pranayama for asthma is Kapalbhati, which involves rapid exhales through the nose while keeping the inhales slow and deep.
9. Shavasana gets its name from the recumbent posture of a dead body. It is a position of rest and relaxation and is usually practiced towards the end of a Yoga session—a session that typically begins with activity and ends in rest; a space or pause when deep healing can take place. It is useful in hypertension as it relaxes and brings calmness to the whole body, leaving the person in a state of rejuvenation. This further helps reducing blood pressure, anxiety and insomnia. This is an excellent way to ground the body and reduce the Vata-dosha (imbalance of the air element) in the body.
10. Bhadrasana or the Gracious Pose is good for activating the Mooladhara chakra. In Sanskrit, 'bhadra' means auspicious and 'asana' means pose. Bhadrasana is mentioned as one of the asanas suitable for prolonged periods of sitting. Many Yoga texts call Bhadrasana the destroyer of diseases. It is also said that a Yogi can get rid of fatigue by sitting in this asana. Those who suffer from knee problems should avoid this asana. Do not practice Bhadrasana if suffering from any kind of knee or hip injuries. People with spinal disc herniation need to practice this asana with utmost caution. Start practising this asana mildly and then increase repetitions gradually as per your overall capacity. While Bhadrasana is contraindicated for people having sciatica, when practised on a moderate basis, it can help in relieving sciatic pain.
11. Bhujangasana is a gentle back-bend practise with a face-down position that warms and strengthens the spine while opening the chest. This term comes from the Sanskrit word 'bhujanga', meaning serpent or snake, and 'asana', meaning posture or seat. Bhujangasana is also referred to as Cobra Pose.

    Performing Bhujangasana leads to a decreased stiffness in the lower back as it stretches muscles in the shoulders, chest and abdomen. This further strengthens arms and shoulders and increases flexibility. In women, it helps in improving menstrual irregularities and elevating mood. It firms and tones up the buttocks, invigorates the heart and strengthens the back, increasing flexibility of the spine which leads to an increase in height.
12. Matsyendrasana, also known as the seated spinal twist or Lord of the Fishes pose, is a seated twisting pose that provides a gentle twist to the spine, stretches the muscles and stimulates the abdominal organs. To perform it:
    (a) Sit on the floor with your legs extended in front of you.
    (b) Bend your right knee and place your right foot on the outside of your left thigh.
    (c) Bend your left knee and place your left foot next to your right hip.
    (d) Inhale and lengthen your spine, and then exhale as you twist your torso to the right, placing your left hand on your right knee and your right hand on the floor behind you.
    (e) Keep your spine straight and gently twist further with each exhale while keeping your hips grounded.
    (f) Hold the pose for a few breaths and then repeat on the other side.

**D.** 1. Asanas should be practiced on an empty stomach. Wait 2 to 3 hours after a large meal bladder and make sure your bowels are empty before starting any asana. Practice sessions should start with a prayer or an invocation as it creates a conducive environment to relax the mind. During asana practice, breathing should be done through the nostrils only. Exhale while bending forward and inhale while moving backwards. After completing the practice of asanas, lie down in Shavasana for at least 10 to 15 minutes. Avoid certain asanas during the menstrual period. Asanas, or yoga postures, fundamentally act as a lubricating routine to the joints, muscles, ligaments and other parts of the body, increasing circulation and flexibility. Yoga postures initially focus on improving body flexibility. Yoga should not be performed in a state of exhaustion, illness, in a hurry or in acute stress conditions. Avoid showering, drinking water or eating food for 30 minutes after doing yoga. Yoga should not be followed with strenuous exercises. Avoid practicing yoga in adverse and extreme weather conditions.

2. This is one of the 12 basic postures of Hatha Yoga and is also a part of the Ashtanga primary series. Paschimottarasana is considered to be a calming posture for the mind and nervous system. It may also be therapeutic for anxiety and depression patients. Paschimottarasana is also known as the seated forward bend.

*Technique:*

(a) Sit with legs stretched out straight in front on the floor.

(b) Keep the spine erect and toes flexed towards you.

(c) Bring your respiration to normal.

(d) Breathing in, slowly raise both the arms straight above your head and stretch up.

*Benefits:*

- Calms the brain and helps relieve stress and mild depression
- Stretches the spine, shoulders and hamstrings
- Stimulates the liver, kidneys, ovaries and uterus
- Improves digestion
- Helps relieve the symptoms of menopause and menstrual discomfort
- Soothes headache and reduces anxiety and fatigue

*Contraindications:*

- Those suffering from lung disease or spinal problem should not practise this asana.
- Should be avoided by people with liver and spleen disease.

3. Asthma is a condition in which the airways become narrow and swell, producing extra mucus. This can make breathing difficult and trigger coughing, wheezing and shortness of breath. Of the many asanas that help, some are Tadasana, Urdhwa Hastottanasana, Uttana-Mandukasana, Bhujangasana, Dhanurasana, Ushtrasana, Vakrasana, Kapalbhati, Gomukhasana, Matsyasana and Anuloma Viloma.

Two most useful ones are described below:

Bhujangasana is a gentle back-bend practise with a face-down position that warms and strengthens the spine while opening the chest. Bhujangasana is also referred to as the cobra pose.

*Procedure:*

(a) To start the pose, lie on your stomach and place the forehead on the floor.

(b) You can have your feet together or hip-width apart.

(c) Keep the top of your feet pressing against the floor.

(d) Place hands underneath your shoulders, keeping your elbows close to your body. Rise upwards by placing your palms flat on the floor.

Dhanurasana has been named after the shape the body takes while performing it– that is of a bow. This asana results in a well-stretched body that helps keep you flexible with a good posture.

*Procedure*

(a) Lie on the stomach with feet apart, in line with hips and arms by the side of the body.

(b) Fold the knees, take hands backward and hold your ankles.

(c) Breathe in, and lift the chest off the ground. Pull the legs up and towards the back.

(d) Look straight ahead.

(e) Be stable while paying attention to your breath. The body is now curved and as taut as a bow. Continue to take long, deep breaths while relaxing. Bend only as far as the body permits. Do not overdo the stretch.

(f) After 15–20 seconds, while exhaling, gently bring the legs and chest to the ground. Release the ankles and relax.

4. Hypertension or high blood pressure is a common condition in which the long-term force of blood against the artery walls eventually causes health problems such as heart disease.

Vajrasana is a simple sitting yoga pose. Its name comes from the Sanskrit word 'vajra', which means thunderbolt or diamond.

*Benefits*

- Good for our digestive system
- Relieves low back pain
- Keeps blood sugar levels under control
- Relieves rheumatic pain
- Strengthens pelvic floor muscles
- Helps calm our mind
- Treats hypertension (high blood pressure)
- Improves sleep

*Contraindications*

- a knee problem or have recently undergone knee surgery
- a spinal cord condition, especially with the lower vertebrae
- intestinal ulcers, a hernia or any other intestinal problems

Ardhachakrasana or the Half-Wheel Pose is good for the flexibility of the back and neck. It strengthens the back muscles and tones the organs in the abdomen, improving their functions.

*Benefits:*

- strengthens the back and abdominal muscles
- tones the organs in the abdomen including the digestive, excretory and reproductive organs
- gives a good shape to the body. It is good for those who have back problems and postural defects
- opens the chest and strengthens the arms and shoulder muscles
- prepares beginners for the more difficult Full-Wheel Pose or the Chakrasana

*Contraindications:*

- Ardhachakrasana should not be practised by those suffering from any neck, hip or spinal injury
- Be cautious while doing this pose if you have vertigo
- Those suffering from high blood pressure should avoid this pose
- Pregnant women should avoid this asana

5. Yoga is widely accepted as a means of staying healthy and to overcome many afflictions. Yoga is a group of physical, mental and spiritual practices or disciplines which originated in ancient India. The origin of Yoga can be traced back to over 5,000 years. However, some researchers surmise that the practice of Yoga may be up to 10,000 years old.

   Pre-Classical Yoga can be traced back to the Indus-Saraswati civilisation in northern India over 5,000 years ago. The Classical period is defined by Patanjali's Yoga-Sûtras, the first systematic presentation of Yoga. Written in the second century, this text describes classical Yoga. Patanjali organised the practice of Yoga into an 'eight-limbed path' containing the steps and stages towards obtaining Samadhi or enlightenment.

   **Post-classical Yoga:** Yoga masters created a system of practices designed to rejuvenate the body and prolong life. They developed Tantric Yoga with radical techniques to cleanse the body and mind to untie the knots that bind us to our physical existence. This led to the creation of Hatha Yoga.

   **Modern Period:** In the late 1800s and early 1900s, Yoga masters began to travel to the West, attracting attention and followers. In the 1920s and 1930s, Hatha Yoga was strongly promoted. Hatha Yoga now has many different schools or styles, all emphasising various aspects of the practice. To the modern world, Yoga has assumed a position of great importance and we now celebrate 21st June as the International Yoga Day.

6. The first four stages of yoga are as follows:

   **Yama:** deals with restraints, moral disciplines or moral vows

   **Niyama:** stands for positive duties or observances

   **Asana:** deals with the posture to be adopted while practicing yoga

   **Pranayama:** deals with breathing techniques

   The word 'Yama' is often translated as restraint, moral discipline or moral vow. The Yamas traditionally guide us towards practices concerned with the world around us. There are five Yamas in total listed in Patanjali's Sutras: Ahimsa, Satya, Asteya, Brahmacharya and Aparigraha.

   The 'Niyama' are recommended habits for healthy living and spiritual existence. Patanjali lists a total of five Niyamas: Saucha, Santosha, Tapas, Svadhyaya and Isvara Pranidhana.

   'Asana' is a Sanskrit word meaning posture, seat or place. Asanas are the physical positions we assume during a Hatha Yoga practice. Each pose has its own Sanskrit and English name.

   Pranayama is the practice of breathing regulation. It is a main component of Yoga, an exercise for physical and mental wellness. In Sanskrit, "prana" means life energy and "yama" means control. The practice of pranayama involves breathing exercises and patterns. A pranayama cycle has three phases: Puraka or inhalation, Kumbhaka or retention and Rechaka or exhalation. Among the different pranayama are Bhramari Pranayama, Kapalbhati Pranayama, Bhastrika Pranayama, Nadi-Shodhana Pranayama, Sitali Pranayama, Ujjayi Pranayama, Anulom Vilom Pranayama and Sheetkari Pranayama.

7. Pranayama is the practice of breathing regulation. It is known as the fourth 'Anga' or limb of Yoga. It is a main component of Yoga, an exercise for physical and mental wellness. In Sanskrit, 'Prana' means life energy and 'Yama' means control. The practice of pranayama involves breathing exercises and patterns. A pranayama cycle has three phases: Puraka or inhalation, Kumbhaka or retention and Rechaka or exhalation. Among the different pranayama are Bhramari Pranayama, Kapalbhati Pranayama, Bhastrika Pranayama, Nadi-Shodhana-Pranayama, Sitali Pranayama, Ujjayi Pranayama, Anulom Vilom Pranayama and Sheetkari Pranayama. Pranayama practices have both slow and fast variations.

   Studies show that fast pranayama, in particular, can help improve auditory and sensory-motor skills. Practicing pranayama can help improve lung function. This includes helping you hold your breath longer and increasing strength in your respiratory muscles. Pranayama can increase mindfulness. Its meditative method of breath focus and awareness can aid your ability to live in the present moment. Pranayama's ability to improve mindfulness has also been found to lower stress and aggression.

Pranayama's focus on breathing and relaxation may alter the levels of stress molecules. Pranayama can significantly lower anxiety levels and any negative feelings associated with it. It can also improve areas of mental focus that are often affected by it such as awareness and attention. Bee Breath Pranayama and chanting may help reduce hypertension or high blood pressure. Some psychosomatic diseases include migraine headaches, ulcers and psoriasis. These can be cured by the practice of regular pranayama.

8. Ushtrasana, also known as the camel pose, is an intermediate level back-bending Yoga posture known to open Anahata (Heart chakra). It boosts shoulder flexibility, increases core strength and stretches the entire front of the body.

   *Procedure:*

   (a) Kneel on the Yoga mat and place the hands on the hips.

   (b) The knees should be in line with the shoulders and the sole of the feet should be facing the ceiling.

   (c) While inhaling, draw in the tail-bone towards the pubis as if being pulled from the navel.

   (d) Simultaneously, arch the back and slide the palms over the feet till the arms are straight.

   (e) Do not strain or flex the neck but keep it in a neutral position.

   (f) Stay in this posture for a couple of breaths.

   (g) Breathe out and slowly come back to the initial pose. Withdraw the hands and bring them back to the hips while straightening up.

   *Benefits:*

   - Stretches and opens the front of the body. It also strengthens the back and shoulders.
   - Relieves of lower backache
   - Improves flexibility of the spine and also improves posture
   - Helps overcome menstrual discomfort
   - Reduces fat on thighs
   - Stretching deep hip flexors
   - Stretches and strengthens the shoulders and back
   - Expands the abdominal region, improving digestion and elimination
   - Improves posture
   - Opens the chest muscler, improving respiration
   - Loosens up the vertebrae

9. Back pain is caused by spinal degeneration and injury. Conditions commonly linked to back pain include muscle or ligament strain. Repeated heavy lifting or a sudden awkward movement can strain back muscles and spinal ligaments. Many asanas recommended include Tadasana, Urdhwa Hastottanasana, Ardh-Chakrasana, Ushtrasana, Vakrasana, Matsyendrasana, Bhujangasana, Gomukhasana, Bhadrasana, Makarasana and Nadi-Shodhana Pranayama.

   Ardhachakrasana or the Half-Wheel Pose is good for the flexibility of the back and neck. It strengthens the back muscles and tones the organs in the abdomen, improving their functions.

   *Procedure:*

   (a) Stand straight and bring your hands together in a clasped position.

   (b) Raise and rotate your hands above the shoulders.

   (c) Slowly bend the upper part of your body along with the hands, as far as you can go.

   (d) Remain in this position for a few seconds or even up to a minute according to your capacity.

   (e) To release, return slowly to the standing position with your hands on the side.

Matsyendrasana, also known as the seated spinal twist or Lord of the Fishes pose, is a seated twisting pose that provides a gentle twist to the spine, stretches the muscles and stimulates the abdominal organs.

*Procedure*

(a) Sit on the floor with your legs extended in front of you.

(b) Bend your right knee and place your right foot on the outside of your left thigh.

(c) Bend your left knee and place your left foot next to your right hip.

(d) Inhale and lengthen your spine, and then exhale as you twist your torso to the right, placing your left hand on your right knee and your right hand on the floor behind you.

(e) Keep your spine straight and gently twist further with each exhale, while keeping your hips grounded.

(f) Hold the pose for a few breaths and then repeat on the other side.

CHAPTER 4

# Physical Education and Sports for CWSN

## (Children with Special Needs — Divyang)

**B.** 1. Inclusion in Physical Education means that students with disabilities participate in all activities equally with normal students. Thus, all students are welcomed by schools in age-appropriate, regular classes and are supported to learn, contribute and participate in all aspects of life at school. There are special departments in many educational institutions that focus on creating and maintaining inclusive environments. Permitting individuals with disabilities and allowing them special education helps them secure opportunities and learn alongside their peers without disabilities in general education classrooms.

2. The role of special educators is quite important. All instructors should undergo specialised training to handle special needs children. Such trainers, in order to be effective, should have a clear understanding of specific disability. Adapted physical education ideas must be ingrained in teachers.

3. Spectators are not just viewers; they play an imperative role in building up the confidence of the players. While generally they clap and hoot to encourage their favourite players, spectator appreciation in Deaflympics is often expressed by waving hands to cheer on their athletes.

4. We need to plan for activities keeping in mind the interest and abilities of these children. Over a period of time, we have developed special programmes labelled as "Adapted Physical Education" (APE). APE is the physical education that is individualised and specially designed to address the needs of students with disabilities who require adaptations or modifications to be physically active, participate safely and make progress.

5. Paralympics are international multisport events that were started for athletes with disabilities like amputations, blindness and cerebral palsy. These games were first held in Rome in 1960 and have been organised every four years since then. The term 'Paralympics' was officially used first at the 1988 Seoul Summer Paralympics. We also have the Winter Paralympics, which were held for the first time in Sweden in 1976.

6. Deaf people usually wave their hands in the air to express their excitement and happiness. Deaf applause (waving in the air) began in the 1980s. To this day, it has been widely prevalent in the Deaf world.

7. Occupational therapists can help children find healthy ways to manage and express their emotions. Some methods include maintaining a journal to express their emotions and regularly engaging in physical activity.

8. The International Paralympic Committee has developed the classification process with the aim of achieving sporting excellence amongst all athletes and sports in the Paralympic Movement, thus providing equitable competition. It is undertaken to ensure that an athlete's impairment is relevant to sports performance. Division in sports focuses on the fundamental difference between Special Olympics competitions and others. Competitions are designed to allow athletes to compete with athletes of similar abilities. All divisions are created such that the variance between the highest and lowest scores within that division does not differ by more than 15 per cent. This 15 per cent statement is a guideline for establishing equitable divisions.

9. Decreased muscle power implies that athletes with impaired muscle power have a health condition that either reduces or eliminates their ability to voluntarily contract their muscles in order to move or generate force. For example, spinal cord injury (complete or incomplete), tetraplegia or paraplegia or paraparesis, muscular dystrophy, post-polio syndrome and spina bifida cause decreased muscle power. Being physically inactive and eating an unhealthy diet can contribute to the condition.

10. Intellectual disability is characterised by a significantly below-average intellectual functioning (generally regarded as IQ below 70) combined with impairment in carrying out various aspects of daily life and adapting to the normal social environment. A person having intellectual disability becomes eligible to participate in Special Olympics.

**C.** 1. Inclusion in Physical Education means that students with disabilities participate in all activities equally with all students. Thus, all students are welcomed by schools in age-appropriate, regular classes and are supported to learn, contribute and participate in all aspects of life at school. There are special departments in many educational institutions that focus on creating and maintaining inclusive environments. Inclusion is an all-embracing societal ideology. Permitting individuals with disabilities and allowing them special education helps them secure opportunities and learn alongside their peers without disabilities in general education classrooms. Inclusion is a basic right and the aim is to include everyone regardless of race, age, gender, disability, religious and cultural beliefs. True inclusion removes all barriers, discrimination and intolerance. To do this, it is essential to make schools, classrooms and lessons such that everyone learns and participates as a group. Inclusive classrooms create a supportive environment for all learners, especially those with learning disabilities.

2. Intellectual disability is characterised by significantly below-average intellectual functioning (generally regarded as IQ below 70) combined with impairment in carrying out various aspects of daily life and adapting to the normal social environment. A person has to have intellectual disability to be eligible to participate in Special Olympics. Such people have a cognitive delay, as determined by standardised measures such as intelligent quotient or IQ testing. They have a closely related developmental disability like limitations in both general learning (such as IQ) and in adaptive skills (such as in recreation, work, independent living, self-direction or self-care).

3. Special Olympics Bharat offers training and competition opportunities in 25 Olympics-style individual and team sports. Training and competitions are organised at local, district, state, national and international levels.

   The Special Olympics Leadership Academy helps Special Olympics leaders to enhance their personal and organisational performance.

   Special Olympics Bharat also runs a Health Program to ensure inclusive health for people with intellectual disabilities, ensuring equitable access to quality health care, education and services throughout a community. Special Olympics Healthy Community is a program that offers help to people with intellectual disabilities enabling them to utilise health and well-being services as well as education and similar support in everyday life. Healthy Athletes Program aims to improve access to care at event-based and other health screening clinics, make referrals for follow-up to community health professionals, train healthcare professionals and students about the needs of people with intellectual disabilities and collect, analyse and disseminate data on their health needs.

4. Education is a basic right that every child must have access to. Through this, we can improve children with disabilities ranging from mental disabilities to hearing impairment, visual handicap or speech impairment. The focus of Adapted Physical Education (APE) is to make these special needs a part of a productive society.

   We, as a society, need to plan for activities keeping in mind the interest and abilities of these children. Over a period of time, we have developed special programmes labelled as "Adapted Physical Education" (APE). APE is the physical education that is individualised and specially designed to address the needs of students with disabilities who require adaptations or modifications to be physically active, participate safely and make progress.

5. Physiotherapists help develop gross motor skills and mobility of the children with special needs. Their role consists of assessing and managing children with motor disorders and disabilities. They intervene by providing physical intervention, care, advice and support. They conduct comprehensive assessments to identify the specific physical limitations and challenges faced by students with special needs. They evaluate the students' range of motion, muscle strength, balance, coordination and overall physical abilities. Physiotherapy is beneficial since children with special needs (CWSN) may require some physical therapy so that they are taught how to overcome the problem. Physiotherapy usually involves massage, manual therapy, stretching exercises, heat pack/cold compresses, electrotherapy (cycling or electronic stimulation) and electrical stimulation.

6. A speech therapist provides treatment, care and support for students with special needs, especially those who have problems in communication. They enable students with special needs to gain ability to communicate through speech and language. Since speech therapist or speech-language pathologists are trained personnel who work with children having speech-related disorders, they also provide screening, consultation, assessment, diagnosis, treatment, management and counseling services for CWSN. A speech therapist can teach the child exercises to improve their chewing and swallowing processes. These techniques for CWSN typically include swallowing maneuvers, improving jaw & tongue strength, and head positioning techniques.
7. Physical disability may either be a motor deficiency or sensory impairment while cognitive disability is a neurological disorder that creates hindrances or obstruction for an individual to store, process and produce information. Intellectual functioning refers to a person's ability to plan, comprehend and reason, while adaptive behaviour refers to an individual's ability to apply social and practical skills in everyday life.

   There are three types of cognitive disability: mild, moderate and severe. Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorder, mental health disabilities like anxiety, delirium, schizophrenia, mood disorders and memory impairments weather limited to short-term memory, missing long-term memory, or limited ability to recall language come under this category. Dementia is one among many different causes of memory impairments. Perceptual disabilities (also called "learning disabilities") involve difficulty processing sensory information such as auditory, tactile and visual. This includes impairments in reading or dyslexia, writing or dysgraphia, managing mathematic concepts or dyscalculia. Seizure disorders including different types of epilepsy and migraines may be in reaction to visual or audio stimulation.

   Physical or "motor" disabilities are limitations of muscular control. These include involuntary movements including tremors, lack of coordination, paralysis, limitations of sensation, joint disorders such as arthritis, pain that impedes movement and missing limbs.
8. The concept of classification is used in disability sports. It is a method for promoting even and fair competition amongst athletes with disability through a specialised grouping of these athletes. The purpose is the same as the grouping system used in all other sports where the competitors are classified as per their age group, gender, weight, etc. This is done to minimise the effect of performance because of variables, viz. age, gender, weight or even abilities. The term classification is associated with Paralympics and para-athletes. It is adopted by the Paralympics to assign categories to athletes based on different types of disabilities.
9. The classification process has three or four steps. The first step is generally a medical assessment followed by a functional assessment by first observing the sportsperson during training and then observing them in the competition. There are various professionals who carry out this classification, including individual classifiers, medical classifiers, technical classifiers, a chief classifier, a head of classification, a classification panel and a classification committee. Classifications in the Paralympics are based on the physical impairments that include decreased muscle power, impaired range of movement, loss of limb or limb deficiency, leg-length differences, short stature Hypertonia, Ataxia Athetosis vision impairment and intellectual impairment.
10. Coaches have an important role in an athlete's life. Coaches interact with athletes more than anyone. So, coaches need to place the health and safety of Special Olympics athletes above all. The Official Sport Rules and the Coaches Code of Conduct need to be followed absolutely. They help the competition management make divisioning work properly because divisioning is also based on the preliminary scores submitted by the coaches. This ensures that the athletes get into appropriate division and get additional competition experience.

**D.** 1. The objective of occupational therapy is to promote, maintain and restore functional independence in daily living skills. Occupational therapy is concerned with human occupation and its importance in health for persons of all ages. Occupational therapists can help children find healthy ways to manage and express their emotions which include writing them down or engaging in physical activity. Working with an occupational therapist can help children with special needs develop the skills and tools

they need to succeed both in education and later in life. Occupational therapists help with barriers that affect a person's emotional, social and physical needs. To do this, they use everyday activities, exercises and other therapies. OT helps kids play, improves their school performance and aids their daily activities. In addition to listening and communicating, a skilled occupational therapist can benefit from having keen observation abilities. These professionals typically observe their patients in order to notice and record their mental and physical health and to recommend the appropriate methods of care. Since occupational therapists work with children, they typically use techniques and routines that seem like play. In reality, they are designed to target areas of delay and difficulty. Some occupational therapists are also trained in therapy with a sensory-integration approach. This method uses play-like activities to help children better process and tolerate the information they get through their senses.

2. Special Olympics Bharat is a national sports federation that provides physical education and training to people with intellectual disabilities and conducts Special Olympics programs throughout the country. It was started as Special Olympics India in 1987, and in 2001, it was rechristened Special Olympics Bharat. Special Olympics Bharat uses sports as a catalyst to transform the lives of children and adults with intellectual disability. It is officially approved by the Special Olympics USA, the world's largest sports organisation for children and adults with intellectual disabilities, which was founded by Eunice Kennedy Shriver, a philanthropist. In June 1962, Shriver started a day camp called Camp Shriver for children with intellectual disabilities. The main objective of this camp was to give these children opportunities to develop physical fitness, demonstrate courage, experience joy and participate in the sharing of gifts, skills and friendship. Camp Shriver became an annual event and evolved into Special Olympics. The first international Special Olympics summer games were held in 1968 in Chicago.

   Special Olympics Bharat is an organisation that has helped and worked with over 12 lakh athletes with intellectual disabilities. It has created over one lakh coaches and has over 6,000 trainers in 679 state and union territory districts. It aims to adds over one lakh fresh athletes every year.

3. The role of numerous professional individuals such as school counsellor, occupational therapist, physiotherapist, etc., for children with special needs is very important. They assist, guide and support such children in realising their full potential, working and improving on their motor skills, enhancing their ability to communicate effectively and aiding their mental as well as physical health. The details of the roles of various professionals for CWSN are as follows:

   **School Counselor:** They are specialists that work with children with special needs, guiding them down the right educational path.

   **Physiotherapist:** They are associated with gross motor skills and mobility of the children with special needs.

   **Occupational Therapist:** An occupational therapist guides children with special needs in enhancing their self-care skills like bathing, grooming, dressing and eating. They help children with special needs to improve their fine motor skills and handwriting.

   **Physical Education Teacher:** Physical education teachers determine the skillset and the abilities of students with special needs. They also evaluate measures that can be implemented to help them participate in sports and fitness. They help in improving hand-eye coordination, flexibility, endurance etc.

   **Speech Therapist:** A speech therapist provides treatment, care and support for students with special needs who have problems or shortcomings in communication. They enable students with special needs to gain ability to communicate through speech and language.

   **Special Educator:** A special educator, more often than not, has students with varying learning, mental, physical and emotional abilities. They aid and help such students in areas of physical skills, learning through play, communication etc. Their primary responsibility is to assess cognitive abilities.

4. Some organisations promoting adaptive sports are Special Olympic Bharat, Paralympics and Deaflympics.

(a) Special Olympic Bharat is a movement that uses sports as a catalyst to change the lives of children and adults with intellectual disabilities or mentally-challenged persons. Special Olympics Bharat is a national sports federation that provides physical education and training to people with intellectual disabilities and conducts Special Olympics programs throughout the country. It was started as Special Olympics India in 1987, and in 2001, it was rechristened Special Olympics Bharat.

(b) Paralympics are international multisport events that were started for athletes with disabilities like amputations, blindness and cerebral palsy. These games were first held in Rome in 1960 and have been organised every four years since then. The term 'Paralympics' was officially used first at the 1988 Seoul Summer Paralympics. We also have the Winter Paralympics, which were held for the first time in Sweden in 1976.

(c) The Deaflympics (previously called World Games for the Deaf and International Games for the Deaf) are approved by the International Olympic Committee in which deaf athletes compete at an elite level. In 2001, these games were renamed as Deaflympics. The first games, known as the International Silent Games, were held in 1924 in Paris, with athletes from nine European nations participating. To be eligible to participate in Deaflympics, an athlete must be at least eight years of age and be certified by an agency or professional as having an intellectual disability.

5. Athletes are expected to give maximum effort when competing. This is the only way the divisioning process can work as it was intended. Athletes who do not participate honestly and with maximum effort in all preliminary trials and/or finals violate the true spirit of competition and may even be disqualified from competition. All athletes will use the 'maximum effort' rule for state-level competition in aquatics (swimming), athletics (track and field) and bowling. Competitions are designed to allow athletes to compete with athletes of similar abilities. All divisions are created such that the variance between the highest and lowest scores within that division does not differ by more than 15 per cent. This 15 per cent statement is a guideline for establishing equitable divisions.

6. The International Paralympic Committee (IPC) has developed the classification process with the aim of achieving sporting excellence amongst all athletes and sports in the Paralympic Movement, thus providing equitable competition. Classification is undertaken to ensure that an athlete's impairment is relevant to sports performance. This ensures that the athlete competes in equality with other athletes, thereby offering a fair chance to all participant athletes.

   This, besides determining an athlete's eligibility, also groups sportspersons for the purpose of competition. The minimum eligibility is an impairment that limits the sportspersons' ability to participate in an activity. The disability needs to be permanent in nature.

   The classification process has three or four steps. The first step is generally a medical assessment followed by a functional assessment by first observing the sportsperson during training and then observing the same sportsperson in the competition. There are various professionals required to carry out this classification, including individual classifiers, medical classifiers, technical classifiers, a chief classifier, a head of classification, a classification panel and a classification committee.

7. The International Paralympic Committee (IPC) has developed the classification process with the aim of achieving sporting excellence amongst all athletes and sports in the Paralympic Movement, thus providing equitable competition. Classification is undertaken to ensure that an athlete's impairment is relevant to sports performance. This ensures that the athlete competes in equality with other athletes, thereby offering a fair chance to all participant athletes. This, besides determining an athlete's eligibility, also groups sportspersons for the purpose of competition. The minimum eligibility is an impairment that limits the sportspersons' ability to participate in an activity. The disability needs to be permanent in nature.

   On the other hand, classification division is based on the fact that the fundamental difference between Special Olympics competitions and others is that athletes of all ability levels are encouraged to participate in Special Olympics. Competitions are designed to allow athletes to compete with athletes of similar abilities. All divisions are created such that the variance between the highest and lowest scores within that division does not differ by more than 15 per cent. This 15 per cent statement is a guideline for establishing equitable divisions.

8. An athlete's ability is the primary factor in divisioning Special Olympics competitions. The ability of an athlete or team is determined by an entry score from a prior competition or from the result of a seeding round or preliminary event at the competition itself. Other factors that are significant in establishing competitive divisions are age and gender.

   **Divisioning Individual Sports:**

   **Step 1:** Divide athletes by gender. Athletes shall normally compete against other athletes of the same gender unless the rules specifically allow mixed-gender. Then divide athletes by age. Divide male and female athletes into the following age groups:

   Ages: 8-11

   Ages: 12-15

   Ages: 16-21

   Ages: 22-29

   Ages: 30 years and over

   An athlete's age group is based on the opening date of the event.

   **Step 2:** Divide athletes by ability

   All Special Olympics team sports competitions shall utilise sport-specific skills assessment tools and a Divisioning round to assess the level of ability of the participating teams.

   **Divisioning Team Sports:**

   **Step 1:** Divide teams by gender

   **Step 2:** Divide teams by age

   (a) Divide male and female teams into the following age groups:

   Ages: 15 and under

   Ages: 16-21

   Ages: 22 and over

   (b) Teams will compete against other teams within the same age group.

   (c) The age group of a team is determined by the age of the oldest athlete in that team on the date of the opening of the competition.

   **Step 3:** Divide teams by ability

   (a) All Special Olympics team sports competitions shall utilise sport-specific skills assessment tools and a Divisioning round to assess the level of ability of the participating teams.

   (b) Group teams according to ability-based on skills assessment tool and results of the Divisioning round.

   (c) Create divisions of no less than three and no more than eight teams.

9. Competitions are designed to allow athletes to compete with athletes of similar abilities. All divisions are created such that the variance between the highest and lowest scores within that division does not differ by more than 15 per cent. This 15 per cent statement is a guideline for establishing equitable divisions.

CHAPTER 5

# Sports & Nutrition

**B.** 1. A balanced diet is one that contains a variety of foods in certain quantities and proportions so that the requirement for calories, proteins, minerals, vitamins and alternative nutrients is adequate.

2. There are some important components of the food that do not provide calories but are very important for us to function well. While most of the non-nutritive part of our diet is helpful, there are undesirable components such as pesticides and insecticides that are invariably found in modern foods. However, there are lots of components of the diet such as phytonutrients that aid health and wellness.

3. Vitamins and minerals are micronutrients that we require daily. These are needed in very small quantities but on a daily basis. They serve very important functions. All the chemical reactions inside our body are aided by vitamins and minerals.

4. Fat soluble vitamins are vitamins that need fats in food to get absorbed. These are vitamin A, vitamin D, vitamin E and vitamin K.

5. Sodium is important for maintaining acid-base balance in our bodies. While helping in maintaining water balance, it is also important for muscle function. Beetroot, celery, carrots, meat, spinach, radish, tomatoes, etc., are dietary sources of sodium. Most of us get our sodium from table salt added to the food.

6. Depending on its origin, proteins are divided into vegetarian or vegetable protein and non-vegetarian or animal protein.

   Animal proteins are derived from animal sources. Meat, poultry, eggs and even milk and milk products are examples of animal-origin protein. Vegetable proteins are derived from vegetables and pulses. Soya is a great example of vegetarian protein. Nuts and grains such as quinoa and buckwheat are reasonably rich protein sources for vegetarians. Peas and rice are now the newer sources of protein, especially in supplements along with soya isolates.

7. Iron is an essential element for producing blood and is the main component of red blood cells. About 70 per cent of our body's iron is found in the red blood cells called **haemoglobin** and in muscle cells called **myoglobin**. Haemoglobin in the blood is essential for transferring oxygen from the lungs to the tissues. Iron comes from green vegetables such as spinach, broccoli, lentils and beans, nuts and seeds, wheat and brown rice and dried fruits like dates and prunes. If our body doesn't have enough iron, it cannot produce enough healthy oxygen-carrying red blood cells. Iron deficiency can cause anaemia.

8. Most of the calcium in human body is found in bones and teeth. Calcium helps in proper heart and muscle function and blood clotting. Rickets is the most common deficiency disease. Calcium-rich foods include milk, cheese, curd, egg yolk, oranges and vegetables like soya beans, spinach, lady-fingers and beans.

9. For the normal functioning of the thyroid gland, iodine is very important. Deficiency of iodine, primarily in the drinking water, causes a disease called goitre. This leads to mental and physical retardation as well as rough skin and hair. Moreover, children who do not get adequate iodine become dwarfed.

**C.** 1. A balanced diet is one that contains a variety of foods in certain quantities and proportions so that the requirement for calories, proteins, minerals, vitamins and alternative nutrients is adequate. Nutrition is required on a daily basis in specific quantities. The requirement is determined by the body weight and activity levels.

   Nutrition basically includes four macronutrients. These are proteins, carbohydrates, fats and water. We need these daily in specified quantities if we are to remain healthy and protect ourselves from diseases. Proteins, carbohydrates and fats are the only sources of calories in our food.

2. Basic elements of diet are components in food that we need on a daily basis to grow and stay healthy and well. These are macronutrients like protein, fats, carbohydrates and water that we need in bigger quantities and micronutrients like vitamins and minerals that we need in smaller quantities. We require these every day. Vitamins can be water soluble or fat soluble.
3. There are some important components of the food that do not provide calories but are very important for us to function well.

   While most of the non-nutritive part of our diet is helpful, there are undesirable components such as pesticides and insecticides that are invariably found in modern foods. However, there are lots of components of the diet such as phytonutrients that aid health and wellness. Fibre is something the body needs but never actually digests—in fact, it remains more or less the same from plate to toilet. It comes in two varieties—soluble and insoluble—and most plant-based foods contain a mixture of the two. Water is very important for all living things. Up to 60 per cent of the adult human body is water. Most of the water in the human body is contained inside our cells. Lastly, phytonutrients are substances in our food that add flavour, colour and taste to the vegetables and fruits we eat.
4. Vitamins are nutrients that our body needs to function and fight off diseases. Our body cannot produce vitamins itself, so we must get them from the food we eat or, in some cases, through supplements. There are 13 vitamins that are essential for our body to work well. There are two types of vitamins: fat-soluble and water-soluble. Fat-soluble vitamins are stored in our fat cells, consequently requiring fat in order to be absorbed. Water-soluble vitamins are not stored in our body. So, they need to be consumed daily. Our body takes what it needs from the food we eat and then excretes what is not needed as waste.
5. Water-Soluble Vitamins are those that need water for absorption and digestion. This includes vitamin B complex and vitamin C.

   Vitamin B-complex and vitamin C are examples of water-soluble vitamins. Vitamin B Complex is made up of eight different vitamins namely Vitamin $B_1$, Vitamin $B_2$, Vitamin $B_3$, Vitamin $B_5$, Vitamin $B_6$, Vitamin $B_9$ and Vitamin $B_{12}$.Their deficiency causes a lot of diseases leading to ill-health.

   Vitamin C is found in citrus fruits and juices such as oranges, lemons, pineapples, grapes and grapefruits, guava and papaya. Red, yellow and green peppers, cabbage and spinach, amla, green chilies and tomatoes are rich in vitamin C. Vitamin C deficiency causes rough, bumpy skin, curled body hair, bright red hair follicles, spoon-shaped fingernails with red spots or lines, dry and damaged skin, easy bruising, slow-healing wounds and painful swollen joints.
6. The nutrients we need daily, by the grams, are called macronutrients. These are proteins, fats, carbohydrates and water. Some nutrients that we need in fractions of grams but regularly are labelled as micronutrients. Balancing our diet means consuming these nutrients daily in the right proportion.

   Vitamins and minerals are the micronutrients that we require daily. These are needed in very small quantities but on a daily basis. They serve very important functions. All the chemical reactions inside our body are aided by vitamins and minerals.
7. The three main purposes a nutrition plan ought to fulfil in relation to sports performance are:
   (a) **Providing energy for training and competition:** Macronutrients, micronutrients, ratios, meal timing and frequency, hydration and supplementation are all factors that should be taken into consideration when creating an optimal diet plan.
   (b) **Facilitating recovery after training and competition:** After a sporting event, glycogen, which is the muscle energy storage, is diminished. By eating soon after (or even during) training and competition, these glycogen stores are replenished which, in turn, prevents muscle protein breakdown and accelerates recovery.
   (c) **Achieving and maintaining optimal body weight and composition:** Athletes need to be at an optimal body weight and body fat. A proper diet plan helps this in the long term.

8. The post- competition meal is designed to replenish glycogen stores and electrolyte imbalances. It must refuel the muscles, allowing preparation for future activity. This, in turn, decreases the chances of muscle fatigue and enhances performance. It is best to eat 15-30 minutes after the competition has ended.

   A liquid meal is easily digested and absorbed by the body. The body is most receptive to energy replacement techniques within 30 minutes after a strenuous activity and eating a full meal 2-4 hours post-event helps with the recovery period. A well-balanced meal, high in carbohydrates, should be adopted as the main energy source but also include appropriate amounts of protein and fatty foods.

   Examples of a post competition meal include:

   - If non-vegetarian, fish or meat sandwich
   - Fresh fruit and vegetables
   - Cheese and crackers
   - 1-2 cups of fresh fruit juice
   - 1-2 cups of cold water
   - A bowl of cereal with milk or curd and toast with jam or jelly.

**D.** 1. Proteins are vital for the growth and development of human body. According to experts, there are 20 amino acids, which are further divided into essential and non-essential amino acids, and two rare amino acids. There are 10 essential and 10 non-essential amino acids. By definition, essential refers to those that have to be derived from food as our body doesn't produce them. Proteins are needed to build our muscles, grow nails and hair, and protect skin and tissues of our internal organs. Most hormones are of protein origin. We need to take 30 per cent of our calorie needs from protein.

   Protein shortage causes various diseases that can deteriorate the quality of life and even cripple some. Protein is found throughout the body—in muscle, bone, skin, hair and virtually every other body part or tissue. It makes up the enzymes that power many chemical reactions and the haemoglobin in our blood that carries oxygen from lungs to the tissues. Hair and nails are mostly made of protein. Our body uses protein to build and repair tissues. We also use protein to make enzymes, hormones and other body chemicals. Protein is an important building block of bones, muscles, cartilage, skin and blood. As a fuel, proteins provide as much energy density as carbohydrates: 4 kcal (17 kJ) per gram. But it is important to consume the right amount and the right kind of protein to derive maximum health benefits.

2. Vitamins are nutrients that our body needs to function and fight off diseases. Our body cannot produce vitamins itself, so we must get them from food we eat or, in some cases, through supplements. There are 13 vitamins that are essential for our body to work well.

   There are two types of vitamins: fat-soluble and water-soluble. Fat-soluble vitamins are stored in our fat cells, consequently requiring fat in order to be absorbed. Water-soluble vitamins are not stored in our body. So, they need to be consumed daily. Our body takes what it needs from the food we eat and then excretes what is not needed as waste. Vitamins are divided into essential (derived from food) and non-essential. They are further divided into water-soluble and fat-soluble vitamins. Fat-soluble vitamins need fats in food to get absorbed while water-soluble vitamins are digested with the help of water. Scarcity of vitamins and minerals in our diets leads to what are called deficiency diseases.

3. The nutrients we need daily, in large quantities as by the grams, are called macronutrients.

   There are four macronutrients, namely protein, fat, carbohydrate and water. Proteins are the building blocks of our body; these are vital for the growth and development of the human body. Proteins are needed to build our muscles, grow nails and hair, and protect skin and tissues of our internal organs. Most hormones are of protein origin. We need to take 30 per cent of our calorie needs from protein. Protein shortage causes various diseases that can deteriorate the quality of life and even cripple some.

Carbohydrates are the energy sources in our food. Our diet should derive 40 per cent calories from this source. Carbohydrates are divided into simple and complex carbohydrates. Simple carbohydrates are broken down quickly by the body to be used as energy. They are found naturally in foods such as fruits, milk and milk products. They are also found in processed and refined sugars such as candy, table sugar, syrups and soft drinks. Any food that is cooked or processed generally becomes a source of simple carbohydrates. Fat in food is essential for many reasons. Fat in human body acts as a protection to the organs, many of which have support only from the surrounding fat. Also, fat under the skin helps regulate body temperature and store and produce many hormones such as leptin. Water is the most essential nutrient in human body. Nutrients are transported to the cells of our organs through water. Body temperature regulation is a function of water. Water also keeps our muscles and skin supple. Since we need water by the litre, it is considered a macronutrient. It helps remove bodily wastes, is a calorie-free nutrient and helps digest the food we eat.

4. A balanced diet is one that contains a variety of food in certain quantities and proportions so that the requirement for calories, proteins, minerals, vitamins and alternative nutrients is adequate. Nutrition is required on a daily basis in specific quantities. The requirement is determined by body weight and activity levels.

   Nutrition includes four macronutrients. These are proteins, carbohydrates, fats and water. We need these daily in specified quantities if we are to remain healthy and protect ourselves from diseases. Proteins, carbohydrates and fats are the only sources of calories in our food. The nutrients we need daily, by the grams, are called macronutrients. Some nutrients that we need in fractions of grams but regularly are labelled as micronutrients. Balancing our diet means consuming these nutrients daily in the right proportion. Everyone needs some basic nutrients that are common but some nutrients are needed in varying quantities. This depends on age, activity level, diseases, etc. A balanced diet ought to have the correct mix of macronutrients and micronutrients. It should be tasty, easy to digest and should take consumers' dietary preferences into account.

5. Proteins are the building blocks of our body. Made up of smaller structures called amino acids, these are vital for the growth and development of human body. Proteins are needed to build our muscles, grow nails and hair, and to protect the skin and tissues of our internal organs. Most hormones are of protein origin. We need to take 30 per cent of our calorie needs from protein. Protein shortage causes various diseases that can deteriorate the quality of life and even cripple some. Protein is found throughout the body—in muscle, bone, skin, hair and virtually every other body part or tissue. It makes up the enzymes that power many chemical reactions and the haemoglobin in our blood that carries oxygen from lungs to the tissues. In sports persons, proteins especially help in regenerating the muscles that get damaged by use in athletic activities.

   Our body uses protein to build and repair tissues especially after strenuous exercises. We also use protein to make enzymes, hormones and other body chemicals. Protein is an important building block of bones, muscles, cartilage, skin and blood.

   As a fuel, proteins provide as much energy density as carbohydrates: 4 kcal (17 kJ) per gram. But it is important to consume the right amount and right kind of protein to derive maximum health benefits. Depending on its origin, proteins are divided into vegetarian or vegetable proteins which are proteins are derived from vegetables and pulses. And non-vegetarian or animal protein derived from animal sources like meat, poultry, eggs.

6. Nutritive components of food are the constituents that supply calories and energy. Thus, we need to focus on proteins, fats and carbohydrates as sources of calories. **Proteins** are the building blocks of our body. Made up of smaller structures called amino acids, these are vital for the growth and development of human body. Proteins are needed to build our muscles, grow nails and hair, and protect the skin and tissues of our internal organs. Most hormones are of protein origin. In sports persons, proteins help regenerate the muscles that get damaged by use in athletic activities. Our body uses protein to build and repair tissues especially after strenuous exercises. **Fat** is an essential part of our diet. It provides energy, absorbs certain nutrients and maintains our core body temperature. We need to consume fat every day to support these function. It is important to have adequate fat in

diet to permit absorption of fat-soluble vitamins. **Carbohydrates**, also known as saccharides or carbs, are sugars or starches. They are a major food source and a key form of energy for most organisms. They consist of carbon, hydrogen and oxygen atoms. The four primary functions of carbohydrates in the body are to provide energy, store energy, build macromolecules and spare protein and fat for other uses. Glucose energy is stored as glycogen, with majority of it in the muscle and liver.

7. Nutrition is vital to overall wellbeing of humans. It helps keep the body fully functional and maintains wellness and decreases the chances of damage and disease. Besides, it helps create a lifestyle that includes healthy eating, regular physical activity and balancing the number of calories you consume with the number of calories your body burns. Staying in control of your weight is a vital function of nutrition. To achieve a healthy weight, it is important to adopt a balanced and nutritious diet. A diet rich in fruits, vegetables, whole grains, lean proteins and healthy fats provides essential nutrients while keeping calorie intake in check. Portion control is crucial, as consuming excess calories can lead to weight gain. Additionally, reducing the intake of processed foods, sugary beverages and high-fat snacks can contribute to weight loss and overall health improvement. Poor nutritional choices lead to the risk of nutritional deficiencies. Many restrictive diets severely limit food groups or overall calorie intake, resulting in inadequate nutrient consumption. When the body does not receive essential vitamins, minerals and macronutrients, various bodily functions can be compromised. Weakened immune systems, impaired organ function and overall diminished well-being are potential consequences of nutrient deficiencies. Preserving muscle mass is a crucial function of nutrition and is vital for maintaining a healthy weight and ensuring optimal functionality of the body.
8. Water-Soluble Vitamins are vitamins that need water for their absorption and digestion.

   These include vitamin B-complex and vitamin C.

   Vitamin B-complex and vitamin C are examples of water-soluble vitamins. Vitamin B Complex is made up of eight different vitamins, namely Vitamin $B_1$, Vitamin $B_2$ Vitamin $B_3$ Vitamin $B_5$ Vitamin $B_6$, Vitamin $B_9$ and Vitamin $B_{12}$. Their deficiency causes a lot of diseases, leading to ill health. These range from beri beri to scurvy, anaemia, fatigue and lassitude. Water-soluble vitamins are not stored in our body. So, they need to be consumed daily. Our body takes what it needs from the food we eat and then excretes what is not needed as waste. Vitamin B complex contain Folic acid which is necessary for optimal brain functioning and has an important role in the production of RNA and DNA. It plays an important role in the brain development of the foetus during pregnancy. Vitamin $B_7$ is essential for the metabolism of carbohydrate and fat.

   Vitamin C is found in citrus fruits and juices such as oranges, lemons, pineapples, grapes and grapefruits, guava and papaya. Red, yellow and green peppers, cabbage and spinach, amla, green chillies and tomatoes are rich in vitamin C. Vitamin C deficiency causes rough, bumpy skin, curled body hair, bright red hair follicles, spoon-shaped fingernails with red spots or lines, dry and damaged skin, easy bruising, slow-healing wounds and painful swollen joints.
9. Fat is an essential part of our diet. It provides energy, absorbs certain nutrients and maintains our core body temperature. We need to consume fat every day to support these functions.

   A diet rich in saturated fat (fatty cuts of meat and dairy foods are top sources) can raise cholesterol levels in the blood. This increases the risk of heart disease. Consumption of too much fat causes you to become overweight or obese which raises your risk of endometrial, breast, prostate and colorectal cancers. Fats are derived both from animal and vegetable sources. Plant-based diets include food that contain fats such as nuts and seeds and oils from grains and seeds. On the other hand, animal sources of fats are butter, whole milk, products made with whole milk, meats and eggs. Fat in food is essential for many reasons. In the human body, fat acts as a protection to the organs, many of which have support only from the surrounding fat. Also, fat under the skin helps regulate body temperature and store and produce many hormones such as leptin.

10. Vitamins and minerals are the micronutrients that we require daily. These are needed in very small quantities but on a daily basis. They serve very important functions. All the chemical reactions inside our body are aided by vitamins and minerals. Today, we understand a lot about how vitamins are important for human health. Vitamins are divided into essential (derived from food) and non-essential. They are further divided into water-soluble and fat-soluble vitamins. Fat-soluble vitamins need fat in food to get absorbed while water-soluble vitamins are digested with the help of water. Scarcity of vitamins and minerals in our diet leads to what are called deficiency diseases. In fact, the discovery of vitamins was a major scientific achievement in our understanding of health and disease.

    Minerals are an important part of our daily diet. There are 16 essential minerals: Calcium, phosphorus, potassium, sulphur, sodium, chloride, magnesium, iron, zinc, copper, manganese, iodine, selenium, molybdenum, chromium and fluoride. Minerals are classified into macro and trace minerals, depending on the quantity we need daily. Just like vitamins, minerals help our body grow, develop and stay healthy. The body uses minerals to perform many different functions—from building strong bones to transmitting nerve impulses. Some minerals are even used to make hormones or maintain a normal heartbeat. The minerals in our diet are essential for a variety of bodily functions. They are important for building strong bones and teeth, blood, skin, hair, nerve function, muscle and for metabolic processes such as those that turn the food we eat into energy.

11. There are some important components of the food that do not provide calories but are very important for us to function well. While most of the non-nutritive part of our diet is helpful, there are undesirable components such as pesticides and insecticides that are invariably found in modern foods. However, there are lots of components of the diet, such as phytonutrients, that aid health and wellness.

    Fibre is something in the body and it comes in two varieties—soluble and insoluble—and most plant-based foods contain a mixture of the two. Soluble fibre turns to gel in the stomach and slows digestion, which helps lower cholesterol and blood glucose. Insoluble fibre, on the other hand, remains unchanged all the way to the colon, making waste heavier and softer so that it can pass through the intestines more easily. Water serves vital functions. It is essential for cells to function properly as it enters into the composition of the cells. Water is responsible for chemical and metabolic reactions, transport of nutrients and removal of waste from the body besides body temperature regulation. Virtually, all food has some water in it. Natural, whole foods have the highest water content. Fruits and vegetables contain 80 to 98 per cent water. Eating dense vegetables such as cucumbers, tomatoes, beets, carrots or celery with a meal or snack is one of the easiest ways to improve hydration. About 80 per cent of water needs are to be met by drinking water. We lose water continuously with sweat, urine and stools besides our breath. Phytonutrients is an important non-nutritive component of food. These are substances in our food that add flavour, colour and taste to the vegetables and fruits we eat. Each colour in the food represents a different phytonutrient with distinct nutritive value. It is suggested we eat fruits and vegetables of all colours so that we get all the vital phytonutrients.

12. Water has many important roles in the body and is required to maintain blood volume and regulate body temperature. Staying hydrated helps maintain blood pressure during exercise so your heart doesn't work harder to maintain normal blood pressure. Staying hydrated also improves blood flow and circulation and thus the delivery of oxygen and nutrients to working muscles. It is said that a body water deficit of 2% body weight can impair athletic performance. As body sweats aim to cool down the body, fluid loss causes the blood to thicken, therefore decreasing oxygen supply and putting extra pressure on the body. Drinking sufficient water increases energy, keeps your muscles and joints lubricated, prevents overeating, impacts brain power and improves the quality of your skin. Your body needs to be hydrated to function at its best. If there isn't enough liquid in your body, essential functions like circulation don't perform as smoothly and your organs won't get necessary nutrients, resulting in less efficient performance.

    Staying hydrated before, during and after exercise is also important for maintaining blood pressure and improving blood flow and circulation. This improves oxygen and nutrient delivery to working and recovering muscles. Water flushes toxins out of the body, transports nutrients into the cells

and helps regulate body temperature and pH balance. Water also helps with muscle soreness and tension. Water plays a crucial function in encouraging muscle gain because it delivers the materials required for constructing protein and glycogen structures, the body's main sources of energy. Not only does it allow better freedom of movement but it also helps you build muscles good enough for flexing them. During exercise, the body cools itself by sweating but this ultimately results in a loss of body fluid which, if not replaced, can lead to dehydration.

13. Sodium is important for maintaining acid-base balance in our bodies. While helping in maintaining water balance, it is also important for muscle function. Beetroot, celery, carrots, meat, spinach, radish and tomatoes are dietary sources of sodium. Most of us get our sodium from table salt added to the food. Sodium aids in the contraction of our muscles and in the conduction of nerve impulses, maintains correct balance of fluid in the cells and supports the absorption of other nutrients including chloride, amino acids and glucose. Too much sodium can increase the risk of developing high blood pressure. We need 180 to 500 mg of sodium per day.

14. One of the primary pitfalls of dieting is the phenomenon known as **yo-yo dieting**. This cycle involves repeatedly experiencing weight loss followed by weight regain. Constant fluctuations in weight put stress on the body, leading to potential health complications. Another significant pitfall of dieting is the risk of nutritional deficiencies. When the body does not receive essential vitamins, minerals and macronutrients, various bodily functions can be compromised. Weakened immune systems, impaired organ function and overall diminished well-being are potential consequences of nutrient deficiencies. Metabolic slowdown is another concern when it comes to dieting. One often overlooked pitfall of dieting is the development of an unhealthy relationship with food. Strict rules and restrictions around food can create an unhealthy mindset, leading to feelings of guilt or shame when deviating from the prescribed diet. Dieting can result in loss of muscle mass alongside fat loss. Diets that drastically cut calories or restrict specific macronutrients may lead to a decrease in overall strength, a lowered metabolism and a less toned physique.

    Preserving muscle mass is crucial for maintaining a healthy weight and ensuring optimal functionality of the body. Constant focus on restrictions, body image and weight loss can have a significant emotional impact on individuals. The pressure to adhere to strict rules and expectations can lead to increased levels of stress, anxiety and self-criticism. Lastly, many diets are not sustainable in the long term. While individuals may experience initial success with restrictive diets, they often struggle to maintain the strict rules and limitations indefinitely. This can result in returning to old eating habits and weight regain, leading to feelings of failure and frustration.

15. While food myths abound, the five very common myths are:

    (a) **Avoid potatoes:** When potatoes are cooked in a healthy way like baked, boiled, roasted or steamed, they do not adversely affect any weight loss plan. In fact, since potatoes are complex carbohydrates, they aid weight loss. But if you add cream, cheese, butter or any other fat-rich product to potatoes, they will surely contribute to weight gain.

    (b) **Avoid yellow of the egg:** It is also a myth that has not been proven by any scientific study. All of the fat-soluble vitamins (A, D, E, K) in eggs are found in the yolk. In addition, the yolk contains healthy fats and cholesterol necessary for the production of hormones such as testosterone. Egg yolk also contains about as much protein as the white portion.

    (c) **Avoid full-fat milk:** It has never been substantiated. In fact, many studies show that full-fat milk is better for human health.

    (d) **Starve to lose weight:** This is not correct. In fact, eating too little is as bad for health as eating too much. Eating right is important.

    (e) **Do not eat certain foods together:** It is commonly said that certain foods should not be combined, *e.g.*, milk and fish. However, this is just a myth and is not at all scientific.

**B.** 1. Elderly people require adequate strength, flexibility and endurance to accomplish even ordinary, everyday tasks. Assessing these components of fitness can detect weaknesses which can be treated before causing serious functional limitations. These are simple, easy-to-use battery of tests that assess the functional fitness of older people. The test measures aerobic fitness, strength and flexibility using minimal and inexpensive equipment.

2. Arm Curl Test is the test designed to test the strength of the upper body muscles, especially of senior persons. This is a test of functional fitness of the subject. It tests the muscles that the daily household chores utilise. To perform this test, we need a five-pound weight for females and an eight-pound weight for males.

   The procedure to be followed in this test is to find out the maximum number of arm curls that one can complete in 30 seconds. This is done using the dominant arm. With the participant sitting in the chair, the weight is held in the hand with palm facing upwards towards the body. The number of movements in 30 seconds is the count.

3. All results need to have a measure. The tests are used to gather information about the athlete evaluating their capacity, ability, needs and endurance. The different types of tests such as Kraus-Weber Test, Harvard Step Test, Johnson Basketball Ability Test, AAHPER Youth Fitness Test and Sit and Reach Test are all used for these assessments.

   Measurements help classify the students on the basis of age, sex, height and weight. Thus, a homogeneous group can be formed. Also, proper guidance can be given based on the weaknesses and strengths of the students. Progress is measured and grading is done on the basis of these measurements.

4. The Arm Curl Test is designed to test the strength of the upper body muscles, especially of senior persons. This is a test for the functional fitness of the subject. It tests the muscles that the daily household chores utilise. To perform this test, we need a five-pound weight for females and an eight-pound weight for males. The aim of this test is to find out the maximum number of arm curls that one can complete in 30 seconds, using the dominant arm. With the participant sitting in the chair, the weight is held in the hand with palm facing upwards towards the body. The arm needs to be lifted upwards, fully bent at the elbow and then fully straightened and then brought down to the original position. The number of movements in 30 seconds is the count.

5. Body Composition refers primarily to the distribution of muscle and fat in the body. The test performed is generally known as Body Mass Index (BMI) which is calculated from body weight (W) and height (H).

$$\text{BMI} = \frac{\text{weight (kg)}}{[\text{Height (m)}]^2}$$

   Take the height measurement on flooring that is not carpeted and against a flat surface. Have the participant stand with feet flat, together, and back against the wall. Make sure the legs are straight, arms are at sides and the shoulders are levelled. Make sure the participant is looking straight ahead and that the line of sight is parallel to the floor. Take the measurement while the participant stands with head, shoulders, buttocks and heels touching the flat wall. Use a flat headpiece to form a right angle with the wall and lower the headpiece until it firmly touches the crown of the head. Lightly mark where the bottom of the headpiece meets the wall. Then use a metal tape to measure from the base on the floor to the marked measurement on the wall to get the height measurement.

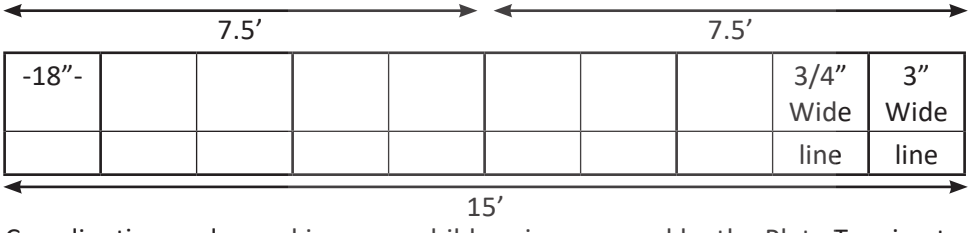
6. The Plate Tapping test is done to measure the speed and coordination of the of limb movement.

   **To Perform the Test:** The table height should be adjusted so that the subject is standing comfortably in front of the discs. The two yellow discs are placed on the table with their centres 60 cm apart.

The rectangle is placed equidistant between both the discs. The non-preferred hand is placed on the rectangle. The subject moves the preferred hand back and forth between the discs over the hand in the middle as quickly as possible. This action is repeated for 25 full cycles (50 taps). The time taken to do so is recorded as the score.

7. The abilities of children between 5 and 8 years are tested by three main tests, namely BMI, Plate Tapping test and Flamingo Balance test.
   (a) **Body Composition (BMI):** BMI primarily refers to the body-mass index, giving information on the distribution of muscle and fat in the body.
   (b) **Coordination (Plate Tapping):** Tests speed and coordination of limb movement.
   (c) **Balance (Flamingo Balance):** This test is used to measure the ability to balance successfully on a single leg. This single leg balance test is useful to assess the strength of the leg, pelvic, and trunk muscle as well as the static balance.
8. The following components are to be considered in Physical Health and Fitness Profile:

   Body Composition refers primarily to the distribution of muscle and fat in the body. Strength is measured by the Curl Up test. It measures abdominal muscular strength and endurance of the abdominals and hip flexors. Flexibility is measured by the Sit and Reach test. It specifically measures the flexibility of the lower back and hamstring muscles. The 600-Metre Run/Walk is used as a measure of cardiovascular fitness and endurance, and speed and acceleration are measured by the 50m Dash.
9. Muscular Endurance in 9 to 18 years of age is measured by Push-Ups for boys and Modified Push-Ups for girls. This test measures upper body strength endurance and trunk stability.

   A standard push-up begins with hands and toes touching the floor, the body and legs in a straight line, feet slightly apart, arms at shoulder width apart, extended and at right angles to the body. Keeping the back and knees straight, the subject lowers the body to a pre-determined point, until there is a 90-degree angle at the elbows, then returns to the starting position with arms extended. For girls, the push-up technique is with the knees resting on the ground. This helps in determining the endurance in children.
10. A 600-Metre Run/Walk is the test used as a measure of cardiovascular fitness and endurance. Participants are instructed to run 600 metres at their fastest possible pace. The participants begin on the signal "ready, start" as they cross the finish line. Elapsed time should be announced to the participants. Walking is permitted but the objective is to cover the distance in the shortest possible time. The score is the time taken for completion (Run or Walk) in minutes and seconds.
11. 


**C.** 1. Coordination and speed in young children is measured by the Plate Tapping test.

To perform the test, the table height should be adjusted so that the subject is standing comfortably in front of the discs. The two yellow discs are placed on the table with their centres 60 cm apart. The rectangle is placed equidistant between both the discs. The non-preferred hand is placed on the rectangle. The subject moves the preferred hand back and forth between the discs over the hand in the middle as quickly as possible. This action is repeated for 25 full cycles (50 taps). The time taken to do so is recorded as the score.

2. The Flamingo test, also known as the single leg balance test, is useful to assess the strength of the leg, pelvic and trunk muscle as well as the static balance.

**To perform the Test:** Stand on the beam. Keep balance by holding the instructor's hand, if required, to start. While balancing on the preferred leg, the free leg is flexed at the knee and the foot of this leg

is held close to the buttocks. The total number of falls or loss of balance in 60 seconds of balancing is recorded. Timing starts when the participant lets go of the instructor. If there are more than 15 falls in the first 30 seconds, the test is terminated. The test is used to measure the ability to successfully balance on a single leg.

3. (a) If you plan to test a group of people, decide date/time in advance.
   (b) Ensure that the playing field is flat and cleared of stones/pointed objects that may injure children.
   (c) Ensure that the required equipment is available at the place where tests are to be conducted.
   (d) Have a first aid box ready.
4. The Back Scratch Test is performed in standing position. One hand is kept behind the head and the test is to reach down gradually to touch the other hand in the middle of the back. The palm of the upper hand should be facing the body with fingers pointing downwards. The palm of the lower hand should face outwards and the fingers point upwards. With the fingers aligned, we measure the distance between the fingertips. Touching of the tips is considered a zero score. Overlapping constitutes a positive score and if the tips do not touch, then it is a negative score. Subjects are allowed to practice a couple of times and then two trials are done. Best of the two trials is taken as the final score.
5. Six-minute Walk Test is designed to test the overall functional fitness of senior citizens.

   Here, we test both the aerobic and anaerobic capacity of the subject. This permits routine activities such as walking, moving in markets and climbing up the stairs. A measuring tape and a stopwatch are needed to do this test. The walking distance is marked on a course with markers placed at regular intervals or the course measured prior to the test. The idea is to walk the maximum possible distance in six minutes. The distance covered in six minutes is measured to the nearest metre.
6. Such a person who has difficultly in tying shoe laces while sitting on a chair suffers from a lack of flexibility in the lower body. This is like the chair sit and reach test which is specially designed to help lower body flexibility which is vital not only for maintenance of good posture but also for normal day-to-day movements like tying shoe laces or even wearing socks.
7. Cardiovascular fitness is defined as the ability of the heart, blood cells and lungs to supply oxygen-rich blood to the working muscle tissues and the ability of the muscles to use oxygen to produce energy for movement. The Harvard Step Test is a good measurement of fitness and of a person's ability to recover after a strenuous exercise by checking the recovery rate. This test is simple to conduct and requires minimal equipment. We need a step or a platform 20 inches high, a stopwatch and a metronome or cadence tape. The athlete steps up and down on the platform at a rate of 30 steps per minute (every two seconds) for 5 minutes or until exhaustion. Exhaustion is defined as when the athlete cannot maintain the stepping rate for 15 seconds. The athlete immediately sits down on completion of the test and the total number of heartbeats is counted. There are two versions of the Harvard Step Test—the short form and the long form.
8. Rikli & Jones set up a series of six individual fitness test items involving common activities such as getting up from a chair, walking, lifting, bending and stretching. These tests were developed to be safe and enjoyable for the older people while still meeting the scientific standards for their reliability and validity. The list includes:

   Chair Stand Test—testing lower body strength

   Arm Curl Test—testing upper body strength

   Chair Sit and Reach Test— testing lower body flexibility

   Back Scratch Test—testing upper body flexibility

   8 Foot Up and Go Test—testing agility

   Walk Test (6 minutes) or Step in Place Test (2 minutes)
9. Although physical fitness has traditionally been associated with the young and the middle-aged, it is most critical for those in their advanced years. Elderly people require adequate strength, flexibility and endurance to accomplish even ordinary, everyday tasks. Assessing these components of fitness

can detect weaknesses which can be treated before causing serious functional limitations. The Senior Fitness Test was developed by Dr. Roberta Rikli and Dr. Jessie Jones. It is a simple, easy-to-use battery of tests that assesses the functional fitness of older people. The test describes easy-to-understand and effective tests to measure aerobic fitness, strength and flexibility using minimal and inexpensive equipment.

Individual fitness test items involve common activities such as getting up from a chair, walking, lifting, bending and stretching. These tests were developed to be safe and enjoyable for the older people, while still meeting the scientific standards for their reliability and validity.

10. To measure BMI, we need to use a flat headpiece to form a right angle with the wall and lower the headpiece until it firmly touches the crown of the head. Lightly mark where the bottom of the headpiece meets the wall. Then use a metal tape to measure from the base on the floor to the marked measurement on the wall to get the height measurement. To measure weight, use a weighing machine.

    To do the Plate Tapping Test, we need a table (adjustable height), 2 yellow discs (20 cm diameter), rectangle (30 × 20 cm) and a stopwatch.

    For the Flamingo Balance Test, the equipment needed is a stopwatch, beam locally procured of standard brick shape and height.

11. The back roll is a task in which the individual performs a backward somersault, rolling over the shoulders and upper back, and landing on the feet. The test is similar to the front roll both in performing and scoring. The subject is to start outside the marked chart area and perform two back rolls in the 2 feet lane area, one up to the first half and the second back roll in the second half. Each correct roll gets 5 points, hence maximum of 10 points. Two points are deducted for over-reaching side line, right or left for each roll; one point is deducted for over reaching the end limit on each roll and full five points are deducted when the subject fails to perform a true back roll.

**D.** 1. The Senior Citizen Fitness Test is a simple, easy-to-use battery of tests that assesses the functional fitness of older people.

The list includes:

**Chair Stand Test:** It is performed using a chair at least 44 cm high and a stopwatch to measure time. To perform this test, the subject sits in the middle of the chair. The test starts with standing up and then sitting down. The number of stands in a 30-second period is the final score.

**Arm Curl Test:** It is performed for testing upper body strength The procedure to be followed in this test is to find out the maximum number of arm curls that one can complete in 30 seconds. This is done using the dominant arm.

**Chair Sit and Reach Test:** It is for testing lower body flexibility. We need a straight-backed chair 44 cm high and a scale to measure the movement. The subject sits on the edge of the chair. The chair is placed firmly against the back of a wall. While one leg is placed with the foot flat on the ground, the other leg is fully extended at the knee. Both hands are placed on top of each other with the middle fingers being in identical position while the back is held up straight. When there is no contact between the fingertips and toes, this is measured and considered a negative score. If the fingertips overlap the toes, this is considered a positive score.

**Back Scratch Test:** It is for testing upper body flexibility. In standing position, one hand is kept behind the head and the test is to reach down gradually to touch the other hand in the middle of the back. With the fingers aligned, we measure the distance between the fingertips. Touching of the tips is considered a zero score. Overlapping constitutes a positive score and if the tips do not touch, then it is a negative score.

**8 Foot Up and Go Test:** It is widely used as a test of agility and coordination in elderly people. The main purpose of this test is to find out balance, speed and agility in elderly persons. To carry out this test, place a flat-backed chair against a wall and make the subject walk towards a marker that is kept at a distance of eight feet. The score is the time taken.

**Walk Test (6 minutes):** The idea is to walk the maximum possible distance in six minutes. The distance covered in six minutes is measured to the nearest metre.

2. **8 Foot Up and Go Test:** This test is widely used as a test of agility and coordination in elderly people. The main purpose of this test is to find out balance, speed and agility in elderly persons. These movements are done on a daily basis as in answering a doorbell or getting off a public transport efficiently. We need a stopwatch and a clear, obstacle-free area. Besides, we need to have a marker and a tape measure. To carry out this test, place a flat-backed chair against a wall. A marker is kept at a distance of eight feet. At the start of the stopwatch, the subject gets up and walks quickly towards the cone, turns back and returns to sit down on the chair. The score is the time taken. Sometimes, two trials can be offered and the best of the two is taken as the score.
3. Cardiovascular Endurance, also known as aerobic endurance, is measured by the 600-Metre (Run/Walk). This test is also used as a measure of Cardiovascular Fitness.

   To Perform the Test, participants are instructed to run 600 metres at their fastest possible pace. The participants begin on the signal "ready, start" as they cross the finish line. Elapsed time should be announced to the participants. Walking is permitted but the objective is to cover the distance in the shortest possible time. The score is the time taken for completion (Run or Walk) in minutes and seconds.
4. Cardiovascular fitness is defined as the ability of the heart, blood cells and lungs to supply oxygen-rich blood to the working muscle tissues and the ability of the muscles to use oxygen to produce energy for movement. The Harvard Step Test is a type of cardiac stress test for detecting and diagnosing cardiovascular disease. It is also a good measurement of fitness and of a person's ability to recover after a strenuous exercise by checking the recovery rate. The Harvard Step Test was developed by Brouha et al. in 1943. This test is simple to conduct and requires minimal equipment. We need a step or a platform 20 inches high, a stopwatch and a metronome or cadence tape. The athlete steps up and down on the platform at a rate of 30 steps per minute (every two seconds) for 5 minutes or until exhaustion. Exhaustion is defined as when the athlete cannot maintain the stepping rate for 15 seconds. The athlete immediately sits down on the completion of the test and the total number of heartbeats is counted.

   There are two versions of the Harvard Step Test—the short form and the long form.
5. Body Composition refers primarily to the distribution of muscle and fat in the body. The test performed is generally known as Body Mass Index (BMI) which is calculated from body weight (W) and height (H).

$$\text{BMI} = \frac{\text{weight (kg)}}{[\text{Height (m)}]^2}$$

   Higher the score, higher is the level of body fat.

   To perform the test, take the height measurement on flooring that is not carpeted and against a flat surface. Have the participant stand with feet flat, together, and back against the wall. Make sure legs are straight, arms are at sides, and shoulders are levelled. Make sure the participant is looking straight ahead and that the line of sight is parallel to the floor. Take the measurement while the participant stands with head, shoulders, buttocks and heels touching the flat wall. Use a flat headpiece to form a right angle with the wall and lower the headpiece until it firmly touches the crown of the head. Lightly mark where the bottom of the headpiece meets the wall. Then use a metal tape to measure from the base on the floor to the marked measurement on the wall to get the height measurement.

Skin fold calipers are used to measure skin fold thickness which was considered to correspond to body fat. Nowadays, body fat is measured with electronic devices such as Body Impendence measurement machines that measure the total body fat content and its location as well.

6. The Rockport walk test is a straightforward test that involves walking and is used to measure cardiorespiratory fitness. For the test, the individual walks one mile (1.6 km) as fast as possible. To make sure that the individual is walking instead of running, they must have one foot in contact with the ground at all times. The one-mile walking test is an evaluation of cardiovascular fitness that seeks to predict an individual's aerobic capacity, which is also known as $VO_2$ max, or maximal oxygen consumption. The one-mile walking test was developed by researchers in 1986 as an alternative assessment to accurately predict an individual's aerobic capacity following a one-mile track walk. The test is both indirect and sub-maximal in nature, making it considerably easier to implement in field-based scenarios. While the test should be completed on a track or suitably flat terrain, it could reasonably be replicated on a treadmill. The one-mile walking test is designed for both men and women aged 20-69 of varying levels of fitness. As the test only requires a participant to perform brisk walk, it is also suitable for deconditioned participants, older adults or those who are overweight. Research conducted in 2011 found the one-mile walk test to be a valid predictor of $VO_2$ max and a reliable alternative to the 1.5-mile run test that is widely used by the military.
7. Johnson-Methney Motor Educability Test is used to find out motor educability, which refers to the ability to learn or the cognitive capacity to learn new skills.

   The test battery consists of the following four motor activities:

   (a) Front Roll
   (b) Back Roll
   (c) Jumping Half-Turns
   (d) Jumping Full-Turns

   While all four are to be performed by boys, only the first three tests are used in the case of girls.

   **Front Roll:** The front roll is a task in which the individual is required to execute a forward somersault, rolling over the head and shoulders and landing on the feet. This task assesses the individual's coordination, body awareness and ability to perform a controlled movement in a sequential manner.

   **Back roll:** The back roll is a task in which the individual performs a backward somersault, rolling over the shoulders and upper back and landing on the feet. The test is similar to the front roll both in performing and scoring. The subject is to start outside the marked chart area and perform two back rolls in the 2 feet lane area, one up to the first half and the second back roll in the second half.

   **Jumping Half-Turns:** The jumping half-turn involves the individual executing a vertical jump while simultaneously rotating the body 180 degrees horizontally. This task assesses the individual's ability to generate power and control during a jump, as well as their spatial awareness and coordination in performing rotational movements.

   **Jumping Full-Turns:** The jumping full-turn is similar to the jumping half-turn, but the individual is required to rotate the body a full 360 degrees horizontally while in the air. This task evaluates the individual's ability to generate power, maintain balance and coordinate the body's movements in a more complex and advanced manner.

CHAPTER 7

# Physiology & Injuries in Sports

**B.** 1. The range of movement at a joint is called flexibility. Many factors determine flexibility; the important ones are muscle strength, joint structure, age and gender and muscle stretchability. Body temperature and past injuries.

2. Blood Pressure is the end result of the pressure exerted by blood on the walls of blood vessels. Pumping of the heart causes this and we can classify it into two types—systolic and diastolic. Systolic blood pressure is the pressure measured as a result of contraction of the heart called systole. Diastolic blood pressure is the pressure on vessels during the relaxation of heart called diastole. Difference between the two is called pulse pressure.

3. The cardiac output is the amount of blood pumped by the heart per minute. The cardiac output is usually expressed in litres/minute. The stroke volume and the pulse rate determine the cardiac output. A normal adult has a cardiac output of about 4.5 litres of blood per minute.

4. Hypertrophy of muscles means an increase in the size and bulk of the muscle. Especially true of the skeletal muscles, the shape and form of the human body is enhanced by regular exercise because of this change. This process increases the strength of the muscles, enabling better exercising capacity.

5. Muscle fatigue is diminished in regularly-used muscles. Muscles are sore because of accumulation of lactic acid as well as carbon dioxide and acid phosphatase. Regularly exercising the muscles lowers this accumulation and delays fatigue. Moreover, since the muscle strength and endurance go up by regular exercise, they can work longer without getting tired, and hence, diminished fatigue.

6. With age, the skin becomes drier and brittle, which can lead to more wrinkles. The fat layer under the skin thins, results in less sweating. This may seem like a good thing but it makes you more susceptible to heat stroke and heat exhaustion in the summer. Fine lines appear around the outer side of eyes, at the cheeks and chin and around the neck.

7. Excessive noise throughout your lifetime can cause hearing loss as you age. Many older people have difficulty in hearing high-pitched voices and sounds, trouble hearing in busy places and more frequently accumulating earwax. Age-related hearing loss, also called presbycusis, comes on gradually as a person grows older. It seems to run in families and may occur because of changes in the inner ear and auditory nerve, which relays signals from the ear to the brain.

8. Ageing is accompanied by changes in all body organs and systems.

   **Digestive System:** Swallowing and digestive reflexes slow down with age. Swallowing may become difficult as the esophagus contracts less forcefully.

   **Kidneys and Urinary Tract:** The kidneys lose cells and become smaller with age. Urinary incontinence may occur due to a variety of health conditions.

   **Brain and Nervous System:** Memory loss occurs and our nervous reflexes slow down.

   **Eyes:** Common eye problems associated with age include cataract, glaucoma and macular degeneration.

   **Ears:** Many older people have difficulty in hearing high-pitched voices and sounds.

   **Hair, Skin and Nails:** With age, skin, hair and nails become drier and brittle. Hair thins and turns grey.

   **Weight:** Fluctuations in weight occur.

9. Separation of a bone from its normal position at a joint is called dislocation. This is evidenced by visible displacement of the joint, intense pain, swelling, discoloration and/or total immobility of the affected area. In case the joint is not completely disrupted, it is labelled as subluxation which indicates partial dislocation of the joint. It can also be accompanied by a break in the bones and is then called a fracture dislocation.

10. Greenstick fractures are peculiar to young children, where the bone bends rather than breaking and only one cortex of the bone is involved. This causes the bone to bend rather than break and may not even be initially seen in x-rays.

**C.** 1. The effects of regular exercise on respiratory system are as below:

(a) **Increased Respiratory Rate:** As one adapts to exercise, the amount inhaled and exhaled with each breath increases.

(b) **Increased Size of Chest and Lungs:** Regular exercise impacts the muscles of the respiratory system as well as lung size. Stronger muscles of the chest walls lead to a more efficient respiratory process.

(c) **Increase in Air Volume:** Both Tidal volume and Minute volume increase.

(d) **Increased Alveolar Use:** Physical activity causes even the most remote alveoli to get inflated and active.

(e) **Delayed Second Wind:** Beginners feel the early onset of breathlessness on activity. As we carry on the activity, the lungs get adapted and the second wind gets minimised, and in many athletes, does not occur at all.

(f) **Increased Endurance:** Regular and longer exercise leads to increased endurance. Fatigue and energy loss decreases and capacity to exercise increases. Also, recovery post exercise becomes better and faster.

2. The skeletal system works as a support structure for our body. It gives the body its shape, allows movement, makes blood cells, provides protection for organs and stores minerals. To sum up, the five major functions of the skeletal system are as follows –

(a) **Support** – The bones and cartilages provide the framework to maintain the body shape.

(b) **Protection** – The vital function of the skeletal system is to protect the internal organs. The structures like the skull, rib cage and vertebrae protect the brain, lungs and spinal cord respectively.

(c) **Movement** – A wider range of body movements is because of the coordinated action of the skeletal system, nervous system and muscles.

(d) **Storage of Minerals** – Bones are a reservoir of minerals like phosphorus and calcium. They also play an important role in calcium metabolism.

(e) **Production of Blood cells** – The bone marrow is a site of haematopoiesis where the formation of blood cells takes place.

3. The differences between the genders in body composition are well known:

(a) Males typically have proportionately more muscle mass, more bone mass and a lower percentage of body fat than women. Males are normally heavier, taller and stronger than females. It has been seen that males have large hearts and lungs when compared to females.

(b) Another physical difference that can be seen between males and females is that the males have more body hair, especially in the chest region.

(c) Females have puberty changes about two years earlier to males. While fertility in females decrease as they age, especially after 35 years, and ends with menopause, males are fertile even in their old age.

(d) While males are physically more aggressive, females tend to be passive.

(e) Females tend to express great intensity of emotion when compared to males.

4. Experts define physical fitness as "one's ability to execute daily activities with optimal performance, endurance, and strength with the management of disease, fatigue, and stress and reduced sedentary behaviour." This description goes beyond being able to run quickly or lift heavy weights. Physical fitness can be broadly divided into Metabolic fitness, Health-related and Skill-related. Metabolic fitness depicts the physiological systems' state of health when they are at rest. This is reflected in blood pressure, pulse rate and blood sugar levels.

The components of health-related fitness includes: body composition, muscular endurance, muscular strength, cardiovascular endurance and flexibility. It is also known as performance-related fitness components. It is associated with athletic competition but should be considered in the overall fitness of all individuals. These components pertain to the athletic ability of an individual. There are 6 components of physical fitness: balance, co-ordination, agility, speed, power, and reaction time. Thus, physical fitness is indeed multidimensional.

5. The oxygen we get from the atmosphere is the oxygen intake while as oxygen uptake is defined as the capacity of the muscle to absorb and consume oxygen.

   The effects of exercise on respiratory system are elucidated below:

   (a) **Increased Respiratory Rate:** Physical activity requires more energy and oxygen. This results in increased respiratory rate.

   (b) **Increased Size of Chest and Lungs:** Regular exercise impacts the muscles of the respiratory system as well as lung size. Stronger muscles of the chest walls lead to a more efficient respiratory process.

   (c) **Increase in Air Volume:** Both Tidal Volume and Minute Volume increase.

   (d) **Increased Alveolar Use:** Physical activity causes even the most remote alveoli to get inflated and active.

   (e) **Delayed Second Wind:** Beginners feel the early onset of breathlessness on activity. With exercise, the lungs get adapted and the second wind gets minimised.

   (f) **Increased Endurance:** Regular and longer exercise leads to increased endurance.

6. Endurance can be defined as the capacity to sustain an activity at a desired rate and speed. A few determinants of endurance include:

   (a) **Aerobic Capacity:** This, in turn, depends upon factors such as oxygen intake, oxygen circulation, oxygen uptake and energy/biochemical reserve.

   (b) **Lactic Acid Tolerance:** Accumulation of lactic acid in the muscles causes tiredness and cramping of the muscles. It is produced as energy is released during anaerobic respiration. It is possible to increase tolerance to lactic acid so that endurance can be increased.

   (c) **Economy of Movement:** Restrained activity preserves energy. Unnecessary movements by athletes cause wasteful expenditure of energy. Unnecessary hand and head movements during running burn up excess energy.

   (d) **Muscle Composition:** The ratio of fast twitch muscle to slow twitch muscle determines an athlete's performance. More the slow twitch fibre, more will be the endurance, especially for marathon and long-distance runners.

7. Injuries on field can occur not only during competitive events but also while practising. Most sportspersons sustain some injury during their formative and competitive careers. No matter how well the preparedness, occurrence of injury is natural. Some sports like physically active contact sports, such as kabbadi, football and hockey, involve higher risks of injuries. While it is difficult to associate injuries as being specific to a sport, we know that some injuries are common to a particular sport.

   It is judicious and scientific to divide sports injuries into the following broad groups:

   - Soft tissue injuries
   - Bone & joint injuries

   Use of protective equipment as well as adequate warm-up, sufficient hydration and nutritional care help minimise injuries. Experts should be made available during all events of a competition. Wear the right gear. Players should wear appropriate and properly fit protective equipment such as pads (neck, shoulder, elbow, chest, knee, shin), helmets, mouthguards, face guards, protective cups and eyewear.

8. Bone Injuries are called fractures. These are among the more serious injuries needing a lot of attention to treatment and rehabilitation. Most bone injuries resolve with no sequelae but some injuries can mean the end of the sporting career.

   Depending upon the type and severity, fractures are classified into the following types:

   (a) **Simple fracture:** When there is no wound and the bone is broken at one place only.

   (b) **Compound fracture:** When the bone is broken and comes out to the surface through the muscles and the skin.

   (c) **Greenstick fracture:** This occurs in young children where the bone bends rather than break and only one cortex of the bone is involved.

   (d) **Comminuted fracture:** When the bone is broken into many pieces at one place or at different places.

   (e) **Oblique fracture:** This occurs when a bone breaks diagonally. It can be displaced or non-displaced.

9. Speed is a vital component of physical fitness. The physiological factors that determine speed are:

   (a) **Nerve impulse excitability:** Muscle activity is controlled by the nervous system. Faster the excitation and inhibition of the nerve impulse, faster is the relaxation and contraction of the muscle. This, thus, determines the speed of the person.

   (b) **Muscle composition:** More the fast twitch or white fibre, faster will be the speed the muscle can attain.

   (c) **Strength:** Muscle strength is classified as strength endurance, maximum strength and explosive strength. Sports like boxing depend upon explosive strength in order to deliver quick punches. More the explosive strength of the muscle, faster will be the speed that can be reached. Training can improve this aspect of the muscle. On the other hand, strength endurance is needed in sports like long-distance running or cycling.

   (d) **Flexibility:** This is the capacity to move the muscles and joints. Higher flexibility means higher capacity to move fast, so faster the speed.

   (e) **Energy reserve and metabolic power:** Energy in our body comes from ATP and CP. These represent the biochemical reserves of our bodies, and with metabolic power, determine the speed.

10. Endurance can be defined as the capacity to sustain an activity at a desired rate and speed. A few determinants of endurance include:

    (a) **Aerobic Capacity:** This, in turn, depends upon factors such as oxygen intake, oxygen circulation, oxygen uptake and energy/biochemical Reserve.

    (b) **Lactic Acid Tolerance:** Accumulation of lactic acid in the muscles causes tiredness and cramping of the muscles. It is produced as energy is released during anaerobic respiration. It is possible to increase tolerance to lactic acid so that endurance can be increased.

    (c) **Economy of Movement:** Restrained activity preserves energy. Unnecessary movements by athletes cause wasteful expenditure of energy. Unnecessary hand and head movements during running burn up excess energy.

    (d) **Muscle Composition:** The ratio of fast twitch muscle to slow twitch muscle determines an athlete's performance. More the slow twitch fibre, more will be the endurance, especially for marathon and long-distance runners.

**D.** 1. Sports medicine is the branch of medicine and related techniques that deals with the prevention, diagnosis, treatment and rehabilitation of sports injuries or illness resulting from participation in sports activities. With the culture of sports and working out steadily growing all over India, the practice of Sports Medicine is increasingly becoming a promising career option, especially for those interested in the sphere of fitness. It is only since the late 20th century that sports medicine emerged as a distinct field of health care. In some countries, sports medicine, also known as sport and exercise medicine, is a recognised medical specialty. In the majority of countries where sports medicine is recognised and practised, it is a non-surgical specialty, but in some, it can equally be a surgical or

non-surgical medical specialty and also a specialty field within primary care. In other contexts, the field of sports medicine encompasses the scope of both medical specialists and also allied health practitioners who work in the field of sport, such as physiotherapists, athletic trainers, podiatrists and exercise physiologists. The various sports medicine experts often work together as a team to ensure the best recovery plan for the individual. Team members can include orthopedic surgeons, certified athletic trainers, sports physical therapists, physical medicine and rehabilitation specialists.

2. Sports injuries can be prevented if attention is paid to the few measures:
   (a) **Take time off:** Plan to have at least 1 day off per week and at least one month off per year from training for a particular sport. This allows the body to recover.
   (b) **Wear the right gear:** Players should wear appropriate and properly fit protective equipment such as pads (neck, shoulder, elbow, chest, knee, shin), helmets, mouthguards, face guards, protective cups and eyewear. However, young athletes should not assume that protective gear will prevent all injuries while performing more dangerous or risky activities.
   (c) **Strengthen muscles:** Conditioning exercises during practice strengthens muscles used in play.
   (d) **Increase flexibility:** Stretching exercises after games or practice can increase flexibility. Stretching should also be incorporated into a daily fitness plan.
   (e) **Use proper technique:** This should be reinforced during the playing session.
   (f) **Play safe:** Strict rules against headfirst sliding (baseball and softball), spearing (football) and checking (in hockey) should be enforced.
   (g) **Stop the activity if it hurts:** Don't play or exercise through pain.
   (h) **Take breaks:** Rest periods during practice and games can reduce injuries and prevent heat strokes.
   (i) **Drink plenty of fluids:** Drink enough fluids before, during and after exercise or play to avoid dehydration. In addition, decrease or stop practices or competitions during high heat/humidity periods and wear light clothing.
   (j) **Healthy Diet:** Be well-nourished and take care of diet, so proper muscle strength and flexibility is ensured.
3. Exercise causes the muscles to contract which leads to increased demand for oxygen. Energy levels can be raised by increasing blood supply to the muscles. This affects the cardiovascular system in the following manner:
   (a) **Increased Heart Rate:** The heart rate increases from the resting rate of 72 to as much as double of this. Higher heart rate means that more blood is being pumped into circulation. This increases the oxygen reaching the muscles.
   (b) **Enhanced Blood Flow:** Physical activity requires more blood for the muscles. This happens as a result of temporary diversion of blood from other organs, such as liver and spleen, to meet the increased demand.
   (c) **Increased Stroke Volume:** Consequent to exercise, the amount of blood pumped by the heart with each contraction increases. Normally, at rest, 70-90 ml of blood is pumped out, but during strenuous exercise, this can go as high as 180-200 ml per beat. Experienced athletes have, however, higher output of blood even at rest.
   (d) **Increased Cardiac Output:** The resting cardiac output of about 4.5 litres of blood per minute can go up to as much as 20-40 litres as a result of strenuous activity.
   (e) **Increased Blood Pressure:** Generally, the systolic blood pressure ranges between 110-130 mm at rest and the diastolic pressure between 60-90 mm. However, during exercise, systolic blood pressure tends to go up to 200 mm. Diastolic blood pressure, however, remains more or less constant while exercising unless there is a pre-existing heart disease.

4. While there are many physiological factors that determine flexibility, the three important ones are:
   (a) **Muscle Strength:** The muscle should be able to overcome fixed resistance for it to be strong. Stronger the muscle, more flexible it is likely to be. Lifting a body part against gravity, for example, lifting the leg to hit the ball in football, is dependent on the flexibility of the abdominal muscles. Training improves strength and flexibility of most muscles.
   (b) **Joint Structure:** Type of the joint as well as range of its movement is an important physiological factor in flexibility. The shoulder joint is the most flexible joint having the capacity to move in a 360-degree range while the spine joints are the most flexible in forward and backward-bending actions. Thus, joint structure is a significant determinant of flexibility.
   (c) **Age and Gender:** As a general rule, more the age, less will be the flexibility. Also, females tend to be less stiff and more flexible than males. Since the body is trainable, we can enhance flexibility with proper training even in older athletes.
5. Muscles, tendons and ligaments are the soft tissues in the body. Soft tissue injuries are as follows:
   (a) **Abrasion:** Abrasions occur mostly on the skin as a result of scraping or wearing away. Abrasions are superficial and heal without leaving scars. The area just needs to be cleaned with gauge and left alone after applying sterile antiseptic solution. However, if players warm up, wear proper protective equipment such as pads, and other gears., and are well-versed in the technique of the sport, they can help decrease the risk of abrasions.
   (b) **Contusion:** It means a region of injured tissue or skin in which blood capillaries have been ruptured as a result of blow to the skin. Contusion occurs after being hit by an object or a body part or by a hard, direct contact to the skin or muscles as in boxing. Protective equipment as well as care on the part of the players helps prevent contusions.
   (c) **Laceration:** It is a deep cut or tear in skin or flesh; it is mostly jagged and irregular. There is bleeding from the wound. Wearing protective gear, using proper equipment and understanding the danger while using sharp equipment as in sword fighting, fencing, etc., is the key to prevention.
   (d) **Sprain:** A sprain is an injury to the ligaments. Sprains can occur from an unexpected twist during different activities. The best way to prevent sprains is to maintain good muscle strength, balance and flexibility.
   (e) **Strain:** A strain is an injury to the tendons, muscles or their junction. Among the factors that predispose to muscle strain are muscle tightness due to lack of adequate pre-sport stretching. Poor conditioning and muscle fatigue also make the muscles more prone to injury.
6. Being physically active has long-term positive effects on the cardiovascular system which are as follows:
   (a) **Increased Heart Size:** Since the muscles of the heart become stronger, the size and volume of the heart also increases.
   (b) **Slower Heart Rate:** Resting heart rate tends to come down. Lower heart rate means a more efficient heart.
   (c) **More Stroke Volume:** Regular exercise causes the heart to pump more blood with every contraction.
   (d) **Better Cardiac Output:** As the stroke volume and rate increase, the output also goes up. Bigger heart size and strength means more output.
   (e) **Better Capillary Network:** People who exercise regularly have more open and higher number of capillaries. This increases the reach of oxygen and other nutrients to the organs because the blood flow is better, thus improving the overall organ health.
   (f) **Decreased Blood Pressure at Rest:** A stronger heart pumps with less effort while at rest, so the blood pressure tends to be lower.

(g) **More Blood Volume:** Increased blood volume means more blood reaches the heart, improving cardiovascular fitness. Also, the number of oxygen-carrying red blood cells tends to increase so that it can cope with increased oxygen demand during exercise.

(h) **Better Recovery Rate:** Post-exercise recovery is quicker in those who exercise regularly. Breathing also normalises faster as does the heart rate if one exercises on a daily basis.

(i) **Lower Risk of Diseases:** Risk of getting diabetes as well as high cholesterol, etc., is lower in people who exercise regularly. Exercising on a regular basis has proved to be effective in preventing lifestyle diseases such as high blood pressure, depression, etc.

7. Sports injuries are divided into the following broad groups:
   - Soft tissue injuries
   - Bone & joint injuries

   Muscles, tendons and ligaments are the soft tissues in the body. Soft tissue injuries are as follows:

   (a) **Abrasion:** Abrasions occur mostly on the skin as a result of scraping or wearing away.

   (b) **Contusion:** It means a region of injured tissue or skin in which blood capillaries have been ruptured as a result of blow to the skin.

   (c) **Laceration:** It is a deep cut or tear in skin or flesh, caused by a sharp object.

   (d) **Sprain:** A sprain is an injury to the ligaments caused by an unexpected twist during activities.

   (e) **Strain:** A strain is an injury to the tendons, muscles or their junction.

   Bone Injuries are called fractures. These are among the more serious injuries. Depending upon the type and severity, fractures are classified into the following types:

   (a) **Simple fracture:** When there is no wound and the bone is broken at one place only.

   (b) **Compound fracture:** When the bone is broken and comes out to the surface through the muscles and the skin.

   (c) **Greenstick fracture:** This occurs in young children where the bone bends rather than breaking and only one cortex of the bone is involved.

   (d) **Comminuted fracture:** When the bone is broken into many pieces at one place or at different places.

   (e) **Oblique fracture:** This occurs when a bone breaks diagonally. It can be displaced or non-displaced.

8. Ageing is accompanied by many changes in brain and contributes to progressive cognitive decline. In normal ageing, brain changes have been relatively mild but important changes in structural, biochemical and molecular level are noticeable. As we age, we naturally lose cells. This is even true of the brain. Memory loss occurs as the number of brain cells decreases. The brain can compensate for this loss by increasing the number of connections between cells to preserve brain function. Also, in old age, our nervous reflexes may slow down. Focus distraction is more likely and coordination between various senses is affected. As we age, our brain and nervous system go through natural changes. The brain and spinal cord lose nerve cells and weight, and this is called age-induced atrophy. Nerve cells may begin to pass messages more slowly than in the past. Waste products or other chemicals such as beta amyloid can collect in the brain tissue as nerve cells break down. Representatively, ageing-associated brain changes include alteration in neurotransmitters and damage accumulation in cellular environment. These effects have causative link with age-associated changes which ultimately result in cognitive decline.

9. The heart pumps all day and night, whether one is awake or asleep. It pumps more than 2.5 billion beats during our lifetime! As one ages, blood vessels lose their elasticity, fatty deposits build up against artery walls and the heart has to work harder to circulate blood through the body. These changes may result in a slightly slower heart rate. The heart may fill more slowly. A slight increase in the size of the heart, especially the left ventricle, occurs in some people. The heart wall thickens, so the amount of blood that the chamber can hold may actually decrease despite the increased

overall heart size. This can lead to high blood pressure and hardening of the arteries. Taking proper care of the body with the right kind of food and regular exercise helps keep the heart healthy and strong. During rest, the older heart functions in almost the same way as a younger heart, except the heart rate is slightly lower. Also, during exercise, older people's heart rate does not increase as much as in younger people. There are age-related changes in the electrical system that can lead to **arrhythmias**—a rapid, slowed or irregular heartbeat. Valves that open and close to control blood flow between the chambers of the heart may become thicker and stiffer. Stiffer valves can limit the flow of blood out of the heart and become leaky, both of which can cause fluid to build up in the lungs or in the body (legs, feet and abdomen). With increasing age, people become more sensitive to salt, which may cause an increase in blood pressure and/or ankle or foot swelling. Thus, there are microscopic and macroscopic changes in cardiovascular structure, function, protective systems and disease associated with ageing.

10. As we age, our bones shrink in size and density. They become more prone to fractures because of loss of bone density called osteoporosis. Muscles, tendons and joints tend to lose strength and flexibility. Posture tends to become stooped. Bones become more brittle and may break more easily. Overall height decreases, mainly because the trunk and spine shorten. Breakdown of the joints may lead to inflammation, pain, stiffness and deformity. Joint changes affect almost all older people. People lose bone mass or density as they age, especially women after menopause. The bones lose calcium and other minerals. The foot arches become less pronounced, contributing to a slight loss of height. The long bones of the arms and legs are more brittle because of mineral loss, but they do not change length. This makes the arms and legs look longer when compared with the shortened trunk. The joints become stiffer and less flexible. Fluid in the joints may decrease. The cartilage may begin to rub together and wear away. Minerals may deposit in and around some joints. Lean body mass decreases. This decrease is partly caused by a loss of muscle tissue. The muscle fibers shrink. Muscle tissue is replaced more slowly. Lost muscle tissue may be replaced with a tough fibrous tissue. Muscles become less toned as they become rigid with age. The posture may become more stooped and the knees and hips may become more flexed. The neck may tilt and the shoulders may narrow, while the pelvis becomes wider. Movement slows and may become limited. The gait becomes slower and shorter. Strength and endurance change. Loss of muscle mass reduces strength.

CHAPTER 8

# Biomechanics and Sports

**B.** 1. The line of gravity is a vertical line from the centre of gravity to the ground the athlete is on. The closer the line of gravity is to the base of support, the better balanced a person is in this position. Line of gravity is important in sports like basketball, where centralising the line of gravity near the base increases stability. This is achieved by having a straight back and head which are held upright to centralise the line of gravity. To get this, crouching and a deep knee bend help lower the centre of gravity and consequently the line of gravity.

2. There are two properties of the centre of gravity that have a great impact on high jump. First of all, its location is dependent on the shape of the body. So, if the same body is to take a different shape, the position of the centre of gravity will shift. Dick Fosbury, by this change in body shape, was able to move his centre of gravity outside his body. Secondly, the energy required for a jump depends on the height of the centre of gravity. So, by lowering its position one also lowers the energy required to clear the bar.

3. Friction is an important force in our lives and sports. It allows us to grip sports equipment, run and even perform well. The use of spiked footwear in sports like racing and use of studs in football shoes and even cricket shoes ensure that friction offers an advantage as a stabiliser. The use of dusting powder by gymnasts and by carrom players is an effort to use friction to their advantage. Sports equipment like badminton racquets have rough grips on the handle to offer the players a stronger hold. During cycling, friction from the track offers protection from skidding off.

4. Static Friction is a force that keeps an object at rest. It must be overcome to start moving the object. When the opposing surfaces of the objects in motion are irregular, they increase resistance to movement. When we try to push a desk or a table and it does not move, it is because of the static friction being exerted.

5. Newton described three Laws of Motion which form the basis of mechanics—

   **1st Law of Motion, (Law of Inertia):** It states that ''a body continues to remain in its state of rest or uniform motion in a straight line unless it is compelled by an external force to change that state."

   **2nd Law of Motion:** It states that "the acceleration produced in a body is proportional to the force applied." This is also known as the Law of Acceleration.

   **3rd Law of Motion:** It states that "for every action there is an equal and opposite reaction." This is also known as the Law of Reaction.

6. Friction is an important force in our lives and sports. It allows us to grip sports equipment, run and even perform well. The use of spiked footwear in sports like racing, use of studs in football shoes and even cricket shoes ensure that friction offers an advantage as a stabiliser.

7. This is Newton's first Law of Motion which states that ''a body continues to remain in its state of rest or uniform motion in a straight line unless it is compelled by an external force to change that state." This is also known as the Law of Inertia. Examples of application of the 1st law of motion in sports are: A diver standing still on the diving board, a runner static at the starting blocks, cyclists move only when they start pedalling and continue to move unless they apply brakes; in boxing, the opponent breaks the movement and stops the moving fist.

8. There are two properties of the centre of gravity that have a great impact on sport. First of all, its location is dependent on the shape of the body. During the Olympic Games in Mexico, in 1968, Dick Fosbury used these principles to create a truly ingenious leap by clearing the bar with his back, and by changing the shape of his body, he could clear the bar without his centre of gravity having to also clear it. He did so by isolating the centre of gravity by changing body shape. By this change in body shape, he was able to move his center of gravity outside his body.

9. Newton's First Law of Motion states that ''a body continues to remain in its state of rest or uniform motion in a straight line unless it is compelled by an external force to change that state." This is also known as the Law of Inertia. Examples of application of the 1st Law of Motion in sports are: A diver standing still on the diving board, a runner static at the starting blocks, cyclists move only when they start pedalling and continue to move unless they apply brakes; in boxing, the opponent breaks the movement and stops the moving fist.
10. Friction is an important force in our lives and sports. It allows us to grip sports equipment, run and even perform well. While friction is advantageous in many cases, sometimes it becomes disadvantageous as well. The use of spiked footwear in sports like racing, use of studs in football shoes and even cricket shoes ensure that friction offers an advantage as a stabiliser. The use of dusting powder by gymnasts and by carrom players is an effort to use friction to their advantage. Sports equipment like badminton racquets have rough grips on the handle to offer the players a stronger hold. During cycling, friction from the track offers protection from skidding off.
11. A projectile is anybody which is thrown or tossed into the air. Once it has left the ground it will follow a flight path called a parabola until it comes down to earth. This applies to balls, javelins, discus, long jumpers, high jumpers and horses' show jumping. In real life, the projectile motion finds applications in sports. Playing basketball and football are examples of projectile motion in real life. While throwing a basketball into the basket, the player shoots the ball in such a way that the flight taken by the ball is in the form of a parabola. Projectile Motion describes the motion of the ball. Whether it is a serve, set or dig, volleyball will always travel in a parabolic motion. This is because the only force that acts on the ball after the ball is thrown is gravity, assuming there is no air resistance.
12. Centre of gravity is that point in a body or system around which its mass or weight is evenly distributed or balanced, and at which, the force of gravity acts. The centre of gravity is fixed, provided the size and shape of the body do not change. Lowering the centre of gravity increases balance and stability in sports. This is why one can change direction faster by bending the legs and getting lower to the ground. It increases stability, thus allowing one to adjust quickly due to greater force produced by the leg. The force of gravity influences the movements in sports.
13. Biomechanics is essentially the science of movement technique and tends to be most utilised in sports where technique is a dominant factor rather than physical structure or physiological capacities. The following are some of the areas where biomechanics and kinesiology are applied: the identification of optimal technique for enhancing sports performance, the analysis of body loading to determine the safest method for performing a particular sport or exercise task, the assessment of muscle recruitment and loading and the analysis of sports and exercise equipment *e.g.*, shoes, surfaces and rackets.
14. Friction is "the force that resists the sliding or rolling of one solid object over another." Friction is also defined as "the force resisting the relative motion of solid surfaces, fluid layers and material elements sliding against each other". Friction is of two types—static which is a force that keeps an object at rest and dynamic friction which starts the moment an object starts moving on another. It is also known as kinetic friction, sliding friction or moving friction. Dynamic friction is further divided into sliding friction and rolling friction.
15. Biomechanics in sports can help players perform at their peak performance. Biomechanics experts can understand the movement patterns involved in specific sports. This enables them to watch out for improvement in players' body composition for their growth in performance. Biomechanics uses techniques including mathematical modelling, computer simulations and measurements to enhance sport performance and reduce injury. It can be applied to a wide variety of sport and exercise activities in order to identify optimal movement patterns to improve sport-specific techniques. Biomechanics also helps minimise the risk of injury and improve sports performance.
16. A lever is a rigid bar that moves on a fixed point called the fulcrum when a force is applied to it. In the human body, the bones practically act as levers while the muscles generate force to produce movement at the joint. The term 'FLE' stands for Fulcrum, Load and Effort. This demonstrates the middle portion of each of the three classes of levers. First class lever – Fulcrum is in the middle.

    Second class lever – Load is in the middle. Third class lever – Effort is in the middle.

**C.** 1. **Static Friction:** It is a force that keeps an object at rest. It must be overcome to start moving the object. When the opposing surfaces of the objects in motion are irregular, they increase resistance to movement. When we try to push a desk or a table and it does not move, it is because of the static friction being exerted. Once the movement starts, static friction ends and dynamic friction comes into play. Static friction acts on objects when they are resting on a surface. For example, if you are hiking in the woods, there is static friction between your shoes and the trail each time you put down your foot.

2. A projectile is anybody which is thrown or tossed into the air. Once it has left the ground, it will follow a flight path called a parabola until it comes down to earth. This applies to balls, javelins, discus, long jumpers, high jumpers and horses' show jumping. Projectile Motion describes the motion of the ball. Whether it is a serve, set or dig, volleyball will always travel in a parabolic motion. This is because the only force that acts on the ball after the ball is thrown is gravity, assuming there is no air resistance. Many sports that apply the concepts of projectile motion include volleyball, basketball, javelin, archery, football and cricket.

3. The path followed by a projectile is known as a trajectory. If gravity were not present, a projectile would travel in a constant straight line. However, the presence of gravity forces projectiles to travel in a parabolic trajectory, thus gravity accelerates objects downwards. Some more common examples of trajectory motion would be a bullet fired from a gun or an athlete throwing a javelin. There are three main factors that affect the trajectory of an object or body in flight—the projection angle, magnitude of projection velocity, and height of projection. The angle of release and air resistance both have a significant impact on the trajectory of a projectile, as they determine the height and distance it travels. Gravity is the force that acts to pull the projectile towards the ground and affects its acceleration and velocity.

4. External aerodynamics is the study of flow around solid objects of various shapes (*e.g.*, around an airplane wing), while internal aerodynamics is the study of flow through passages inside solid objects (*e.g.*, through a jet engine). Aerodynamic principle in sports is basically the pressure interaction between an athlete/his equipment and the surrounding air. For example, a downhill skier passing over a bump. Aerodynamics plays a prominent role in defining the flight of a ball that is struck or thrown through the air in almost all ball sports. The main interest is in the fact that the ball can often deviate from its initial straight path, resulting in a curved or sometimes an unpredictable, flight path.

5. The optimum projectile angle for achieving maximum horizontal range in throwing events is considerably less than 45 degrees. This is because an athlete can generate a greater projection velocity at low projectile angle than at high angles. The range of projectile is strongly dependent on projectile speed. In sports, the fact is that the projection speed of implement decreases when you throw within the higher projection angle. Shot put has a projectile angle from 26 degree to 42 degree. The flight of discus is greatly affected by aerodynamic forces acting upon it. The stability of discus flight comes from the spin of the discus. Discus has a projectile angle from 27 degree to 43 degree for maximum range. To achieve maximum distance in Javelin, the athlete will have to balance three components– speed, strength and technique. After approach – run of 13 – 17 strides, the releasing angle for Javelin has to take into consideration aerodynamic lift and drag. The optimum angle of releases falls between 26 degree to 40 degree.

6. When the archer releases the bowstring, the arrow will be flung forward toward the top of the target where they are aiming. But another force will also act on the arrow in a different direction. The other force is gravity, and it will pull the arrow down towards the Earth. Because of projectile motion, to hit the bull's eye of a target with an arrow, you actually have to aim for a spot above the bull's eye. A bow that is harder to draw, shoots an arrow faster and farther than a lighter bow. A lighter arrow on the same bow will also travel farther and faster.

7. Friction is important in sports. It allows us to grip sports equipment, run and even perform well. While friction is advantageous in many cases, sometimes it becomes disadvantageous as well.

   The use of spiked footwear in sports like racing, use of studs in football shoes and even cricket shoes ensure that friction offers an advantage as a stabiliser. The use of dusting powder by gymnasts and by carrom players is an effort to use friction to their advantage. Sports equipment like badminton racquets have rough grips on the handle to offer the players a stronger hold. During cycling, friction from the track offers protection from skidding off.

   Friction, however, is disadvantageous in a few sports. While cycling at high speed, the tyres heat up due to friction offered by the road and may burst. Similarly, racing cars experience tyre bursts because of the immense heat generated from the racing track due to friction. Skiers need to decrease friction as it tends to slow them down. Weightlifters need more friction between their feet and the floor to prevent slipping while lifting heavy weights.

8. Dynamic friction starts the moment an object starts moving on another. It is also known as kinetic friction, sliding friction or moving friction. It is the retarding force between two objects that are moving relative to each other. Dynamic friction is of two types– Sliding Friction, where friction starts when one object slides over the other; for example, a table slipping over a slope or when we slide down the slides or in ice skating; and Rolling Friction, where one object rolls over another. For example, a car moving on tyres or the movement of roller skates on a road.

9. Equilibrium is defined as a state of balance or a stable situation, where opposite forces cancel out each other and where no changes are occurring.

   Equilibrium is a state of zero acceleration where there is no change in the speed or direction of the body. Balance is the ability to control equilibrium (either static or dynamic).

   Stability is the resistance to a change in the body's acceleration or the resistance to a disturbance in the body's equilibrium. When the net resultant of all forces acting on a body is zero, it has achieved a state of equilibrium. When all the forces acting on the body are balanced, the net force acting on the body is zero, and hence, the acceleration is also zero. The three conditions for a body to be in equilibrium are:

   **Condition 1:** Net external force acting on body is zero.

   **Condition 2:** Net external torque acting on body is zero.

   **Condition 3:** Internal forces and torque due to internal forces must be absent.

10. In the case of diving, once the diver has left the starting block, the only force acting on them is the force of the earth, causing the swimmer to fall downward into the water. Any forward motion made by the diver after leaving the starting block is a result of inertia.

11. **Second class lever:** The load is in the middle, between the fulcrum and the effort.

    This type of lever is found in the ankle area. When standing on tiptoe, the ball of the foot acts as the fulcrum, the weight of the body as the load and the effort comes from contraction of the gastrocnemius muscle. This second-class lever is used when taking off for a jump or pushing against the blocks in a sprint start. Standing heel lift too is a great example of the second-class lever.

**D.** 1. Friction is "the force that resists the sliding or rolling of one solid object over another." Friction is also defined as "the force resisting the relative motion of solid surfaces, fluid layers and material elements sliding against each other." Friction depends upon the material of the two surfaces, the relative action and force between the two surfaces as well as the smoothness or roughness of the two surfaces. Simply put, if we measure the force required to start movement between two objects that are in contact with each other, we get the idea of friction between them.

   Friction is an important force in sports. It allows us to grip sports equipment, run and even perform well. While friction is advantageous in many cases, sometimes it becomes disadvantageous as well. The use of spiked footwear in sports like racing, use of studs in football shoes and even cricket shoes ensure that friction offers an advantage as a stabiliser. The use of dusting powder by gymnasts and

by carrom players is an effort to use friction to their advantage. Sports equipment like badminton racquets have rough grips on the handle to offer the players a stronger hold. During cycling, friction from the track offers protection from skidding off.

Friction, however, is disadvantageous in a few sports. While cycling at high speed, tyres may heat up due to friction offered by the road and may burst. Similarly, racing cars experience tyre bursts because of the heat generated from the racing track due to friction. Skiers need to decrease friction as it tends to slow them down. Weightlifters need more friction between their feet and the floor to prevent slipping while lifting heavy weights. Thus, while friction can be advantageous in some sports, it can prove to be deterrent in others.

2. While all actions need a coordination between all muscles to perform well, some muscles aid certain actions more than others. Running uses gluteus, quadriceps, calves, hamstrings and the core muscles, especially the biceps. Specific muscles which are involved in jumping are gluteus maximus, hamstrings, quadriceps and soleus. In throwing, major muscles are pectorials major, latissimus dorsi, anterior deltoid, trapezius biceps, triceps, external abdominal oblique and teres major. These muscles are comparatively responsible for velocity during the throw. In the beginning of a stride, when the foot hits the ground, quadriceps – the large muscles on the front of your thigh – are doing most of the work. As the body moves forwards, the effort shifts into the gastrocnemius muscles. These are on the upper back of your calf.

3. Movement is the change in the position of a body part with respect to the whole body. It is one of the significant features of all living beings. These movements are possible because of muscle and joints. The body movements in humans are of the following types:

   Flexion is a movement in which the angle between two body components is reduced. The angle between the ulna and the humerus is reduced when the elbow is flexed. The term "extension" refers to a movement in which the angle between two body components is increased. The angle between the ulna and the humerus is increased as the elbow is extended. Abduction and adduction motions involve medial-lateral motions of the coronal plane of the limbs, fingers, toes or thumb. Abduction causes the limb to move laterally away from the body's midline, whereas adduction causes the limb to move towards the body or across the midline. The phrases abduction and adduction describe motions that bring the body closer to or further away from its midline. Abduction is a movement away from the midline. Abduction of the shoulder, for example, raises the arms out to the sides of the body. Adduction is a movement in the direction of the midline. The legs are squeezed together when the hip is abducted. Circumduction is a unique movement that is circular. Circumduction is limited to ball-and-socket joints like the shoulder and hip because of various movements. Rotation is when the limb rotates around its long axis, similar to how a screwdriver works. Like hitting a driving shot in golf, the same occurs in the hip joint, and when playing a topspin forehand in tennis, the same happens in the shoulder joint.

4. Newton described three laws which form the basis of mechanics. Basic sports movements are all governed by these three laws.

   1st Law of Motion states that ''a body continues to remain in its state of rest or uniform motion in a straight line unless it is compelled by an external force to change that state." This is also known as the Law of Inertia. Examples of application of the 1st Law of Motion in sports are: A diver standing still on the diving board or a runner static at the starting blocks, cyclists move only when they start pedalling and continue to move unless they apply brakes; in boxing, the opponent breaks the movement and stops the moving fist. The 2nd Law of Motion states that "the acceleration produced in a body is proportional to the force applied." This is also known as the Law of Acceleration. Applied to sports, we know that throwing the cricket ball needs force. Faster the arms swing, greater the speed of the ball. Swimmers use the wall of the pool to generate the force needed to take off. In football, players stop, slow down or reverse the ball, depending upon the force applied and its direction. The 3rd Law of Motion states that "for every action there is an equal and opposite reaction." This is also known as the Law of Reaction. This is applied virtually in every sport. Thus, a swimmer pushes the hands and feet against the water while the water pushes back the swimmer, thus moving the swimmer

forward. While walking, we press the ground backwards with the feet while the ground pushes us forward in the opposite direction. When a gun is fired, the recoil is a direct reflection of an opposite force—the gun going backwards as the bullet goes forward.

5. The line of gravity (LOG) is a vertical line from the centre of gravity to the ground the athlete is on. The closer the line of gravity is to the base of support, the better balanced a person is in this position.

   The Line of gravity is important in sports like basketball, where centralising the line of gravity near the base increases stability. This is achieved by having a straight back and head which are held upright to centralise the line of gravity. To get this, crouching and a deep knee bend help lower the centre of gravity and consequently, the line of gravity. There are two properties of the centre of gravity that have a great impact on sport. First of all, its location is dependent on the shape of the body. So, if the same body is to take a different shape, the position of the centre of gravity will shift. An athlete that bends their legs will lower their centre of gravity position. This, amongst other things, will result in greater stability, something especially important in sports such as wrestling. Also, the centre of gravity can lie entirely outside the body itself. Secondly, the energy required for a jump depends on the height of the centre of gravity. So, by lowering its position one also lowers the energy required to clear the bar.

   Thirdly, a low centre of gravity, as in Fosbury Flop, works by keeping the centre of gravity so low that it goes underneath the bar.

6. The Third Law of Motion states that "for every action there is an equal and opposite reaction." This is also known as the Law of Reaction. This is applied virtually in every sport. Thus, a swimmer pushes the hands and feet against the water while the water pushes back the swimmer, thus moving the swimmer forward. When a swimmer swims in water, it experiences a force. This force is opposite to the direction of movement of the swimmer. In order to overcome this force, swimmers must stroke in downward direction to float in water and move forward. Both the forces applied by water and by swimmer are equal in magnitude and opposite in nature. Simply put, in swimming, this can relate this concept to the standard hand/arm stroke when the hand travels downward in the water and then backwards to propel the swimmer forward. In creating an equal and opposite reaction, the swimmer is kept afloat and propelled forward. Thus, this is how swimming makes use of the Third Law of Motion.

7. Friction plays a very important role in many sports, such as bowling and curling. There is both Static Friction and Kinetic Friction. Static friction is the friction before an object starts to slide, while Kinetic friction is the friction when the object is actually moving or sliding. The force of friction is the force resisting the displacement of one surface over another and material elements sliding against each other. In all sports, friction represents a braking force that needs to be overcome; the more you can overcome this force, the better your chances of success. The friction between the finger pad/palm and items of sports equipment strongly influences how well an athlete is able to perform. It not only determines how well equipment can be gripped and manipulated but also how the equipment feels to use and the perceived level of performance. Other examples of friction in sports include Sliding Friction—When an ice skater is skating. Air Friction— A sky diver falling out of the air is affected by air friction. Fluid Friction— When a swimmer swims, the water and the swimmer's body rub together. Static Friction— When you hit a tennis ball, the friction applied is static. Advantages of friction include runners not slipping off on the tracks or roads. Basketball, football, rugby, hockey players able to move themselves fast and maneuver the ball across other players conveniently, because of the friction offered by the playing surface.

CHAPTER 9

# Psychology and Sports

**B.** 1. Stress can be defined as a state of worry or mental tension caused by a difficult situation. Stress is a natural human response that prompts us to address challenges and threats in our lives. Everyone experiences stress to some degree. Stress is also defined as how we react when we feel under pressure or threatened. It usually happens when we are in a situation that we don't feel we can manage or control.

2. Self-esteem is reflected in the degree of worth and competence that we attribute to ourselves. Through sport, we may enhance our self-esteem by having a positive image of our bodies and the physical skills and abilities that we develop.

   Self-esteem leads to self-confidence which, in turn, helps a sportsperson reach higher levels. Self-confidence allows athletes to thrive in their environment. It gives them the belief that they can overcome any obstacle and achieve their goals. Positive self-worth comes from recognition from family, friends and social relationships.

3. Successful athletes prepare themselves for competition by imagining performing well in the competition. Most successful sportspersons make mental images that are detailed, specific and most importantly realistic. Mental imagery helps a sportsperson calm down. Effective imagery helps develop confidence while performing. Imagery uses multiple senses to create or recreate experiences in one's mind. There are two types of self-imagery—internal imagery, where one pictures doing the skill, and external imagery, where one pictures watching the skill being done by them.

4. Aggression is defined as a "feeling of anger or antipathy resulting in hostile or violent behaviour, readiness to attack or confront". Aggression in sports has been divided into two categories: Hostile Aggression, where the main aim is to cause harm or injury to the opponent and is prohibited in all sports, and Instrumental Aggression, where the main aim is to achieve a goal by using aggression; for example, a hockey player using aggression to tackle his opponent using the hockey stick to snatch the ball.

5. Goal-setting can define challenging but achievable outcomes, whatever your sporting level or skills. A specific, measurable, achievable, relevant, time-bound (SMART) goal should be clear, realistic and possible. Goals must be created by the athlete. Imposed goals are not effective. Identifying the goal and then working towards is the most effective way of reaching it. Each long-term goal should also have a series of short-term goals that progress in difficulty. Short-term goals should progress from those that are easy to achieve to those that are more challenging long-term goals.

6. Personality is defined as ''the type of person you are, shown by the way you behave, feel and think." It is also defined as ''the special combination of qualities in a person that makes that person different from others, as shown by the way the person behaves, feels and thinks." Personality is a combination of characteristics or qualities that form an individual's distinctive character. Personality also refers to individual differences in characteristic patterns of thinking, feeling and behaving.

7. Goals must be created by the athlete. Imposed goals are not effective. There are three major types of goals in sports psychology: outcome goals, performance goals and process goals. Outcome goals focus on how an individual or team aims to compare to other competitors. Winning is the most common outcome goal. This type of goal is the least effective because it depends on so many factors that are extrinsic to the individual. Performance goals are concerned with personal achievement in an end result. Process goals are focused on the process of performance. Examples include controlling breath, maintaining body posture or the use of imagery.

8. In sports, aggression is a characteristic that can have many negative as well as positive effects on performance. Aggression is defined as "any form of behaviour directed towards the goal of harming or injuring another live being." Some sport psychologists agree that aggression can improve performance which is called assertive behaviour. For example, a hockey player using aggression to

tackle his opponent using the hockey stick to snatch the ball. Assertive behaviour is another form of aggression in which sportspersons use verbal or, at times, physical force to achieve a goal. Sledging in cricket is an example of assertive behaviour.

9. Sports psychology studies how psychological factors influence sports, athletic performance, exercise and physical activity. It is important as it helps analyse the behaviour of sportspersons and their mental state. It helps identify talent for specific sports and creates a better learning situation. It also helps sportspersons stabilise their performances for a longer period by helping achieve attention focus and the ability to tune out distractions as well as achieve the mental strength required to reach peak performance. It aids in developing coping skills to deal with setbacks and errors as well as helps teams develop communication skills and cohesion.
10. Mental and intellectual qualities distinguish a person. Many of these are genetic but many are acquired after training, learning and practice. Mental development is paramount to progress of a person and, hence, society. We are distinguished by our thinking capabilities. An agile mind makes an attractive personality. Intelligence adds charm to personality. A good physique fades if sound mental personality is absent. Intellectual qualities of a person attract others, add to leadership value and make leadership easier.

**C.** 1. Body image can be described as your personal evaluation of self and others, based on body weight, shape, size and appearance. A negative body image can develop from many different influences, including family, peer group, media and social pressures. It is connected to self-esteem and self-worth. Athletics can play a role in how a student perceives their body shape, size and its performance level. Regarding the main physical components of body image, there are three main points to consider:

   (a) perceived face/hair, which includes three subthemes—facial features, facial shape/form and hair,
   (b) perceived body, which includes three subthemes—body size, body shape and bone structure, and
   (c) perceived physical functioning—Body image issues are not unusual in athletes and can start at a young age. Negative consequences of poor body image include quitting sports, eating disorders and low self-esteem.

2. Self-esteem is reflected in the degree of worth and competence that we attribute to ourselves. Through sports, we may enhance our self-esteem by having a positive image of our bodies and the physical skills and abilities that we develop. Self-esteem leads to self-confidence which, in turn, helps a sportsperson reach higher levels. Self-confidence allows athletes to thrive in their environment. It gives them the belief that they can overcome any obstacle and achieve their goals. Positive self-worth comes from recognition from family, friends and social relationships. Low self-esteem arises if we feel our body to be inadequate, unfit or inappropriate for the chosen sport. Losses and wins determine self-esteem more than abilities and efforts. Self-esteem impacts our decision-making process, our relationships, our emotional health and our overall well-being. It also influences motivation as people with a healthy, positive view of themselves understand their full potential and are truly inspired to take on new challenges. This is especially true if we regularly take part in some sports activity. During exercise, the body releases endorphins that make a person feel positive and happy. The praise and recognition that comes with playing sports improves self-esteem. Socialisation and working well together further boosts self-esteem.
3. Personality is a combination of characteristics or qualities that form an individual's distinctive character. Personality also refers to individual differences in characteristic patterns of thinking, feeling and behaving. The study of personality focuses on two broad areas: to understand individual differences—in particular, personality characteristics such as sociability or irritability, and to understand how various parts of a person come together as a whole. Carl Jung, a Swiss psychiatrist, divided personality into three groups based on a person's social habits.

   (a) **Introverts:** Introverts are people who prefer their own world of thoughts, dreams, feelings, fantasies and need private space.

(b) **Extroverts:** They are people who prefer outer world and interaction with people. They are sociable beings who get energised from going to parties, interacting with people and so on. They are talkative, make friends easily and are happy-go-lucky.

(c) **Ambiverts:** These are occasionally introverts and can occasionally behave as extroverts. They have selective choices of behaviour and can be quite unpredictable.

4. Several independent sets of researchers discovered and defined the five broad traits based on empirical, data-driven research. The five big factors that are markers of personality are:

   (a) **Openness:** Being open to new ideas and experiences is among the foremost personality traits. This leads to a person being flexible, curious, imaginative and innovative.

   (b) **Conscientiousness:** Such people tend to be goal-oriented. Hardworking, self-disciplined, systematic and organised, they tend to be very reliable and high performers.

   (c) **Extroversion:** Extrovert people are totally outgoing and gregarious. They get along well with everyone and believe in pomp and show.

   (d) **Agreeableness:** Such people tend to avoid any controversy by agreeing with everyone. They are cooperative, friendly and caring. Compatible with most people, such people tend to be docile.

   (e) **Neuroticism:** Emotionally unstable, such people are always the worrying kind. This is an index of emotional stability as well. They express fear and distress.

5. Aggression in sports has been divided into two categories:

   (a) **Hostile Aggression:** Here, the main aim is to cause harm or injury to the opponent. This is often violent. Examples include hitting the opponent, rioting and damaging public property and sports facilities. Hostile aggression is always with an intent to destroy and harm. This is unsportsmanlike and is prohibited in all sports.

   (b) **Instrumental Aggression:** When the main aim is to achieve a goal by using aggression, it is known as instrumental aggression. There is no anger in this type of aggression. Contact sports is often the one where this sort of aggression is mostly used. For example, a hockey player using aggression to tackle his opponent using the hockey stick to snatch the ball. The player is not using his aggression to hurt the opponent but rather to get the ball. Experienced athletes use more instrumental aggression to their advantage and hostile aggression is less frequently used.

6. Self-talk is the way you talk to yourself or to your inner voice. Self-talk combines conscious thoughts with in-built beliefs and biases to create an internal monologue throughout the day. There are three types of self-talk: Positive, Negative and Instructional. Positive self-talk helps immensely with work performance, learning, self-awareness and managing anxiety. Positive self-talk changes the way to look at stressful situations. This helps the sportsperson to substitute "this is too difficult" with "I can do this!" The underlying idea behind self-talk is that positive self-talk changes the cognitive, motivational, behavioural and effective mechanisms, thus leading to decreased anxiety, improved concentration and focus, and ultimately, to better performance. Positive self-talk is an effective stress-reducing tool.

   Self-talk is backed up by science. Studies prove that positive affirmations help activate parts of the brain that are associated with self-related processing and reward. The same studies also indicate that positive affirmations can help build or restore self-competence.

7. Mood elevation is an important advantage of regular exercise. It is proven beyond doubt that exercise is a very potent mood elevator. Exercise releases feel-good hormones called endorphins. It generates positive outlook and definitely improves mental health. People who exercise regularly have better mental health and emotional wellbeing and lower rates of mental illness. Exercise is important for people with mental illness – it not only boosts our mood, concentration and alertness, but improves our cardiovascular and overall physical health. Some examples include aerobic exercise and weight training; both increase your heart rate and release feel-good endorphins in the brain.

8. It is important to understand the reasons and then develop strategies for exercise adherence. Everyone knows exercise is good for our overall well-being but just knowing this does not assure consistent exercise compliance. Regular exercise is a complex, multifactorial behaviour that fitness professionals and scientists need to appreciate as they can increase exercise compliance in their students. 50% of those starting an exercise programme drop out within six months. Self-perception plays a major role in starting an exercise programme, which also discourages some individuals even if it has been recommended for medical reasons. Many people lack the will without even trying to exercise. But these self-perceptions are modifiable with social support and encouragement from others. Research shows that positive feedback from exercise professionals, reinforcement that exercise is worthy, and beneficial and social support from spouse, friends or peers improve self-perception and encourages a person to start exercising.
9. Intrinsic motivation is an internal feeling that says, "I really want to do this thing." There is no external pressure. Intrinsic motivation builds on itself. There exist certain methods to increase a sportsperson's motivation. These include:
   (a) **Goal setting:** Goals ought to be in line with an athlete's physical and mental capacity. Aiming high is a good idea. These goals should be divided into immediate, medium-term and long-term goals.
   (b) **Healthy environment:** Having healthy and supportive surroundings are great motivators. Facilities for rest, relaxation and competition are other key motivators.
   (c) **Positive attitude:** Champions are made from the attitude of believing that everything is possible for them to achieve and nothing is impossible.
   (d) **Music:** Motivational music in the arena has a buoyant effect on the athletes as well as the audience. Music relaxes. Music peps up the mind and soothes frayed nerves. All this is important for any competing sportsperson.
   (e) **Positive self-talk:** An athlete who has self-belief tends to do better than people who doubt their own skills and capacity. The best performance comes from people who have unshakable belief in their capacity and skills.
10. Goal setting is indeed an important part of motivation. Goals ought to be in line with an athlete's physical and mental capacity. Aiming high is a good idea. These goals should be divided into immediate, medium-term and long-term goals. The idea is to divide the ultimate goal into incrementally progressive steps. Also, the goals ought to be regularly evaluated by the mentors and the approach should be flexible, allowing sufficient time and resources to reach the set goal. Goal-setting can define challenging but achievable outcomes, whatever your sporting level or skills. A specific, measurable, achievable, relevant, time-bound (SMART) goal should be clear, realistic and possible. Identifying the goal and then working towards it is the most effective way of reaching it. Each long-term goal should also have a series of short-term goals that progress in difficulty. Short-term goals should progress from those that are easy to achieve to those that are more challenging, long-term goals.

**D.** 1. Positive body image is related to body satisfaction and acceptance, while negative body image is related to dissatisfaction and wanting one's body to be different. A negative body image can contribute to Body Dysmorphic Disorder (BDD), eating disorders and other serious conditions. Thus, a negative body image means that an individual is generally unhappy with how they look. They may feel like they need to change their body size or shape. Past events and circumstances can cause you to have a negative body image, including being teased or bullied as a child for how you looked. Being told you're ugly, too fat or too thin, or having other aspects of your appearance criticised also affects body image. In addition, seeing yourself as unattractive and undesirable and having an image of yourself as a stupid or unintelligent person can lead to a negative body image. It can also mean seeing an unhappy, unhealthy person when looking in the mirror and believing that you are nowhere near your ideal version of yourself. Body image is something that can frequently change throughout a lifetime. Body image is also closely connected to self-esteem and positive lifestyle choice. A positive self-image can boost our physical, mental, social, emotional and spiritual well-being. On the other

hand, a negative self-image can decrease our satisfaction and ability to function in these areas. A positive body image can improve self-esteem, self-acceptance and a healthy relationship with food and physical activity. Positive body image, however, is typically associated with better physical health, improved mood and greater overall life satisfaction.

2. Aggression in sports has been divided into two categories:
   (a) **Hostile Aggression:** Here, the main aim is to cause harm or injury to the opponent. This is often violent. Examples include hitting the opponent, rioting and damaging public property and sports facilities. Hostile aggression is always with an intent to destroy and harm. This is unsportsmanlike and is prohibited in all sports.
   (b) **Instrumental Aggression:** When the main aim is to achieve a goal by using aggression, it is known as instrumental aggression. There is no anger in this type of aggression. Contact sports is often the one where this sort of aggression is mostly used. For example, a hockey player using aggression to tackle his opponent using the hockey stick to snatch the ball. The player is not using his aggression to hurt the opponent but rather to get the ball. Experienced athletes use more instrumental aggression to their advantage and hostile aggression is less frequently used. Experienced athletes use self-control to help them with their aggression. In sports, assertive behaviour is another form of aggression in which sportspersons use verbal or at times physical force to achieve a goal. Sledging in cricket is a classical example of assertive behaviour. There is no intention to harm or cause hurt. Most trainers expect their students to be assertive when they encourage assertive behaviour. A player's personality plays a vital role in determining whether they are aggressive or not in certain situations.
3. Carl Jung, a Swiss psychiatrist, divided personality into three groups based on a person's social habits.
   (a) **Introverts:** Introverts are people who prefer their own world of thoughts, dreams, feelings, fantasies and need private space. Interactions drain their energy whereas being alone energises them. They have rigid ideas, are often perceived as self-centred and have difficulty in adjusting to society.
   (b) **Extroverts:** The characteristics of extroverts are in contrast to introverts. They prefer outer world and interaction with people to being alone. They are sociable beings who get energised from going to parties, interacting with people and so on. They are talkative, make friends easily and are happy-go-lucky. They express their opinions freely and are quick to take decisions and act upon them. More action, less thinking is their motto.
   (c) **Ambiverts:** These are occasionally introverts and may occasionally behave as extroverts. They have selective choices of behaviour and can be quite unpredictable.
4. Assertiveness is a key element of any sport and can be defined as forceful behaviour with the intention to achieve the goal. However, with this people cause unintentional hurt to the other player. In sports, assertive behaviour is another form of aggression in which sportspersons use verbal or at times physical force to achieve a goal. Sledging in cricket is a classic example of assertive behaviour. Other examples would be deliberately elbowing someone in the face during a game of netball. Assertive behaviour is well-motivated behaviour, which is within the rules. An example would be tackling someone in football. Tackling is allowed and although someone may get injured, that is not the intention. There is no intention to harm or cause hurt. When one is being assertive, the intention is to establish dominance rather than to harm the opponent. Behaviours such as tackling in rugby, checking in ice hockey, and breaking up a double play in baseball may be seen as assertive as long as these are performed as legal components of the contest and without malice. Most trainers expect their students to be assertive when they encourage assertive behaviour. A player's personality plays a vital role in determining whether they are aggressive or not in certain situations. In sports, certain events trigger stress. These stressors can help in understanding what causes an athlete to become frustrated which can lead to aggression and a decline in performance. Stress can have a negative impact on performance and has been shown to even increase the likelihood of injury. Learning how to deal with stress is key as players must find ways to overcome these problems.

5. Personality is multifactorial and multifaceted. No single factor makes a good personality. Of course, some traits are dominant but there are a lot of small things that make up a complete personality. All these factors are collectively needed to form a good, wholesome personality but for ease of understanding, we can sub-divide these as:
   (a) **Physical Dimension:** This is among the most important aspects of personality. A healthy, well-toned body is necessary for the first impression. Physique is inherited but one can get a finishing effect with proper diet and exercise. A good height, attractive face and confident posture draw immediate attention of people. On the other hand, if the posture is stooping or not very confident, it leaves a poor impression.
   (b) **Mental Dimension:** Mental and intellectual qualities distinguish a person. Many of these are genetic but many are acquired after training, learning and practice. Mental development is paramount to progress of a person and, hence, society. We are distinguished by our thinking capabilities. An agile mind makes an attractive personality. Intelligence adds charm to personality. A good physique fades if a sound mental personality is absent.
   (c) **Social Dimension:** Humans need a social environment to exist and thrive. We are social animals, interdependent on society. Good attitude, good habits, sportsmanship and helpfulness towards others are all aspects of a socially healthy person.
   (d) **Emotional Dimension:** Stable and controlled emotions help us do well. We need to learn to control anger, anxiety, aggression and fear. Sportspersons especially need a developed social personality as they deal with a lot of people like coaches, umpires and even audiences. Temper tantrums are signs of a bad social personality. Victory and defeat must be accepted graciously. Healthy mental status allows control over emotions and is a desirable trait in athletes and sportspersons.
6. Stable and controlled emotions help us do well. We need to learn to control anger, anxiety, aggression and fear. Sportspersons especially need a developed social personality as they deal with a lot of people like coaches, umpires and even audiences. Temper tantrums are signs of a bad social personality. Victory and defeat must be accepted graciously. Healthy mental status allows control over emotions and is a desirable trait in athletes and sportspersons. Thus, if one has to create a favourable impression on others, they need to develop a well-rounded personality so as to create a positive image. Athletes with high discipline, responsibility, achievement motivation and goal orientation have high performance in the game. But, athletes with neuroticism characteristics such as anxiety, depression, aggression, anger and selfishness have low emotional and behavioral stability. Emotional stability influences our ability to cope with stress, resist our impulses and adapt well to change. People who score high on emotional stability tend to be calm, composed and stress-resistant. They're also generally confident and not easily provoked or disheartened by setbacks. An emotionally stable sportsperson itself can influence many aspects of sports performance and behaviour, some of which may well be out of the athlete's cognitive control. It is important to understand personality when dealing with athletes to promote the best coping strategies and goals to assist in improving their performance. Champions are presumably balanced and usually resistant to stress. They are not very sensitive to various stressors. They have better attention span and they do not panic in difficult situations. Their well-being is stable and their emotional reactions are adequate to the stimuli.
7. Negative factors leading to exercise dropouts include:
   (a) Exercise programme does not meet individual expectations, *e.g.*, a person who expects to lose weight but does not see it happening will most likely abandon the exercise programme. So, we need to present "realistic" goals with an "attainable timeline".
   (b) People who smoke are less likely to adhere to an exercise programme.
   (c) People with low self-worth (*i.e.*, self-doubt, insecurity, negative self-talk) and poor body image are more likely to abandon their exercise programme.

   Other factors that may be contribute to exercise dropout include excessive travel, the expense of training and competition, inconvenient training times, low levels of physical literacy or

perceptions of competence and an environment that is 'too competitive'. Other reasons that contribute to people dropping out of exercise programs are lack of time, exercise intensity too high, orthopedic injury and lack of enjoyment.

8. People are motivated to exercise for many reasons including—
   (a) **Demographic and biological factors:** Men are more involved in physical activity as compared to women. However, being overweight or obese consistently proves to be negatively associated with exercise adherence.
   (b) **Psychological, cognitive and emotional factors:** The most important factor associated with exercise adherence is a person's confidence in their ability to exercise and be consistent with it.
   (c) **Self-worth:** This is also a key factor in exercise adherence. The more people think they can exercise, the more likely they are to adhere to an exercise program. The influence exercise professionals can exert has a tremendous role to play in exercise compliance. Easy-to-do exercises are essential if they are to be sustained. Individualised exercise programmes are important.
   (c) **Behaviour/attributes and skills:** Behaviours, such as diet, sleep, smoking, alcohol use, etc., greatly influence exercise adherence. There is a positive association between a healthy diet and exercise adherence. Positive health benefits are a big boost to exercise compliance.
   (d) **Social and cultural support:** Social support from family and close friends is highly associated with exercise adherence.
   (e) **Easy access to exercise facilities:** This is of great help in encouraging exercise adherence. Satisfaction with the workout facility including the users' perception that the equipment is safe and the facility is user-friendly is also very helpful in ensuring exercise adherence. Watching others exercise is another motivator to start exercising.
9. Self-determination theory divides motivation into two types, as explained below—
   - **Intrinsic motivation:** The main feature of intrinsic motivation is that it is an internal feeling that says, "I really want to do this thing." There is no external pressure. This is sometimes called self-determination or autonomy. This is the ultimate goal for well-being. Another important point is that intrinsic motivation builds on itself and there is a feeling of naturally moving forward rather than stagnation.
   - **Extrinsic motivation:** Extrinsic motivation comes from outside forces. Outside motivation helps us overcome the fear of failure or the feeling that the task is too tough for us.

   There exist certain methods to increase a sportsperson's motivation. These include—
   (a) **Goal setting:** Goals ought to be in line with an athlete's physical and mental capacity.
   (b) **Healthy environment:** Having healthy and supportive surroundings are great motivators.
   (c) **Teaching methods:** How a sportsperson is taught is also important. The teaching should be based on reward method.
   (d) **Spectator participation:** A very positive environment is created when there is constant spectator encouragement.
   (e) **Rewards:** Getting appreciation awards in the form of cash or trophy or even a certificate is a great way to motivate athletes.
   (f) **Positive attitude:** Coaches and trainers should, at all times, exhibit a very encouraging and positive attitude towards their students.
   (g) **Music:** Motivational music in the arena has a buoyant effect on the athletes as well as the audience.
   (h) **Tracking results:** If a sportsperson has been tracking their improvement and realises that it is getting better day by day, their motivation goes up as does the desire to perform better.
   (i) **Positive self-talk:** An athlete who has self-belief tends to do better than people who doubt their own skills and capacity.

10. While there are many traits to describe personality, one of the well-known is what is known as the big five leading to what is called the big five theory.

    The big five are remembered by the acronym OCEAN (Openness, Conscientiousness, Extroversion, Agreeableness and Neuroticism).

    The five big factors that are markers of personality are:

    (a) **Openness:** Being open to new ideas and experiences is among the foremost personality traits. This leads to a person being flexible, curious, imaginative and innovative. Such persons have a variety of hobbies and interests.

    (b) **Conscientiousness:** Such people tend to be goal-oriented. Hardworking, self-disciplined, systematic and organised, they tend to be very reliable and high performers.

    (c) **Extroversion:** Extrovert people are totally outgoing and gregarious. They get along well with everyone and believe in pomp and show.

    (d) **Agreeableness:** Such people tend to avoid any controversy by agreeing with everyone. They are cooperative, friendly and caring. Compatible with most people, such people tend to be docile and timid.

    (e) **Neuroticism:** Emotionally unstable, such people are always the worrying kind. This is an index of emotional stability as well. They express fear and distress. These people find it difficult to adjust with others, in general. Such people are moody and stressed.

CHAPTER 10

# Training in Sports

**B.** 1. Training is the act of teaching a person a particular skill or type of behaviour. With special reference to sports, we can define it specifically as "the action of undertaking a course of exercise and diet in preparation for a sporting event."

Training is teaching or developing skills and knowledge that relates to specific useful competencies. Training has specific goals of improving one's capability, capacity, productivity and performance. There is a need to continue training to maintain, upgrade and update skills.

2. The Law of Progression suggests to increase muscle gaining gradually to prevent damage. The Principle of Progression states that in time, weight or intensity should be kept within 10% or less each week to allow for a gradual adaptation while minimising the risk of injury. As the body adapts to the fitness routine, you have to challenge yourself to keep seeing the progress. That challenge could be a variety of things, from increasing your time, intensity, weight, sets, reps or more. Progression of exercise can be done by increasing 5% of weight if the participant can comfortably lift the weight for up to 12 to 15 repetitions.

3. The word isometric comes from 'iso' meaning same and 'metric' meaning length. Isometric exercises are tightening of a specific muscle or group of muscles. During isometric exercises, the muscle doesn't noticeably change length. The affected joint also doesn't move. Hence, all exercises where the length of the muscle does not change are classified as isometric exercises. Doing these exercises leads to increased strength of the muscles. During isometric exercises, while the limbs do not move, there is movement in the muscle mass.

4. Endurance involves the capacity to resist fatigue during an activity. The idea of endurance training is to ensure that the athlete is able to do all physical activities that raise the heart rate to above 50% of the resting rate. There are two types of endurance: Specific endurance, which is the ability to stand against fatigue in sport-specific conditions, and General endurance, which characterises the ability of the whole body to tolerate endurance exercises and diminish fatigue.

5. Speed Endurance is an ability to maintain high speed of movement for a time period longer than 15 s or an ability to repeatedly produce high speed of movement with minimum resting period between individual repetitions. This is vital in sports lasting less than a minute. Thus, sprints and 400-metre dashes require speed endurance. Speed endurance is a direct result of power and capacity to produce energy during an activity. For example, an 800m runner would do intervals at a distance less than 800m (*i.e.*, 400m repeats) at a speed of race pace or faster.

6. The Continuous Training Method is the most widely used and recommended method to develop endurance. This involves running for long periods of time at a steady pace without any break. This is a low-intensity prolonged exercise. The suggested rate of activity is to keep the heart rate between 130 and 160 per minute. Time duration ranges from 30 minutes in young athletes to 120 minutes in case of more matured athletes. Training for long-distance events such as marathons focuses on this method. The focus is to increase the oxygen uptake as well as oxygen utilisation capacity of the athlete.

7. Flexibility or limberness refers to the range of movement in a joint or series of joints and length in muscles that cross the joints to induce a bending movement or motion. Flexibility varies from individual to individual, particularly in terms of difference in muscle length of multi-joint muscles.

Flexibility is also defined as the range of motion in a joint or group of joints or the ability to move joints effectively through a complete range of motion. Good flexibility allows a person to move through the full range of the body at joints. More the flexibility, better is the range of motion of the individual.

8. Cardiovascular endurance, or aerobic fitness, is how well your heart and lungs can supply the oxygen you need while you exercise at medium to high intensity. If you have good cardiovascular endurance, you can exercise at medium intensity for a long time (and high intensity for a while) before it makes

you tired. Forms of exercise that depend on cardiorespiratory endurance include vigorous distance running, swimming and cycling. Thus, cardiovascular endurance indicates a person's level of aerobic health and physical fitness.

9. Interval Training Method is a method of physical training consisting of alternating periods of high and low-intensity activity. Intense activity of about 30 seconds is followed by less intense activity of about 3 to 4 minutes. Research shows that interval training—workouts in which you alternate periods of high-intensity exercise with low-intensity recovery periods—increases fitness and burns more calories over a short period of time than continuous training method. This lets the effort followed by rest and recovery. The rest period allows for the cardiovascular system adjustments.
10. The word isometric comes from 'iso' meaning same and 'metric' meaning length. Hence, all exercises where the length of the muscle does not change are classified as isometric exercises. Doing these exercises leads to increased strength of the muscles. During isometric exercises, the limbs do not move, while we can see movement in the muscle mass. These exercises are important to gain strength but do not contribute to flexibility. Bodybuilders, wrestlers, weightlifters and gymnasts benefit most from these exercises. These exercises are also used extensively in rehabilitating injured sportspersons.
11. These are exercises in which variable resistance is applied to a limb in constant motion. While performing isokinetic exercises, one contracts the muscle while quickly moving the limb. These movements are a combination of isometric and isotonic movements that are most commonly used in all sporting activities. Isokinetic exercise, a type of strength training, is mostly done on machines. These exercises allow the muscle to gain strength consistently through a range of muscle movements. It uses specialised exercise machines that produce a constant speed no matter how much effort you expend. These machines control the pace of an exercise by fluctuating resistance throughout your range of motion.
12. The four types of training methods include endurance, strength, balance and flexibility. Each one has different benefits. Doing one kind also can improve your ability to do the others, and variety helps reduce boredom and risk of injury.

    Strength affects performance in all areas of sports. It is a very important factor in fitness. Strength is simply defined as the quality or state of being physically strong. It is of paramount importance that sportspersons are not only strong but also continue to enhance their strength resulting in better performance. Muscular strength refers to the amount of force a muscle can produce with a single maximal effort. Muscle strength is measured during muscular contraction. The size of your muscle fibres and the ability of nerves to activate muscle fibres are related to muscle strength.
13. Static stretching requires you to move a muscle as far as it can go without feeling any pain, then hold that position for 20 to 45 seconds. This is a very effective way to increase flexibility. Static stretching involves holding a position for 30 seconds or longer, whereas dynamic stretching involves movement. For example, bending over and touching toes is a static stretch. Static stretching has a relaxation, elongation effect on muscle which increases range of motion (ROM), decreases musculotendinous stiffness and also reduces the risk of acute muscle strain injuries. It is a slow controlled movement with emphasis on postural awareness and body alignment.
14. Acceleration sprints are a good form of anaerobic training. They are particularly an effective means of emphasising and maintaining the technical components of the sprint action as the speed increases. The progressive nature of acceleration sprinting reduces the risk of muscle injury.

    Acceleration is the rate at which the speed of an object changes. Acceleration takes place in the first 0–30 metres or in about 3–4 seconds from the start of a sprint. After approximately 30 metres, acceleration turns into the maximum velocity and the top speed is hit. Acceleration run is a special form of sprint training in which running speed is gradually increased from jogging to striding.
15. Circuit training is a form of body conditioning that involves endurance training, resistance training, high-intensity aerobics and exercises performed in a circuit, similar to high-intensity interval training. It targets strength building and muscular endurance. Examples include treadmill running, rowing,

stationary cycling, jumping rope, jumping jacks, mountain climbers, jump squats, burpees, jumping lunges, box jumps, sprinting in place and side-to-side hops. Impact of circuit training are getting maximum result in minimum time, increasing rate of metabolism, enhancing cardiovascular fitness, enhancing muscle endurance and of course helping in strength training.

16. This can be done by increasing the duration or number of repetitions for each exercise, decreasing the rest period between each exercise and each circuit, increasing the number of circuits you want to complete, changing the exercises or the order of the exercises, and/or adding resistance or weight to the exercises. You can perform each exercise for 30 to 60 seconds or 10 to 20 repetitions. Additionally, you should decide on the rest period between each exercise and each circuit based on your fitness level and intensity. For example, you can rest for 10 to 30 seconds between each exercise and 1 to 2 minutes between each circuit.

**C.** 1. Fartlek training, developed in Sweden, (meaning 'speed play') incorporates aspects of interval training with regular distance running. This training consists of distance running with "bursts of harder running at more irregular points, lengths and speeds as compared to interval training." For example, a Fartlek training session might consist of a warm up for 5–10 minutes; running at a steady, hard speed for 2 km; rapid walking for 5 minutes (recovery); sprints of 50–60 seconds, interspersed with easy running; full-speed uphill for 200m; rapid walking for one minute; and repeating this routine until the time schedule has elapsed (a minimum of 45 minutes). The development of aerobic and anaerobic capacities occurs.

Advantages of Fartlek Training are:

(a) It is a great test for strength and endurance.

(b) It improves speed and endurance.

(c) It improves mental strength.

(d) It improves the ability to put on a spurt in races and overtake a competitor when tired or knock time off your finish time.

2. For the purpose of sports, speed is defined as the ability to move quickly across the ground or move limbs rapidly to grab or throw. A simple version of this is the time taken by an athlete to cover a specified distance. Speed in sports is important as it makes up one of the components of fitness. Obviously, speed of a sportsperson has a direct impact on their performance. Most sports need speed during some point of the activity. For example, the speed of a footballer's leg as it hits the ball into the goal is important. Speed is the main component of performance-related fitness and appears in different forms. Accelerating, stopping, quickness, agility and change of direction are important parts of game speed. Depending on the sport and position, athletes will use different speed skills including linear sprinting, agility and multi-directional speed.

3. Law of Continuity is an important component of understanding sports training. Training needs to be continued. Flexibility tends to be lost if training is slowed or discontinued. According to this principle, the training should be a continuous process. There should not be any break. It should be a regular phenomenon. In fact, there should not be a long period of inactivity. It has been observed that discontinuity of training reduces the physiological capacities of sportspersons. Along this, the interval between two training sessions should be maximum but not too long. Sportsman should be educated regarding the importance of continuity by highlighting the positive effects of training. All sportspersons should understand that all performance factors are developed through the long and continuous process of training.

4. Coordinative ability is the combined effect of coordination abilities, rhythmic ability, reaction ability, flexibility, balance ability and agility. Coordinative abilities are also defined as the abilities that depend upon coordinated effort of the central nervous system and the musculoskeletal system.

These abilities help sportspersons do a group of movements with better quality and effect. They are able to use the muscles efficiently and with optimum energy usage. Coordinative motor abilities are particularly important at the initial stages of sports development. A high level of coordination from the beginning makes it feasible to make use of technical and tactical skills during sports effectively.

What is learned early on is maintained till a later age and is an important reason for a more accurate performance.

5. Specific Endurance is an ability to resist fatigue during specific sports movement for a longer time period—both with low intensity of load and during competitions with high intensity of load. Delayed fatigue, at a particular sport for an athlete, represents specific endurance. Since the duration, intensity and strength needs are different for various sports, the specific endurance also varies. Needs of a boxer are different from weightlifters or hockey players. The better your sport specific endurance, the better you perform at this specific sport. Test match cricketers need a different specific endurance than, say, a limited-over cricketer. Specific endurance is when you fight against fatigue in sport-specific conditions. It can be characterised as a combination of various types of endurance you need to maximise your ability to succeed in your discipline. Basically, this is what everybody does for their own sports – for example, if you're a 1500m runner, you use a combination of endurance training methods to perform better at your specific distance.
6. Kinetic or Ballistic Method is a method of improving flexibility by focusing on movements at a joint in a rhythmic way, called kinetic movements. The stretch is rhythmic to account each time a joint is stretched to its maximum limit. Warm-up is a prerequisite to such exercises as one can easily overstretch the joint this way. Ballistic stretching is a form of passive stretching or dynamic stretching in a bouncing motion. Ballistic stretches force the limb into an extended range of motion when the muscle has not relaxed enough to enter it. It involves fast ''bouncing'' movements where a double bounce is performed at the end range of movement.
7. Coupling Ability is the ability of a player to move his physical organs in order to do his activities. It is also defined as the ability of the body to allow coordination of different parts of the body and is considered so as to perform better at sports. Mostly, this needs coordinative action between hands and eyes and feet and eyes. This ability is based on the muscle strength and flexibility. For example, in volleyball, a player smashes the ball according to the lift of the ball and the blockers very quickly sync the movements of their hands, head and feet. Similarly, while dribbling a basketball the coordination of both the limbs is required. This ability is very significant for in team games gymnastics and combative sports boxing and combative sports like boxing and wrestling.
8. For the purpose of sports, speed is defined as the ability to move quickly across the ground or move limbs rapidly to grab or throw. Speed is the main component of performance-related fitness and appears in different forms like Reaction Ability, Acceleration Ability, Movement Speed, Locomotor Ability and Speed Endurance. Many factors impact the speed of a sportsperson—from genetic to environmental, dietary choices and even socio-economic status. Many of these factors can be altered and improved upon. Factors like genetics where the composition of the muscle and fast fibre to slow fibre ratio is fixed, are not alterable. However, training the body and working on muscular strength, techniques and willpower may help in improvement.
9. The following are the three important physiological factors for determining speed:

   **Muscle composition:** The muscles which consist of more percentage of fast twitch fibres contract with more speed and, in turn, produce a greater speed. Different muscles of the body have different percentages of fast twitch fibres.

   Explosive strength depends on the shape, size and coordination of muscles. For very quick and explosive movement, explosive strength is required. The related proportion of fast twitch fibres and slow twitch fibres determines the maximum possible speed with which the muscle can contract.

   **Biochemical reserves and metabolic power:** A muscle requires more amount of energy and high rate of consumption for maximum speed performance. For this purpose, the stores of ATP & CP in the muscles should be enough. If the store is less, the working process of the muscles slows down after short time.
10. The Continuous Training Method is the most widely used and recommended method to develop endurance. This involves running for long periods of time at a steady pace without any break. This is a low-intensity prolonged exercise. Suggested rate of activity is to keep the heart rate between

130 and 160 per minute. Time duration ranges from 30 minutes in young athletes to 120 minutes in case of more matured athletes. Training for long-distance events such as marathons focuses on this method. The focus is to increase the oxygen uptake as well as oxygen utilisation capacity of the athlete.

Advantages of training with this method include:

(a) Better glycogen stores in liver and muscles

(b) More efficient lungs and heart

(c) Boosts confidence and mental make-up

(d) Low risk of training injuries and accidents

(e) Reduces body fat and decreases the risk of lifestyle diseases

11. Circuit training is a form of body conditioning that involves endurance training, resistance training, high-intensity aerobics and exercises performed in a circuit, similar to high-intensity interval training. It targets strength building and muscular endurance. Some examples include treadmill running, rowing, stationary cycling, jumping rope, jumping jacks, mountain climbers, jump squats, burpees, jumping lunges, box jumps, sprinting in place and side-to-side hops. Advantages of circuit training include getting maximum result in minimum time, Increasing the rate of metabolism, enhancing cardiovascular fitness, enhancing muscle endurance and, of course, helping in strength training. It also aids in increasing strength and muscle growth, offers a full-body workout, is time efficient, improves exercise adherence and may improve mood. Circuit training can be adjusted to be made specific for certain sports.

**D.** 1. The three types of muscle strengthening exercises are Isometric, Isotonic and Isokinetic.

(a) **Isometric Exercises:** All exercises where the length of the muscle does not change are classified as isometric exercises. Doing these exercises leads to increased strength of the muscles. During isometric exercises, the limbs do not move so movement occurs in the muscle mass. These exercises are important to gain strength. Bodybuilders, wrestlers, weightlifters and gymnasts benefit most from these exercises. These exercises are also used extensively in rehabilitating injured sportspersons.

(b) **Isotonic Exercises:** These are exercises where the strength of the muscle does not change but length does. Any exercise that causes movements at joints is classified as isotonic exercise. The need for increased elasticity of the muscle or elastic strength requires the athlete to do isotonic exercises. Stationary jumps, squats, calisthenics and weight training are good examples of isotonic exercises.

(c) **Isokinetic Exercises:** These are exercises in which variable resistance is applied to a limb in constant motion. While performing isokinetic exercises, one contracts the muscle while quickly moving the limb. These movements are a combination of isometric and isotonic movements that are most commonly used in all sporting activities. Isokinetic exercise, a type of strength training, is mostly done on machines. These exercises allow the muscle to gain strength consistently through a range of muscle movements. It uses specialised exercise machines that produce a constant speed, no matter how much effort you expend. One of the major benefits of isokinetic exercises is the reduced likelihood of injury. Since the resistance and speed of the exercise are controlled, straining the muscles is highly unlikely. Another benefit of isokinetic exercises is close monitoring of muscle activation and strain, allowing far more controlled muscle development and increased muscle flexibility.

2. For the purpose of sports, speed is defined as the ability to move quickly across the ground or move limbs rapidly to grab or throw.

A simple version of this is the time taken by an athlete to cover a specified distance. Obviously, speed of a sportsperson has a direct impact on their performance.

The methods of developing speed include—

(a) **Acceleration Run:** It is a special form of sprint training in which running speed is gradually increased from jogging to striding and, finally, to sprinting at the maximum pace. Each component is usually about 50 metres long. Acceleration sprints are a good form of anaerobic training. Adequate rest is suggested in between each acceleration run.

(b) **Pace Run:** This means running a specific distance at a constant pace. A sportsperson is trained to maintain the speed throughout the distance. Longer the race, steadier should be the speed. Peak speed is avoided but constant speed is the norm. This helps improve endurance as well as speed. To complete a race of, say, 1500 metres, the runner ought to run at a suggested pace that is 33% slower than the maximum possible speed. Rather than burning out early, the idea is to pace out the energy consumption so that it lasts the whole distance. Practice runs should be about 20% more than the actual distance to be run in the competition. Also, the speed should be just below the maximum speed.

The advantages of Speed Development are:

(i) It helps decrease reaction time to start signal.

(ii) Capacity for quick acceleration to maximum speed is made possible.

(iii) Better balancing of different body movements.

(iv) Maximum speed for longer periods becomes possible.

3. We can classify flexibility into Active Flexibility and Passive Flexibility.

(a) **Active Flexibility:** This is the capacity of a joint to perform motion while the muscles are also moving. It is focused on increasing the extensibility and the neuromuscular efficiency of a muscle. Active flexibility is also known as mobility. This is of two types:

(i) **Dynamic Flexibility:** It is the ability to perform dynamic movements within the full range of motion in the joint. Common examples include twisting from side to side or kicking an imaginary ball. Dynamic flexibility is generally more sport-specific than other forms of mobility.

(ii) **Static Flexibility:** This refers to the ability to stretch an antagonist muscle using only the tension in the agonist muscle. An example is holding one leg out in front of you as high as possible. The hamstring (antagonist) is being stretched while the quadriceps and hip flexors (agonists) are holding the leg up.

(b) **Passive Flexibility:** This is the ability to hold a stretch using body weight or some other external force such as an assistant or an aid. Passive flexibility is greater than active flexibility and is a base for active flexibility. Here, we use the weight of the limb or the wall or a chair to enhance flexibility.

Thus, active straight leg raising is an example of active flexibility but if we use a band to stretch it even further, it is passive flexibility. Active flexibility depends on muscle strength while passive flexibility depends on joint flexibility.

4. The main Laws of Training for flexibility are:

(a) **Law of Specificity:** Focus on one particular joint or its one action where increase in flexibility is required. The training must go from highly general—such as lifting weights and cardio—to very specific, so it includes performing that exercise or skill. For instance, to be a good cyclist, you must cycle. A runner should train by running and a swimmer should train by swimming.

(b) **Law of Overload:** This states that in order to progress and improve, putting the body under additional stress beyond what is normal is the key. The idea is that, because the level of stress is constantly increasing, the body will adapt to be able to keep up. However, the important part is not to overdo it. Adding too much additional stress can cause injury. For those who are new to exercising, for example, going straight for heavyweights is not a good idea because the body's normal is little to no exercise. So even just the implementation of light exercise is stress beyond

normal for the body, and then as it gets acclimated to regular exercise, implement further overload.

(c) **Law of Reversibility:** Flexibility is reversible and will diminish with time to be ultimately lost completely. Remember something that is used grows and vice versa.

(d) **Law of Continuity:** Training needs to be continued. Flexibility tends to be lost if training is slowed or discontinued.

(e) **Law of Progression:** Increase in muscle gain gradually to prevent damage.

(f) **Law of Individuality:** Remember no two people are alike. Respect has to be given to the differences and customisation of the programme.

5. Sports training is a special process of preparation of sports persons based on scientific principles aimed at improving and maintaining higher performance capacity in different sports activities. It is a particular type of training designed to improve fitness and abilities to perform in a given sport. The 10 principles of fitness training are Specificity, Overload, Progression, Individualisation, Recovery, Variation, Reversibility, Balance, Warm-up and Cool Down, and Cardiovascular/Respiratory Endurance. Each principle should be followed to ensure that your body is being challenged in the best way possible.

   The importance of sports training is as follows:

   (a) **Physical Fitness:** Physical fitness is the basic requirement of any game and sports. There is a specific requirement of each component of physical fitness according to the specific sport. Sports training helps in building a fine physique and ensures good health.

   (b) **Self-Discipline:** Sports training helps in incorporating a sense of discipline in a person's life.

   (c) **Teamwork:** Sports training teaches a sports person about teamwork, the sense of belonging and unselfish play. It also encourages to play for team rather than for one's personal accomplishment.

   (d) **Confidence:** It boosts the morale of a person when he performs and also when he excels towards a particular game. It improves self-esteem as well as body posture, which makes one feel more confident and determined.

   (e) **Focus:** Counsellors and mental trainers help in identifying those areas which are causing the sportsman to become distracted on the field and enhance focus on the field.

6. Reaction Ability is a combination of reaction and coordination ability. Once the starter signal is given, how fast the athlete reacts is the measure of his starting speed. This is of two types:

   (a) **Simple Reaction Ability:** Reaction to predetermined signal in a predetermined direction is exhibited in swimming, cycling or racing at the starter block.

   (b) **Complex Reaction Ability:** This is useful when the direction of movement of the athlete is not predetermined as in football or hockey. Similarly, the non-striker in cricket has to respond to the batsman's call for a run.

   Reaction time is the time taken by a sportsperson to respond to the given command. For example, how fast the swimmer jumps into water after the command determines the performance. Less reaction time translates into a better performance.

   A variety of different exercises can aid in increasing reaction time, such as ladder drills, agility drills and specialised plyometrics. Digital reaction drills have also become popular among elite athletes to optimise their brain's ability to process information faster. Improving general health and fitness by regular exercise and a healthy diet will improve overall health and fitness levels, which, in turn, improve reaction time. Exercise also offers the benefit of promoting blood flow, which boosts cognitive function and reaction speed. Getting enough sleep, staying hydrated and practising meditation or mindfulness also help. Obviously, reflexes can be improved with committed training. The martial arts student who trains to better reflexes does more than react quickly. The athlete also strengthens the connection between mind and body, which enables a correct response with every move.

7. Strength is defined as ''the capacity of an object or substance to withstand great force or pressure.'' The three types of muscle strengthening exercises are Isometric, Isotonic and Isokinetic.
   (a) **Isometric Exercises:** All exercises where the length of the muscle does not change are classified as isometric exercises. Doing these exercises leads to increased strength of the muscles. During isometric exercises, the limbs do not move so movement occurs in the muscle mass. These exercises are important to gain strength. Bodybuilders, wrestlers, weightlifters and gymnasts benefit most from these exercises. These exercises are also used extensively in rehabilitating injured sportspersons.
   (b) **Isotonic Exercises:** These are exercises where the strength of the muscle does not change but length does. Any exercise that causes movements at joints is classified as isotonic exercise. The need for increased elasticity of the muscle or elastic strength requires the athlete to do isotonic exercises. Stationary jumps, squats, calisthenics and weight training are good examples of isotonic exercises.
   (c) **Isokinetic Exercises:** These are exercises in which variable resistance is applied to a limb in constant motion. While performing isokinetic exercises, one contracts the muscle while quickly moving the limb. These movements are a combination of isometric and isotonic movements that are most commonly used in all sporting activities. Isokinetic exercise, a type of strength training, is mostly done on machines. These exercises allow the muscle to gain strength consistently through a range of muscle movements. It uses specialised exercise machines that produce a constant speed no matter how much effort you expend. One of the major benefits of isokinetic exercises is the reduced likelihood of injury. Since the resistance and speed of the exercise are controlled, straining the muscles is highly unlikely. Another benefit of isokinetic exercises is close monitoring of muscle activation and strain, allowing far more controlled muscle development and increased muscle flexibility.
8. Flexibility or limberness refers to the range of movement in a joint or series of joints and length in muscles that cross the joints to induce a bending movement or motion. Flexibility varies from individual to individual, particularly in terms of difference in muscle length of multi-joint muscles.

   Flexibility is also defined as the range of motion in a joint or group of joints or the ability to move joints effectively through a complete range of motion.

   Improving flexibility and developing it to the maximum possible happens with:
   (a) **Active, slow stretching:** Active stretching is also referred to as static-active stretching. An active stretch is one where you assume a position and then hold it there with no assistance other than using the strength of your agonist muscles.
   (b) **Passive Stretching Method:** Passive stretching, also known as static stretching, can be done to develop muscle strength by holding stretched limbs for some time. This is designed to increase flexibility without the active use of muscles. Static stretching means a stretch is held in a challenging but comfortable position for a period of time.
   (c) **Kinetic or Ballistic Method:** Movements at a joint in a rhythmic way are called kinetic movements. The stretch is rhythmic to account each time a joint is stretched to its maximum limit.
   (d) **Proprioceptive Neuromuscular Facilitation:** This is a more advanced form of flexibility training that involves both stretching and contraction of the muscle group being targeted. PNF stretching was originally developed as a form of rehabilitation, and to that effect, it is very effective. It is also excellent for targeting specific muscle groups and increasing flexibility as well. It also improves muscular strength.
9. The Fartlek Training Method was developed in Sweden. Meaning 'speed play', it incorporates aspects of interval training with regular-distance running. This training consists of distance running with "bursts of harder running at more irregular points, lengths and speeds as compared to interval training." For example, a Fartlek training session might consist of a warm up for 5–10 minutes; running at a steady, hard speed for 2 km; rapid walking for 5 minutes (recovery); sprints of 50–60

seconds, interspersed with easy running; full-speed uphill for 200m; rapid walking for one minute; and repeating this routine until the time schedule has elapsed (a minimum of 45 minutes). The development of aerobic and anaerobic capacities occurs. Running hard up the hill to the crest, jogging to cross walk, accelerating the short downhill, jogging to the intersection, running quickly around the block versus running 6-5-4-3-2 minutes faster with 2 minutes jogging recovery, is an example of a structured fartlek training. This type of training is very individual as the participant can determine the intensity and pace. It can be fun and offers much more variety compared to the monotony of a steady state session. It is a good way to train all three of the energy systems and also different muscle fibre types because of the large variations in intensity. Fartlek helps to train your body to react to changing intensities which can be very important in some sports, especially team sports such as hockey, rugby or football. You can do Fartlek Training indoors or outdoors. If training on a cardiovascular machine, such as a treadmill, selecting the 'random' programme would somewhat simulate Fartlek Training but you could also just change the pace and incline manually throughout your run, depending on how you are feeling. Fartlek Training is quite random in nature and allows you the freedom to alter the intensity of your training session.

10. In sports, coordinative abilities are as follows:

    (a) **Differential Ability:** It is the ability to determine the position of the body and its parts in time and space in relation to gravity. This ability to achieve a high degree of accuracy and economy of separate body movements is phased in a motor action.

    (b) **Orientation Ability:** It is the ability of a person to adjust as per time and movement. Thus, while playing, say, football, the person not only needs to sense his position but also that of the moving ball and his opponent.

    (c) **Coupling Ability:** It is the ability of a player to move his physical organs in order to do his activities. Mostly, this needs coordinative action between hands and eyes, feet and eyes.

    (d) **Reaction Ability:** It is the ability to react immediately and effectively to a signal. This is of two types—simple and complex reaction ability.

    - *Simple Reaction Ability:* It is the ability to respond to a stimulus that is known beforehand to the person such as a starters' gun.
    - *Complex Reaction Ability:* It is the response to unknown or unexpected signals. These are not known beforehand, *e.g.*, the reaction of the non-striker responding to the batsman's call for a run.

    (e) **Balance Ability:** It is the ability to maintain balance during the complete body movement and to regain balance quickly after the balance-disturbing movement. Examples include a gymnast landing after a manoeuvre or a skier or skater twisting along the course yet maintaining an erect posture.

    (f) **Rhythm Ability:** It is the ability to observe and perceive the rhythm of a movement and to do the movement with external rhythm-like music.

    (g) **Adaptation Ability:** It refers to adjusting or changing the movement effectively on the basis of changes or anticipated changes in the situation.

    (h) **Kinaesthetic Ability:** It helps sportspersons play using kinaesthetic impressions. Hitting a ball behind you as in tennis or a backstroke to pick up the shuttle in badminton involves this ability.

11. Dynamic Strength is the strength produced by the movement of muscles. These are also called the isotonic movements as the tone of muscles remains the same while the length alters.

    Repetition of such movements leads to fatiguing of the muscle relatively early as a lot of energy is expended in performing these movements. Different sports need different muscles to possess dynamic strength. Three types of dynamic muscle strengths exist, namely, Maximum Strength, Explosive Strength and Endurance Strength.

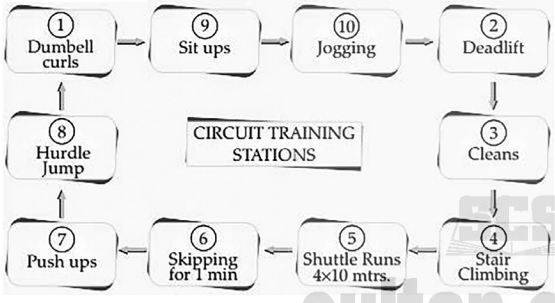
    (a) **Maximum Strength:** The highest strength in a single effort by the muscle is defined as maximum strength. This is best used in sports like weightlifting where a single lift has to be the heaviest

possible. More the resistance to be overcome, more has to be the maximum strength of the muscle. Sports like hammer throw, javelin throw, discus throw and shotput need maximum strength.

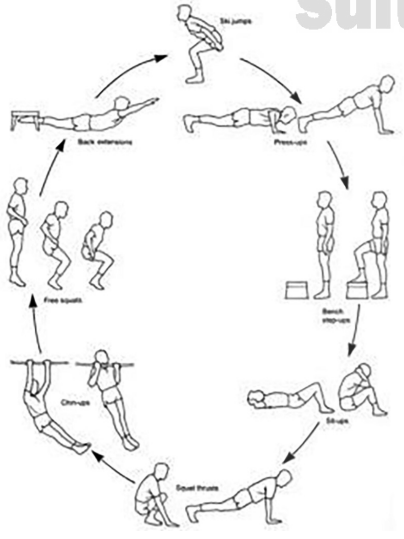
(b) **Explosive Strength:** This is the ability of the muscle to overcome resistance while functioning at high speed, produce a maximal amount of force in a minimal amount of time and muscle lengthening, followed by rapid acceleration through the shortening phase. The focus is on the speed of movement through a range of motion of the muscle. The force generated is just like an explosion, hence the name. Explosive strength is based on the ability of the contractile element to rapidly generate tension, while power enhances the ability of elastic tissue to minimise the transition time from lengthening to shortening during the stretch-shorten cycle. Examples include throwing a shot-put and Olympic lifts such as the snatch and clean-and-jerk.

(c) **Endurance Strength:** The ability to maintain muscular contractions or a consistent level of muscle force for extended periods of time is called strength endurance. Here, we need to ensure that there is a large supply of oxygen and nutrients to the muscles as also rapid removal of metabolic waste. This combines both static and dynamic strengths in the muscle. Long-distance running, swimming, long-distance cycling and combative sports need endurance strength.

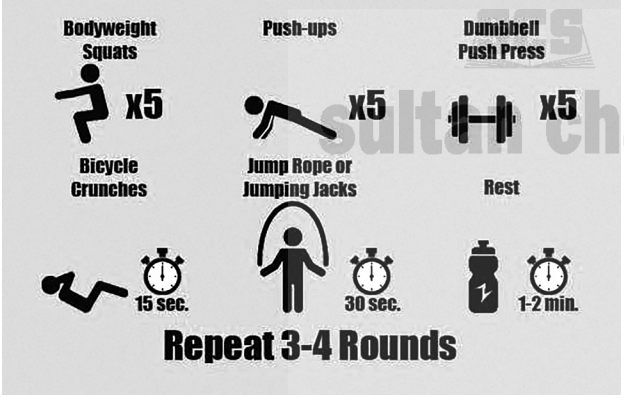
12.




13.



14. Circuit Training is a high volume but low resistance weight workout with 2–3 minute rest intervals involving cardio. Moreover, it is a form of body-conditioning that combines high-intensity exercises with strength/resistance training. A 'circuit' is assigned exercises completed one after another. Each exercise is given a certain number of repetitions within a time limit, in order to keep the heart rate up to target optimum weight loss and toning. Circuit Training can use free weights, weight machines at a gym and body weight. The uniqueness of the convenience of not relying on a gym to achieve results and using your body as weight has attracted many fitness enthusiasts and athletes alike. Circuit Training can be for anyone interested in a fast-paced workout, especially those who want to lose weight and tone up at the same time due to busy work schedules. Circuit Training has been recognised as one of the fastest methods for burning fat.




15. Continuous Training Method is the most widely used and recommended method to develop endurance. This involves running for long periods of time at a steady pace without any break. This is a low-intensity, prolonged exercise. Continuous training is a form of exercise that is performed at a 'continuous' intensity throughout and doesn't involve any rest periods. Continuous training typically involves aerobic activities such as running, biking, swimming and rowing. The suggested rate of activity is to keep the heart rate between 130 and 160 per minute. Time duration ranges from 30 minutes in young athletes to 120 minutes in case of more matured athletes. Training for long-distance events such as marathons focuses on this method. The focus is to increase the oxygen uptake as well as oxygen utilisation capacity of the athlete. It improves cardiovascular and muscle endurance for sports such as long-distance running. It also helps with better glycogen stores in liver and muscles, a more efficient lung and heart, a boosted confidence and mental make-up with a much lower risk of training injuries and accidents. Since it reduces body fat, it decreases the risk of lifestyle diseases.

    However, it is not good at improving performance in sports which require sprinting for, say, 100m. Other disadvantages of this method include monotony and consequent boredom as well as the inability to improve anaerobic fitness.