

3 Chapter

PHYSIOLOGICAL ASPECTS OF PHYSICAL EDUCATION

WARMING UP

Warming up is a short time activity carried out prior to any severe or skilled activity. It is important to warm up before exercising which is usually done by including ten minutes of light activities, such as slow jog, calisthenics and stretching. Through such a workout, we try to bring the group of muscles expected to take part in the activity to follow, in a state of readiness to respond efficiently. It makes the body more flexible and thus we can avoid injuries resulting from sudden strain etc.

When we stretch our muscles slowly, it results in increased blood flow and prevents injuries to the muscles, tendons, ligaments. Warm up exercises are not supposed to be done vigorously. Any light exercise such as spot jogging, cycling at slow pace, walking can be done. Warming up also prevents fatigue, muscle pulls and soreness. This preparation before a competition or training is called warming-up.

The following definitions may help to know more about warming up :

1. It is a practice in itself.
2. It consists of a series of preparatory exercises either before a training session or before competition.
3. It is a process of heating the whole body by running and performing exercises prior to the activity or competition.
4. It is done to tone up the body to meet the ensuing activity.
5. **Davries** concludes in his research study that warming up increases temperature of body thereby improving the performance.
6. According to **Hill**, if normal temperature of body is decreased slightly, the reaction time will be less and if body temperature is increased than normal temperature, then contractile force and speed of muscles will be increased.

Thus we can conclude that warming up includes certain exercises which are performed before any training, competition, or any strenuous activity to prepare well physically, mentally and psychologically.

We have often seen that before a game like badminton, football, tennis, basketball etc. starts, players do some exercises. These activities suggest that these exercises do help players in the initial stages of their respective games.

It is very often observed that when a tennis player starts his game without warming up, he/she usually commits lots of faults in service.

Research scholars and educationists hold different opinions on the issue of warming up. Some of them consider warming-up as a time wasting, energy depleting useless activity. They also think that it comes in the way of peak-performance as they have exhausted their energy during warming-up.

But very few people have this opinion and majority of them advocate the benefits of warming up. Though they suggest that it should not be followed indiscriminately. It should be specific to the activity being performed. Warming up reduces the chances of making mistakes in the game.

Experts agree that proper warming up is essential before a severe activity in order to prevent injuries to muscles, joints or bones etc. and to give better performances.

There are various advantages of warming up which are as follows :-

- (a) Increase of blood flow in the working muscles.
- (b) Regularising the heart beat and enabling it to get activated to face the expected strain.
- (c) Oxygen and fuel is transferred to the muscles speedily.
- (d) Decrease in resistance of muscles.
- (e) Speed of contraction and relaxation of muscles is increased.
- (f) The speed of conduction of nerve impulses is also fastened.
- (g) There is better coordination between different groups of muscles that help in better performance and grace in doing activities.
- (h) It prepares the sportsperson psychologically before the start of an activity.
- (i) It also prevents injuries due to sudden strain on body parts.

TYPES OF WARMING-UP

Warming up is of two types viz-General warming-up and Specific warming up. These two types of warming up are described below :

1. **General Warming-Up** - In general warming up, basically, we do some general exercises like jogging, running, jumping, stretching, calisthenics striding, wind sprints and other general exercises. It is helpful before almost all types of activities as it improves muscle tone of the body. It increases agility and flexibility, coordination abilities of muscles and joints. It is also beneficial in improving Neuro-muscular coordination of muscles that results in developing better control on muscles. Coordination is essential in activities that require skill to perform. This warming up in turn increases the body temperature resulting in reduced viscosity in muscle fibres and thus helps in getting better results. The duration of warming-up depends upon the nature of work to be performed.
2. **Specific Warming-Up** - In specific warming up some special sets of exercises need to be perform which have a direct relation with the activity to be carried out. This exercises are done with the help of implements. These special exercises should be done along with or after the activities of general warming up. The set of activities in specific warming-up differ from sport to sport so no one set is common to all. These are especially designed to meet the requirement of different activities and sports. *For example* in a game of Badminton, we need to do some forward, backward, sideward bending and body twisting exercises, along with some arms and legs exercises. Along with general warming-up, specific exercises for warming-up are also needed because separate group of muscles take part in different activities and the group of muscles to be involved in a particular game or activity may not be warmed up by general warming up. A basketball player practicing lay up shots or free throws before the competition helps to improve his coordinating abilities.

Different games have specific warming-up exercises. Some of them are described along with the games they concern as follows.

1. **Basketball** - Shooting, dribbling, lay-up shots, free throws, shuttle run and doging etc.
2. **Cricket** - Bowling, catching, batting, fielding, running etc.
3. **Lawn Tennis** - Wall practice, Service practice, Passing shots, Knocking etc.
4. **Shot put** - Standing throws, putting the shot with both hands, gliding practice with or without shot etc. Shifting the shot from left hand to right hand and *vice-versa*.
5. **Hockey** - Dribbling, rotation of stick, short passes, long hits, scoop, stopping the ball with stick etc.

METHODS OF WARMING UP

There are various methods of warming up for games and athletics, out of which the following ones are the most commonly used : -

1. By exercise
2. By massage
3. By taking hot water bath
4. By sipping some hot beverages.

1. By Exercise

Most sets of warm up exercises include four to five very simple movements. The body should be sweating lightly when the set is done. It is the simplest and most effective method of warming-up. The following exercises are included in this method.

(a) Jogging : Jogging or easy running should be done where open spaces are available and at one's own pace. This will be very helpful in regulating the circulatory and the respiratory systems of the body. This type of running is usually done for three to four minutes. Duration of running mostly depends on the fitness level of an individual.

(b) Bending and Stretching Exercises : These exercises should include arms and shoulders, legs, trunk and hips, knees and calves, head and neck, shoulders and chest. They can be done for about five minute and then some forward, backward, sideward bending and trunk rotation exercises should be done to stretch the muscles which are not active. It should be done slowly for 5 to 10 minutes without any jerky movements.

The following exercises will help to warm up the specific areas mentioned below.

Head and Neck : Stand straight with your feet slightly apart and then start rolling your head in a circular motion in a way that your neck should be bent down when your roll it forward. When the neck moves from forward to sideward it should be bending towards your shoulders and then taking it backwards with your neck turned backwards. After this, your neck should bend towards another side and then return to starting position. Repeat it eight to ten times but do it slowly.

Arms and Shoulders : In this also, one needs to first stand absolutely straight with the distance between the feet not more than 1 foot apart. Then start to raise your arms in upward direction extending them as far as comfortable and then keep raising

them till you start to feel that your chest muscles and shoulder muscles are stretching. Remain for a few counts and then lower your hands. Repeat it eight to ten times.

Shoulders and Chest : Again in standing position with complete awareness that your back should be absolutely straight and feet should have a gap of about one foot. Move your hands backwards and clasp them together. After joining your hands at your back side extend them slowly towards backside till your upper chest and shoulder muscles feel the stretch in them. Remember not to strain. All movements should be smooth. Then come back to starting position. Repeat this process eight to ten times.

Trunk : To warm up this part of the body we have a very simple but effective exercise. In this one has to first assume standing position with back absolutely straight and feet should be a little more than a feet apart approximately one and a half feet gap. Lifting your left hand up and then bending your body right at the waist, try to slide your right hand as much as possible downwards parallel to your leg and just below the knee. Remember that your left hand which you have raised will also bend toward right but the above elbow should be straight. Come to the starting position after doing it on the right side and similarly, repeat the process on your left.

Hips and Trunk : In this particular exercise first stand straight with your back absolutely erect then slowly bend a little forward at the waist. Once you have bent a little in front, bring your left leg upward and try to touch your face with your knee and straighten it. After finishing one lap repeat the process with right leg. Do it five to six times. As for your trunk or torso first stand straight with your feet slightly apart and your arms stretched sideways. Then slowly swing your arms and torso to face right and then swing again to face left. Do this in a smooth motion for at least eight to ten times. Again avoid any jerky movements which might hurt your upper back muscles.

Knee and Calves : For this too first we need to stand erect with back completely straight and with almost no gap between your feet. Now slowly and carefully bring your left leg forward, put your weight on that leg. Your knee should be bent. Do it for 30 seconds and then come to start position. Repeat it with right leg. Repeat this exercise for six to eight times gradually increasing the laps as one gets flexible.

(c) Striding

It is very helpful to athletes who are preparing for running events. He should be able to run for about 50 meters at three fourth's($\frac{3}{4}$) of his actual running speed. In between he should relax and then repeat the process four to five times with repeated intervals of relaxation.

(d) Wind Sprints

This is actually sprinting for short distances (20-25 metres) and should be done five to six times with suitable intervals in between.

(e) Arm Rotation Exercises

In this exercise one needs to extend his/her arm straight out to the sides from your shoulders. The arm are then rotated in circles about a foot in diameter. Your arm should be able to do 20 circles while rotating forward and 20 more while doing backward.

(f) Deep Breathing Exercises

This type of exercise requires that you rise on your toes while inhaling deeply and then extend both your arms straight out to the sides. While you are breathing and rising on your toes, your arms should be raised from shoulder level until your hands come together over your head. Stay in this position for a few seconds. Then exhale and covers your arms simultaneously to your sides and return to starting position. Do this exercise six to twelve times.

The purpose of all the above mentioned exercises is to prepare a player or an athlete both physically and mentally before any event. These should not strain the individual in any way. His breathing rate, heart rate should remain normal before the start of an event or game.

2. By Massage

Massaging of muscles is a good method to gain muscle tone and is an effective means of warming up. A lot of teams today appoint their own massagers who travel with them wherever the team goes. It also helps in reducing the effect of minor injuries to muscles.

3. By Taking Hot Water Bath

This technique is very helpful in warming up and relaxation of muscles after competition. A hot bath is helpful in raising body temperature which results in the activation of muscles by increasing blood circulation in them. This is more common in colder climate regions as it is very efficient and quickly increases the efficiency of muscles.

4. By Sipping Some Hot Beverage

A small intake of tea, soup, coffee, or any other hot beverage stimulates the body functions and helps in preparing the body for competition. The drink should not be consumed in large quantities as it may cause discomfort.

A lot of factors decide what method is to be adopted, depending upon the availability of facilities as well. Seasons, weather/ climate etc. also play a major role in selecting or modifying a method. *For example*, a lighter workout is needed in summer months than in the winter season.

PHYSIOLOGICAL BASIS OF WARMING UP

When we observe the contraction and relaxation of an isolated muscle, we note that when the muscle is warmed, the speed with which the muscle contracts and relaxes and the force of contraction are increased. We can see that when a muscle is stimulated repeatedly, then the first few contractions are small and the feeling of relaxation is not satisfying. Whereas, when the contractions become stronger the feeling of relaxation is also complete. This points to the fact that warming up does produce physiological changes in the working of a muscle and that warming up helps in building a strong and efficient formation for the working of muscles.

The Physiological basis of Warming Up are as follows :

1. Increases the Body Temperature.

A proper warming-up increases the body and muscle temperature locally which helps in the efficiency of contractions and relaxation of muscles. So it has a lot of benefits for the sportspersons. Researches point that if the muscles have been slightly warmed-up just before the beginning of activity the performance is greatly improved. If one fails to do warm-up exercises before vigorous activity it may lead to tearing of muscle fibres.

2. Decreases the Viscosity of Muscles.

Warming-up decreases the viscosity of muscles. It is found out that if a previously inactive muscle is stimulated repeatedly, the first few contractions are often small and irregular and relaxation is incomplete. But once the contractions become stronger relaxation is complete. It takes place due to decrease in the viscosity of muscles. This leads to faster and efficient rate of muscular contraction and relaxation. It also reduces the occurrence of injury or wear and tear of muscles and ligaments.

3. Increases the Speed of Nerve Impulses.

Warming-up increases the speed of nerve impulses, which improves and sharpens the reaction time of sportspersons. Improvement in reaction time is most vital to sports persons in most of the game and sports.

4. Decreases the Resistance in Muscle Capillaries.

A lot of research papers reveal that warming up decreases the resistance in muscle capillaries. Warming up also brings the muscles in a state of readiness. It responds to stimuli efficiently.

5. Increases the Speed of Oxygen and Fuel Transfer to Tissues.

A proper warming-up schedule increases the speed of oxygen and fuel transfer to tissues. Its occurrence takes place due to the enhancement of blood flow through the muscles by dilating the small blood vessels. Increase in oxygen supply improves the functionality of muscles.

6. Increases Metabolic Rate.

Warming-up increases the metabolic rate which ultimately improves energy level. In fact, the metabolic rate increases due to rise in core temperature. If there is an increase in temperature by 0.5°C, the metabolic rate increases by 7%. A high metabolic rate points to higher production of energy.

7. Reduces the Blood Lactic Acid.

Research conducted in this field indicate that heart rate and consumption of oxygen are directly related to muscle temperature. If the temperature is high the consumption of oxygen and heart rate will also be higher and will reduce blood lactic acid.

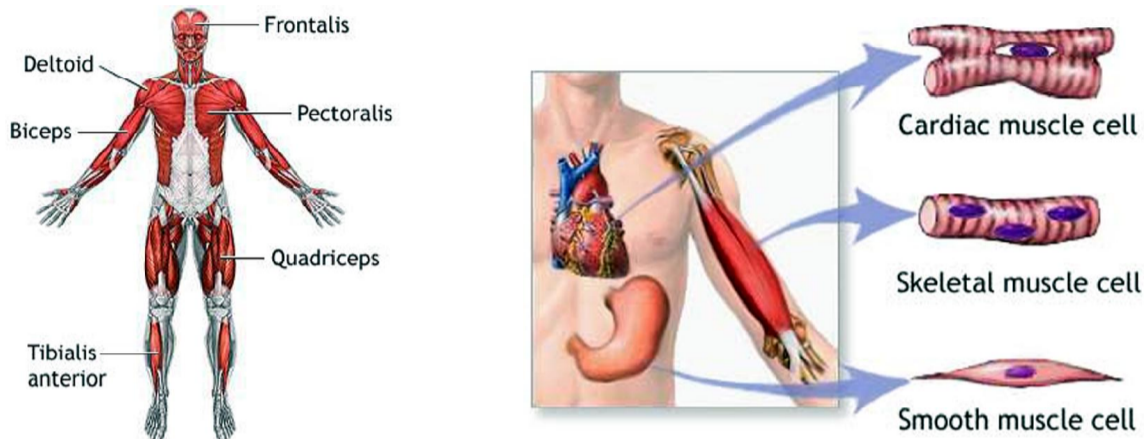
8. Increase in Working Capacity.

The above mentioned physiological adaptations increase the capacity of a person to do physical work. All the systems of body become efficient to do their related work.

THE MUSCULAR SYSTEM

About Muscular System

Over 600 skeletal muscles function for body movement through contraction and relaxation of voluntary, striated muscle fibers. These muscles are attached to bones, and are typically under conscious control for locomotion, facial expressions, posture, and other body movements. Muscles account for approximately 40 percent of body weight.



Cardiac Muscle

Cardiac muscle is only in the heart and makes up the atria and ventricles (heart walls). Like skeletal muscle, cardiac muscle contains striated fibers. Cardiac muscle is called involuntary muscle because conscious thought does not control its contractions. Specialized cardiac muscle cells maintain a consistent heart rate.

Smooth Muscle

Smooth muscle is throughout the body, including in visceral (internal) organs, blood vessels, and glands. Like cardiac muscle, smooth muscle is involuntary. Unlike skeletal and cardiac muscle, smooth muscle is nonstriated (not banded). Smooth muscle, which is extensively within the walls of digestive tract organs, causes peristalsis (wave-like contractions) that aids in food digestion and transport.

Skeletal Muscle

A skeletal muscle has regular, ordered groups of fascicles, muscle fibers, myofibrils, and myofilaments. A muscle fiber divides into even smaller parts. Within each fiber are strands of myofibrils. These long cylindrical structures appear striped due to strands of tiny myofilaments. Myofilaments have two types of protein: actin (thin myofilaments) and myosin (thick myofilaments).

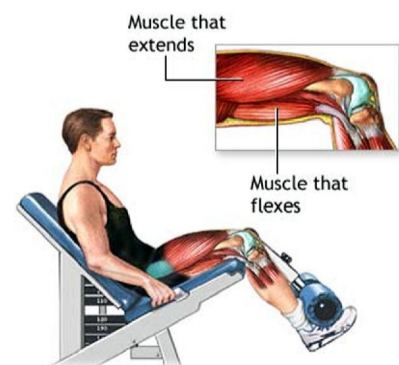
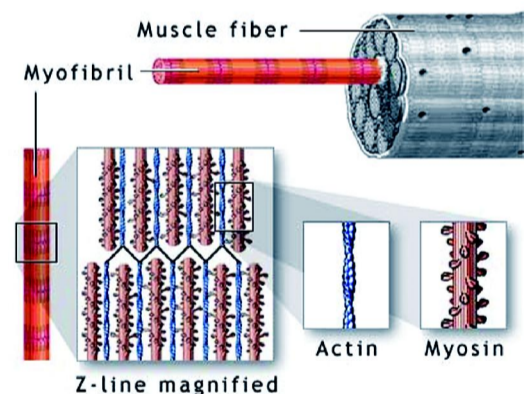
The actin and myosin myofilaments align evenly, producing dark and light bands on the myofibril, causing the striated appearance of skeletal muscle.

The region between two Z-lines is a sarcomere, the functional unit of skeletal muscle. Muscle contraction occurs when overlapping actin and myosin myofilaments overlap further and shorten the muscle cell. The myofilaments keep their length.

Skeletal muscle is a system of pairs that relax and contract to move a joint. For example, when front leg muscles contract, the knee extends (straightens) while back leg muscles relax. Conversely, to flex (bend) the knee, back leg muscles contract while front leg muscles relax.

Tendons attach most skeletal muscles to bones. Tendons are strong sheets of connective tissue that are identical with ligaments. Tendons and ligaments differ in function only: tendons attach muscle to bone and ligaments attach bone to bone. Physical exercise strengthens the attachment of tendons to bones.

Skeletal muscles have muscle tone (remain partly contracted), which helps maintain body posture. Ongoing signals from the nervous system to the muscle cells help maintain tone and readiness for physical activity.

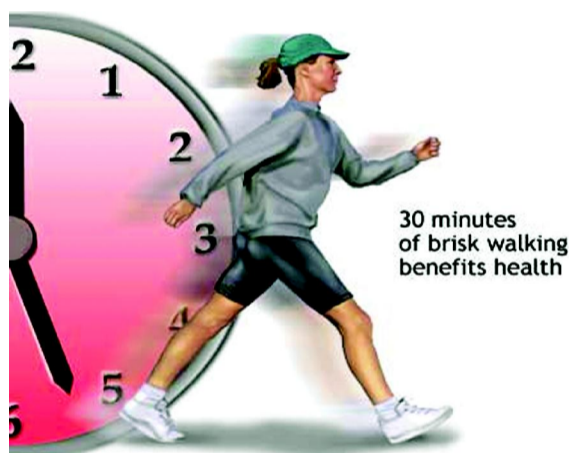


Skeletal muscle aids in heat generation. During muscle contractions, muscle cells expend much energy, most of which is converted to heat. To prevent overheating, glands in the skin produce sweat to cool the skin; and, the body radiates heat from the blood and tissues through the skin. When the body is chilly, shivering causes quick muscle contractions that generate heat.

EFFECT OF EXERCISE ON THE MUSCULAR SYSTEM

Supply of Oxygen

Skeletal muscles have two types of muscle fibers: fast-twitch and slow-twitch. Anaerobic exercise uses fast-twitch fibers. Such exercise includes activities that are fleeting and require brief high-energy expenditure. Weightlifting, sprinting, and push-ups are examples of anaerobic exercise. Because all cells require oxygen to produce energy, anaerobic exercise depletes oxygen reserves in the muscle cells quickly. The result is an oxygen debt. To repay the debt, humans breathe deeply and rapidly, which restores the oxygen level. Anaerobic exercise creates excess lactic acid (a waste product). By increasing oxygen intake, the liver cells can convert the excess lactic acid into glucose, the primary food molecule used in cellular metabolism.



Aerobic exercise uses slow-twitch muscle fibers. Such exercise includes activities that are prolonged and require constant energy. Long distance running and cycling are examples of aerobic exercise. In aerobic exercise, the muscle cell requires the same amount of oxygen that the body supplies. The oxygen debt is slashed and lactic acid is not formed.

Effect of Steady Exercise

Steady exercise is when sufficient oxygen can be breathed in to satisfy the needs of the muscles. Oxygen is required by the muscles to clear away waste products [lactic acid] which are formed during the contraction of muscle.

During steady exercise the muscles use mostly fat for the creation of energy, but also glucose. As long as the glucose supplies last, the body can continue the exercise quite comfortably. However, when the glucose is all used then the body has to continue on fats alone. The effect of this is a build up of acid in the blood stream, and heavy sweating resulting in dehydration. The body cannot continue due to a raising of temperature and the person has to stop. If he attempted to continue he would eventually collapse.

Effect of Intense Exercise

When the level of exercise reaches the stage where the amount of oxygen breathed in is insufficient to clear away the waste products formed by the muscle contractions, then an oxygen debt builds up. The waste products (mainly lactic acid) continue to build up causing pain in the muscles and breathlessness. Soon, the performer has to stop or at least slow down. The rate of breathing will stay very high until the oxygen debt has been paid off, i.e. the waste products have been cleared away.

THE PRODUCTION OF ENERGY FOR EXERCISE

Chemicals Needed By Muscles

GLUCOSE — A type of sugar, found in carbohydrate-rich foods.

FAT ————— Visible (saturated) and invisible (unsaturated)

OXYGEN ——— Obtained by breathing, not from food.

These chemicals are carried to the muscle cells in the blood stream. Oxygen is either used or breathed back out, but glucose and fat can be stored until needed. Stored glucose is called Glycogen.

The Muscles At Work

The muscles contract when the brain tells them to. The message to contract travels from the brain to the muscle along the nerves. The message is called a nervous impulse.

How The Muscle Contraction Is Triggered Off

When the nervous impulse reaches the muscle, the nerve actually goes into the muscle. At the end of the nerve (inside the muscle) the impulse causes a tiny electrical charge to be given off. This charge sets off a chemical reaction in the muscle cells which results in the muscle contracting.

Work And Energy

Any work requires energy. When muscles contract, they are working. This work requires energy, and the energy is provided by the chemical reactions which take place inside the muscle.