MANTALY TEST III
PART – II

SOUND		
9th book	**Unit - 8**	**Sound**
10th book	**Unit - 5**	**Acoustics**
Fertilizer, pesticides and insecticides		
REFER APPOLO MATEIRAL		
HEALTH& HYGIENE (HUMAN DISEASES)		
6th term 1	**Unit- 6**	**Health & Hygiene**
7th Term 1	**Unit- 6**	**Health & Hygiene**
8th book	**Unit- 6**	**Microorganisms**
9th book	**Unit - 21**	**Nutrition & Health**
10th book	**Unit - 21**	**Health & Disease**
11th zoology vol - 1	**Unit - 5**	**Digestopm And Absorption**
12th zoology vol - 1	**Unit - 7**	**Human Health & Disease**
	Unit - 8	**Immunology**
	Unit - 9	**Microbes in Human Welfare**

SOUND
(Physics)
9th book - Unit – 8 Sound

Introduction

- Sound is a form of energy which produces sensation of hearing in our ears. Some sounds are pleasant to hear and some others are not. But, all sounds are produced by vibrations of substances. These vibrations travel as disturbances in a medium and reach our ears as sound. Human ear can hear only a particular range of frequency of sound that too with a certain range of energy. We are not able to hear sound clearly if it is below certain intensity. The quality of sound also differs from one another. What are the reasons for all these? It is because sound has several qualities. In this lesson we are going to learn about production and propagation of sound along with its various other characteristics. We will also study about ultrasonic waves and their applications in our daily life.

Production of sound

- In your daily life you hear different sounds from different sources. But, have you ever thought how sound is produced? To understand the production of sound, let us do an activity.

- When you strike the tuning fork on the rubber pad, it starts vibrating. These vibrations cause the nearby molecules to vibrate. Thus, vibrations produce sound.

Propagation of Sound Waves
Sound needs a medium for propagation

- Sound needs a material medium like air, water, steel etc., for its propagation. It cannot travel through vacuum. This can be demonstrated by the Bell – Jar experiment.

- An electric bell and an airtight glass jar are taken. The electric bell is suspended inside the airtight jar. The jar is connected to a vacuum pump, as shown in Figure 8.1. If the bell is made to ring, we will be able to hear the sound of the bell. Now, when the jar is evacuated with the vacuum pump, the air in the jar is pumped out gradually and the sound becomes feebler and feebler. We will not hear any sound, if the air is fully removed (if the jar has vacuum).

Sound is a wave

- Sound moves from the point of generation to the ear of the listener through a medium. When an object vibrates, it sets the particles of the medium around to vibrate. But, the vibrating particles do not travel all the way from the vibrating object to the ear. A particle of the medium in contact with the vibrating object is displaced from its equilibrium position. It then exerts a force on an adjacent particle. As a result of which the adjacent particle gets displaced from its position of rest. After displacing the adjacent particle the first particle comes back to its original position. This process continues in the

medium till the sound reaches our ears. It is to be noted that only the disturbance created by a source of sound travels through the medium not the particles of the medium. All the particles of the medium restrict themselves with only a small to and fro motion called vibration which enables the disturbance to be carried forward. This disturbance which is carried forward in a medium is called wave.

Longitudinal nature of sound waves

- From the above activity you can see that in some parts of the coil, the turns are closer together. These are regions of compressions. In between these regions of compressions we have regions where the coil turns are far apart called rarefactions. As the coil oscillates, the compressions and rarefactions move along the coil. The waves that propagates with compressions and rarefactions are called longitudinal waves. In longitudinal waves the particles of the medium move to and fro along the direction of propagation of the wave. Sound also is a longitudinal wave. Sound can travel only when there are particles which can be compressed and rarefied. Compressions are the regions where particles are crowded together. Rarefactions are the regions of low pressure where particles are spread apart. A sound wave is an example of a longitudinal mechanical wave. Figure 8.2 represents the longitudinal nature of sound wave in the medium.

Characteristics of a Sound Wave

- A sound wave can be described completely by five characteristics namely amplitude, frequency, time period, wavelength and velocity or speed.

Amplitude (A)

- The maximum displacement of the particles of the medium from their original undisturbed positions, when a wave passes through the medium is called amplitude of the wave. If the vibration of a particle has large amplitude, the sound will be loud and if the vibration has small amplitude, the sound will be soft. Amplitude is denoted as A. Its SI unit is meter (m).

Frequency (n)

- The number of vibrations (complete waves or cycles) produced in one second is called frequency of the wave. It is denoted as n. The SI unit of frequency is s–1 (or) hertz (Hz). Human ear can hear sound of frequency from 20 Hz to 20,000 Hz. Sound with frequency less than 20 Hz is called infrasonic sound. Sound with frequency greater than 20,000 Hz is called ultrasonic sound. Human beings cannot hear infrasonic and ultrasonic sounds.

Time period (T)

- The time required to produce one complete vibration (wave or cycle) is called time period of the wave. It is denoted as T. The SI unit of time period is second (s). Frequency and time period are reciprocal to each other.

Wavelength (λ)

- The minimum distance in which a sound wave repeats itself is called its wavelength. In a sound wave, the distance between the centers of two consecutive compressions or two consecutive rarefactions is also called wavelength. The wavelength is usually denoted as λ (Greek letter, lambda). The SI unit of wavelength is metre (m).

Velocity or speed (v)

- The distance travelled by the sound wave in one second is called velocity of the sound. The SI unit of velocity of sound is m s–1.

Distinguishing different Sounds

- Sounds can be distinguished from one another in terms of the following three different factors.

1. Loudness
2. Pitch
3. Timbre (or quality)

1. Loudness and Intensity

- Loudness is a quantity by virtue of which a sound can be distinguished from another one, both having the same frequency. Loudness or softness of sound depends on the amplitude of the wave. If we strike a table lightly, we hear a soft sound because we produce a sound wave of less amplitude. If we hit the table hard we hear a louder sound. Loud sound can travel a longer distance as loudness is associated with higher energy. A sound wave spreads out from its source. As it move away from the source its amplitude decreases and thus its loudness decreases. Figure 8.4 shows the wave shapes of a soft and loud sound of the same frequency.

- The loudness of a sound depends on the intensity of sound wave. Intensity is defined as the amount of energy crossing per unit area per unit time perpendicular to the direction of propagation of the wave.

- The intensity of sound heard at a place depends on the following five factors.

  i. **Amplitude of the source.**
  ii. **Distance of the observer from the source.**
  iii. **Surface area of the source.**
  iv. **Density of the medium.**

v. **Frequency of the source.**

- The unit of intensity of sound is decibel (dB). It is named in honour of the Scottish-born scientist Alexander Graham Bell who invented telephone.

2. Pitch

- Pitch is one of the characteristics of sound by which we can distinguish whether a sound is shrill or base. High pitch sound is shrill and low pitch sound is flat. Two music sounds produced by the same instrument with same amplitude, will differ when their vibrations are of different frequencies. Figure 8.6 consists of two waves representing low pitch and high pitch sounds.

3. Timbre or Quality

- Timbre is the characteristic which distinguishes two sounds of same loudness and pitch emitted by two different instruments. A sound of single frequency is called a tone and a collection of tones is called a note. Timbre is then a general term for the distinguishable characteristics of a tone.

Speed of Sound

- The speed of sound is defined as the distance travelled by a sound wave per unit time as it propagates through an elastic medium.

$$\textbf{speed (v)} = \frac{Distance}{Time}$$

- If the distance traveled by one wave is taken as one wavelength (λ), and the time taken for this propagation is one time period (T), then

$$\textbf{speed (V)} = \frac{one\ wavelengh\ (\gamma)}{one\ time\ period\ (T)} \quad \textbf{(or)} \quad \textbf{v} = \frac{\gamma}{T}$$

As, $T = \frac{1}{n}$, the speed (v) of sound is also written as, $v = n\lambda$.

The speed of sound remains almost the same for all frequencies in a given medium under the same physical conditions.

Speed of sound in different media

- Sound propagates through a medium at a finite speed. The sound of thunder is heard a little later than the flash of light is seen. So, we can make out that sound travels with a speed which is much less than the speed of light. The speed of sound depends on the properties of the medium through which it travels.

- The speed of sound is less in gaseous medium compared to solid medium. In any medium the speed of sound increases if we increase the temperature of the medium. For example the speed of sound in air is 330 m s–1 at 0 °C and 340 m s–1 at 25 °C. The speed of sound at a particular temperature in various media is listed in Table 8.1.

State	Medium	Speed in m s-1
solids	Aluminum	6420
	Nickel	6040
	Steel	5960
	Iron	5950
	Brass	4700
	Glass	3980
Liquids	Water	1531
	Water (distilled)	1498
	Ethanol	1207
	Methanol	1103
Gases	Hydrogen	1284
	Helium	965
	Air	340
	Oxygen	316
	Sulphur dioxide	213

Sound travels about 5 times faster in water than in air. Since the speed of sound in sea water is very large (being about 1530 m s-1 which is more than 5500 km/h-1), two whales in the sea which are even hundreds of kilometres away can talk to each other very easily through the sea water.

Reflection of Sound

- Sound bounces off a surface of solid or a liquid medium like a rubber ball that bounces off from a wall. An obstacle of large size which may be polished or rough is needed for the reflection of sound waves. The laws of reflection are:
- The angle in which the sound is incident is equal to the angle in which it is reflected.

- Direction of incident sound, the reflected sound and the normal are in the same plane.

Uses of multiple reflections of sound
Musical instruments

- Megaphones, loud speakers, horns, musical instruments such as nathaswaram, shehnai and trumpets are all designed to send sound in a particular direction without spreading it in all directions. In these instruments, a tube followed by a conical opening reflects sound successively to guide most of the sound waves from the source in the forward direction towards the audience.

Stethoscope

- Stethoscope is a medical instrument used for listening to sounds produced in the body. In stethoscopes, these sounds reach doctor's ears by multiple reflections that happen in the connecting tube.

Echo

- When we shout or clap near a suitable reflecting surface such as a tall building or a mountain, we will hear the same sound again a little later. This sound which we hear is called an echo. The sensation of sound persists in our brain for about 0.1s.

- Hence, to hear a distinct echo the time interval between the original sound and the reflected sound must be at least 0.1s. Let us consider the speed of sound to be 340 m s–1 at 25° C. The sound must go to the obstacle and return to the ear of the listener on reflection after 0.1 s. The total distance covered by the sound from the point of generation to the reflecting surface and back should be at least 340 m s–1 × 0.1 s = 34 m.

- Thus, for hearing distinct echoes, the minimum distance of the obstacle from the source of sound must be half of this distance i.e. 17 m. This distance will change with the temperature of air. Echoes may be heard more than once due to successive or multiple reflections. The roaring of thunder is due to the successive reflections of the sound from a number of reflecting surfaces, such as the clouds at different heights and the land.

Reverberation

- A sound created in a big hall will persist by repeated reflection from the walls until it is reduced to a value where it is no longer audible. The repeated reflection that results in this persistence of sound is called reverberation. In an auditorium or big hall excessive reverberation is highly undesirable. To reduce reverberation, the roof and walls of the auditorium are generally covered with sound absorbing materials like compressed fiber board, flannel cloths, rough plaster and draperies. The seat materials are also selected on the basis of their sound absorbing properties. There is a separate branch in physics called acoustics which takes these aspects of sound in to account while designing auditoria, opera halls, theaters etc.

Ultrasonic Sound or Ultrasound

- Ultrasonic sound is the term used for sound waves with frequencies greater than 20,000 Hz. These waves cannot be heard by the human ear, but the audible frequency range for other animals includes ultrasound frequencies. For example, dogs can hear ultrasonic sound. Ultrasonic whistles are used in cars to alert deer to oncoming traffic so that they will not leap across the road in front of cars.

- An important use of ultrasound is in examining inner parts of the body. The ultrasonic waves allow different tissues such as organs and bones to be 'seen' or distinguished by

bouncing of ultrasonic waves by the objects examined. The waves are detected, analysed and stored in a computer. An echogram is an image obtained by the use of reflected ultrasonic waves. It is used as a medical diagnostic tool. Ultrasonic sound is having application in marine surveying also.

Applications of ultrasonic waves

- Ultrasounds can be used in cleaning technology. Minute foreign particles can be removed from objects placed in a liquid bath through which ultrasound is passed.
- Ultrasounds can also be used to detect cracks and flaws in metal blocks.
- Ultrasonic waves are made to reflect from various parts of the heart and form the image of the heart. This technique is called 'echo cardiography'.
- Ultrasound may be employed to break small 'stones' formed in the kidney into fine grains. These grains later get flushed out with urine.

SONAR

- SONAR stands for sound Navigation and Ranging. Sonar is a device that uses ultrasonic waves to measure the distance, direction and speed of underwater objects. Sonar consists of a transmitter and a detector and is installed at the bottom of boats and ships.
- The transmitter produces and transmits ultrasonic waves. These waves travel through water and after striking the object on the seabed, get reflected back and are sensed by the detector. The detector converts the ultrasonic waves into electrical signals which are appropriately interpreted. The distance of the object that reflected the sound wave can be calculated by knowing the speed of sound in water and the time interval between transmission and reception of the ultrasound.
- Let the time interval between transmission and reception of ultrasound signal be 't'. Then, the speed of sound through sea water is $2d / t = v$
- This method is called echo-ranging. Sonar technique is used to determine the depth of the sea and to locate underwater hills, valleys, submarine, icebergs etc.

Electrocardiogram (ECG)

- The electrocardiogram (ECG) is one of the simplest and oldest cardiac investigations available. It can provide a wealth of useful information and remains an essential part of the assessment of cardiac patients. In ECG, the sound variation produced by heart is converted into electric signals. Thus, an ECG is simply a representation of the electrical activity of the heart muscle as it changes with time. Usually it is printed on paper for easy analysis. The sum of this electrical activity, when amplified and recorded for just a few seconds is known as an ECG.

Structure of Human Ear

- How do we hear? We are able to hear with the help of an extremely sensitive device called the ear. It allows us to convert pressure variations in air with audible frequencies into electric signals that travel to the brain via the auditory nerve. The auditory aspect of human ear is discussed below.

- The outer ear is called 'pinna'. It collects the sound from the surroundings. The collected sound passes through the auditory canal. At the end of the ear is eardrum or tympanic membrane. When a compression of the medium reaches the eardrum the pressure on the outside of the membrane increases and forces the eardrum inward. Similarly, the eardrum moves outward when a rarefaction reaches it. In this way the eardrum vibrates. The vibrations are amplified several times by three bones (the hammer, anvil and stirrup) in the middle ear. The middle ear transmits the amplified pressure variations received from the sound wave to the inner ear. In the inner ear, the pressure variations are turned into electrical signals by the cochlea. These electrical signals are sent to the brain via the auditory nerve and the brain interrupts them as sound.

10th standard

Unit – 5 ACOUSTIC

INTRODUCTION

- Sound plays a major role in our lives. We communicate with each other mainly through sound. In our daily life, we hear a variety of sounds produced by different sources like humans, animals, vehicle horns, etc. Hence, it becomes inevitable to understand how sound is produced, how it is propagated and how you hear the sound from various sources. It is sometimes misinterpreted that acoustics only deals with musical instruments and design of auditoria and concert halls. But, acoustics is a branch of physics that deals with production, transmission, reception, control, and effects of sound. You have studied about propagation and properties of sound waves in IX standard. In this lesson we will study about reflection of sound waves, Echo and Doppler effect.

SOUND WAVES

- When you think about sound, the questions that arise in your minds are: How is sound produced? How does sound reach our ears from various sources? What is sound? Is it a force or energy? Let us answer all these questions.
- By touching a ringing bell or a musical instrument while it is producing music, you can conclude that sound is produced by vibrations. The vibrating bodies produce energy in the form of waves, which are nothing but sound waves

- Suppose you and your friend are on theMoon. Will you be able to hear any sound produced by your friend? As the Moon doesnot have air, you will not be able to hear anysound produced by your friend. Hence, you understand that the sound produced due to the vibration of different bodies needs a material medium like air, water, steel, etc, forits propagation. Hence, sound can propagate through a gaseous medium or a liquid medium or a solid medium.

Longitudinal Waves

- Sound waves are longitudinal waves that can travel through any medium (solids,liquids, gases) with a speed that dependson the properties of the medium. As soundtravels through a medium, the particles of the medium vibrate along the direction of propagation of the wave. This displacement involves the longitudinal displacements of the individual molecules from their mean positions. This results in a series of high and low pressure regions called compressions and rarefactions.

Categories of sound waves based on their frequencies

- (i) Audible waves - These are sound waves with a frequency ranging between 20 Hz and 20,000 Hz. These are generated by vibrating bodies such as vocal cords, stretched strings etc.

- (ii) Infrasonic waves - These are sound waves with a frequency below 20 Hz that cannot be heard by the human ear. e.g., waves produced

during earth quake, ocean waves, sound produced by whales, etc.

- (iii) Ultrasonic waves - These are sound waves with a frequency greater than 20 kHz, Human ear cannot detect these waves, but certain creatures like mosquito, dogs, bats,dolphins can detect these waves. e.g., waves produced by bats.

Difference between the sound and light waves

s.no	sound	light
1	Medium is required for the propagation.	Medium is not required for the propagation.
2	Sound waves are longitudinal.	Light waves are transverse.
3	Wavelength ranges from 1.65 cm to 1.65 m.	Wavelength ranges from 4×10^{-7} m to 7×10^{-7} m.
4	Sound waves travel in air with a speed of about 340 ms^{-1} at NTP	Light waves travel in air with a speed of 3×108 ms^{-1}.

Velocity of sound waves

- When you talk about the velocity associated with any wave, there are two velocities, namely particle velocity and wave velocity. SI unit of velocity is ms-1.

Particle velocity:

- The velocity with which the particles of the medium vibrate in order to transfer the energyin the form of a wave is called particle velocity. Wave velocity:

- The velocity with which the wave travels through the medium is called wave velocity. In other words, the distance travelled by a sound wave in unit time is called the velocity of a sound wave.

∴ Velocity =Distance/Time taken

- If the distance travelled by one wave istaken as one wavelength

(λ) and, the time taken for this propagation is one time period (T), then, the expression for velocity can be written as

$$\therefore V = \lambda / T \quad (5.1)$$

- Therefore, velocity can be defined as the distance travelled per second by a sound wave. Since, Frequency (n) =1/T, equation can be written as

$$V = n\lambda$$

- Velocity of a sound wave is maximum in solids because they are more elastic in nature than liquids and gases. Since, gases are least elastic in nature, the velocity of sound is the least in a gaseous medium.

So, vS > vL > vG

Effect of density:

- The velocity of sound in a gas is inversely proportional to the square root of the density of the gas. Hence, the velocity decreases as the density of the gas increases.

v /√1d

Effect of temperature:

- The velocity of sound in a gas is directly proportional to the square root of its temperature. The velocity of sound in a gas increases with the increase in temperature. V ∝ √T. Velocity at temperature T is given by the following equation:

vT = (vo + 0.61 T) ms-1

- Here, vo is the velocity of sound in the gas at 0° C. For air, vo = 331 ms-1. Hence, the velocity of sound changes by 0.61 ms-1 when the temperature changes by one degree celsius.

Effect of relative humidity:

- When humidity increases, the speed of sound increases. That is why you can hear sound from long distances clearly during rainy seasons. Speed of sound waves in different media are given in table

s.no	Nature of the medium	Name of the medium	Speed of sound (in ms^{-1})
1	Solid	Copper	5010
2		Iron	5950
3		Aluminium	6420

4	Liquid	Kerosene	1324
5		Water	1493
6		Sea water	1533
7	Gas	Air	331
8		Air	343

Factors affecting velocity of sound

- In the case of solids, the elastic properties and the density of the solids affect the velocity of sound waves. Elastic property of solids is characterized by their elastic moduli. The speed of sound is directly proportional to the square root of the elastic modulus and inversely proportional to the square root of the density. Thus the velocity of sound in solids decreases as the density increases whereas the velocity of sound increases when the elasticity of the material increases. In the case of gases, the following factors affect the velocity of sound waves.

REFLECTION OF SOUND

- When you speak in an empty room, you hear a soft repetition of your voice. This is nothing but the reflection of the sound waves that you produce. Let us discuss about the reflection of sound in detail through the following activity.When sound waves travel in a given medium and strike the surface of another medium, they can be bounced back into the first medium. This phenomenon is known as reflection. In simple the reflection and refraction of sound is actually similar to the reflection of light. Thus, the bouncing of sound waves from the interface between two media is termed as the reflection of sound. The waves that strike the interface are termed as the incident wave and the waves that bounce back are termed as the reflected waves.

Laws of reflection

- Like light waves, sound waves also obey some fundamental laws of reflection.

The following two laws of reflection are applicable to sound waves as well.

- The incident wave, the normal to the reflecting surface and the reflected wave at the point of incidence lie in the same plane.

- The angle of incidence ∠i is equal to the angle of reflection ∠r.

- The sound waves that travel towards the reflecting surface are called the incident waves. The sound wavesbouncing back from the reflecting surface are called reflected waves. For all practical purposes, the point of incidence and the point of reflection is the same point on the reflecting surface.

- A perpendicular line drawn at the point of incidence is called the normal. The angle which the incident sound wave makes with the normal is called the angle of

incidence, ‘i’. The angle which the reflected wave makes with the normal is called the angle of reflection, ‘r’.

Reflection at the boundary of a denser medium

- A longitudinal wave travels in a medium in the form of compressions and rarefactions. Suppose a compression travelling in air from left to right reaches a rigid wall. The compression exerts a force F on the rigid wall. In turn, the wall exerts an equal and opposite reaction R = - F on the air molecules.

- This results in a compression near the rigid wall Thus, a compression travelling towards the rigid wall is reflected back as a compression. That is the direction of compression is reversed

Reflection at the boundary of a rarer medium

- Consider a wave travelling in a solid medium striking on the interface between the solid and the air. The compression exerts a force F on the surface of the rarer medium. As a rarer medium has smaller resistance for any deformation, the surface of separation is pushed backwards. As the particles of the rarer medium are free to move, a rarefaction is produced at the interface.Thus, a compression is reflected as a rarefaction and a rarefaction travels from right to left.

More to know:
What is meant by rarer and denser medium?
The medium in which the velocity of sound increases compared to other medium is called rarer medium. (Water is rarer compared to air for sound).The medium in which the velocity of sound decreases compared to other medium is called denser medium. (Air is densercompared to water for sound)

Reflection of sound in plane and curved surfaces

- When sound waves are reflected from aplane surface, the reflected waves travel in adirection, according to the law of reflection.The intensity of the reflected wave is neither decreased nor increased. But, when the sound waves are reflected from the curved surfaces,the intensity of the reflected waves is changed.When reflected from a convex surface, the reflected waves are diverged out and the intensity is decreased. When sound is reflected from a concave surface, the reflected waves are converged and focused at a point. So the intensity of reflected waves is concentrated at a point. Parabolic surfaces are used when it is required to focus the sound at a particular point.

- Hence, many halls are designed with parabolic reflecting surfaces. In elliptical surfaces, sound from one focus will always be reflected to the other focus, no matter where it strikes the wall.

- This principle is used in designing whispering halls. In a whispering hall, the speech of a person standing in one focus can be heard clearly by a listener standing at the other focus.

Whispering Gallery One of the famous whispering galleries is in St. Paul's cathedral church in London. It is built with elliptically shaped walls. When a person is talking at one focus, his voice can be heard distinctly at the other focus. It is due to the multiple reflections of sound waves from the curved walls.

ECHOES

- An echo is the sound reproduced due to the reflection of the original sound from various rigid surfaces such as walls, ceilings, surfaces of mountains, etc.

- If you shout or clap near a mountain or near a reflecting surface, like a building you can hear the same sound again. The sound, which you hear is called an echo. It is dueto the reflection of sound. One does not experience any echo sound in a small room.This does not mean that sound is not reflected in a small room. This is because smaller rooms do not satisfy the basic conditions for hearing an echo.

Conditions necessary for hearing echo

1. The persistence of hearing for human ears is 0.1 second. This means that you can hear two sound waves clearly, if the time interval between the two sounds is at least 0.1 s. Thus, the minimum time gap
between the original sound and an echo must be 0.1 s.

2. The above criterion can be satisfied only when the distance between the source of sound and the reflecting surface would satisfy the following equation:

Velocity = distance travelled by sound / time taken

$$\mathbf{V = 2d/t}$$

$$\mathbf{d = vt/2}$$

Since, t = 0.1 second, then $d = v \times 0.1/2 = v/20$

- Thus the minimum distance required to hear an echo is 1/20th part of the magnitude of the velocity of sound in air. If you consider the velocity of sound as 344 ms-1,the minimum distance required to hear an echo is 17.2 m.

- Thus the minimum distance required to hear an echo is 1/20th part of the magnitude of the velocity of sound in air. If you consider the velocity of sound as 344 ms-1,the minimum distance required to hear an echo is 17.2 m.

Applications of echo

- Some animals communicate with each other over long distances and also locate objects by sending the sound signals and receiving the echo as reflected from the targets.
- The principle of echo is used in obstetric ultrasonography, which is used to create real-time visual images of the developing Embryo or fetus in the mothers uterus.This is a safe testing tool, as it does not useany harmful radiations.
- Echo is used to determine the velocity of sound waves in any medium.

Measuring velocity of sound by echo method Apparatus required:

- A source of sound pulses, a measuring tape, a sound receiver, and a stop watch.

Procedure:

1. Measure the distance 'd' between the source of sound pulse and the reflecting surface using the measuring tape.

2. The receiver is also placed adjacent to the source. A sound pulse is emitted by the source.

3. The stopwatch is used to note the time interval between the instant at which the sound pulse is sent and the instant at which the echo is received by the receiver. Note the time interval as 't'.

4. Repeat the experiment for three or four times. The average time taken for the given number of pulses is calculated.

Calculation of speed of sound:

- The sound pulse emitted by the source travels a total distance of 2d while travelling from the source to the wall and then back to the receiver. The time taken for this has been observed to be 't'. Hence, the speed of soundwave is given by:

Speed of sound =distance travelled/time taken = 2d/t.

APPLICATIONS REFLECTION OF SOUND

Sound board

- These are basically curved surfaces (concave), which are used in auditoria and halls to improve the quality of sound. This board is placed such that the speaker is at the focus of the concave surface. The sound of the speaker is reflected towards the audience thus improving the quality of sound heard by the audience.

Ear trumpet

- Ear trumpet is a hearing aid, which is useful by people who have difficulty in hearing.In this device, one end is wide and the other end is narrow. The sound from the sources fall into the wide end and are reflected by its walls into the narrow part of the device. This helps in concentrating the sound and the sound enters the ear drum with more intensity. This enables a person to hear the sound better.

Mega phone

- A megaphone is a horn-shaped device used to address a small gathering of people. Its one end is wide and the other end is narrow. When a person speaks at the narrow end, the sound of his speech is concentrated by the multiple reflections from the walls of the tube. Thus, his voice can be heard loudly over a long distance.

DOPPLER EFFECT

- The whistle of a fast moving train appears to increase in pitch as it approaches a stationary listener and it appears to decreaseas the train moves away from the listener.

- This apparent change in frequency was first observed and explained by Christian Doppler (1803-1853), an Austrian Mathematician and Physicist. He observed that the frequency of the sound as received by a listener is different from the original frequency produced by the source whenever there is a relative motion between the source and the listener.

- This is known as Doppler effect This relative motion could be due to various possibilities as follows:

(i) The listener moves towards or away from a stationary source
(ii) The source moves towards or away from a stationary listener
(iii) Both source and listener move towards or away from one other
(iv) The medium moves when both source and listener are at rest

- For simplicity of calculation, it is assumed that the medium is at rest. That is the velocityof the medium is zero. Let S and L be the source and the listener moving with velocities vS and vL respectively.

- Consider the case of source and listener moving towards each other (Figure 5.7). As the distance between them decreases, the apparent frequency will be more than the actual source frequency.

- Let n and n' be the frequency of the sound produced by the source and the sound observed by the listener respectively. Then,the expression for the apparent frequency n' is

$$n' = (v + v_L / v - v_s)n$$

- Here, v is the velocity of sound waves in the given medium. Let us consider different possibilities of motions of the source and the listener. In all such cases, the expression for the apparent frequency

s.no	Position of source and listener	Note	Expression for apparent frequency
1	1.Both source and listener move 2.They move towards each other	a)Distance between source and listener decreases. b)Apparent frequency is more than actual frequency	$n' = (v+v_L/v-v_s)n$
2	1.Both source and listener move 2.They move away from each other	Distance between source and listener increases. b) Apparent frequency is less than actual frequency. c) v_S and v_L become opposite to that in case-1.	$n' = v-(v_L/v+v_s)n$
3	Both source and listener move They move one behind the other Source follows the listener	a)Apparent frequency depends on the velocities of the source and the listener. b) v_S becomes opposite to that in case-2.	$n' = (v - v_L/v - v_s)n$
4	Both source and listener move They move one behind the other Listener follows the source	a)Apparent frequency depends on the velocities of the source and the listener. b)v_S and v_L become opposite to that in case-3.	$n' = (v + V_l/v + v_s)n$
5	Source at rest Listener moves towards the source	a)Distance between source and listener decreases. b)Apparent frequency is more than actual frequency. c) $v_S = 0$ in case-1.	$n' = (v + v_L/v)\ n$

6	Source at rest Listener moves away from the source	a)Distance between source and listener increases. b)Apparent frequency is less than actual frequency. c) vS = 0 in case-2.	$n' = (v - vL/v)\, n$
7	Listener at rest Source moves towards the listener	a)Distance between source and listener decreases. b)Apparent frequency is more than actual frequency. c) vL = 0 in case-1.	$n' = (v/v - vs)n$
8	Listener at rest Source moves away from the listener	a) Distance between source and listener increases. b) Apparent frequency is less than actual frequency. c) vL = 0 in case-2.	$n' = (v/v + vs)n$

- Suppose the medium (say wind) is moving with a velocity W in the direction of the propagation of sound. For this case, the velocity of sound, 'v' should be replaced with (v + W). If the medium moves in a direction opposite to the propagation of sound, then 'v' should be replaced with (v – W).

Conditions for no Doppler effect

- Under the following circumstances, there will be no Doppler effect and the apparent frequency as heard by the listener will be the same as the source frequency.

(i) When source (S) and listener (L) both areat rest.

(ii) When S and L move in such a way that distance between them remains constant.

(iii) When source S and L are moving in mutually perpendicular directions.

(iv) If the source is situated at the center of the circle along which the listener is moving.

Applications of Doppler effect

(a) To measure the speed of an automobile

- An electromagnetic wave is emitted by a source attached to a police car. The wave is reflected by a moving vehicle, which acts as a moving source. There is a shift in the

frequency of the reflected wave. From the frequency shift, the speed of the car can be determined. This helps to track the over speeding vehicles

(b) Tracking a satellite

- The frequency of radio waves emitted bya satellite decreases as the satellite passes away from the Earth. By measuring the change in the frequency of the radio waves, the location

of the satellites is studied.

(c) RADAR (Radio Detection And Ranging)

- In RADAR, radio waves are sent, and the reflected waves are detected by the receiver of the RADAR station. From the frequency change, the speed and location of the aeroplanes and aircrafts are tracked.

(d) SONAR

- In SONAR, by measuring the change in the frequency between the sent signal and received signal, the speed of marine animals and submarines can be determined.

Fertilizer, pesticides and insecticides

FERTILIZERS

1. **Nitrogenous Fertilizers**: These type of fertilizers generally supply nitrogen to the soil. Examples: Ammonium sulphate [$(NH_4)_2S0_4$], Calcium ammonium nitrate (CAN, basic calcium ammonium nitrate $Ca(N0_3)_2CaO$, Calcium cyanamide CaNCN, urea etc.

2. **Phosphorous Fertilizers:** These fertilizers provide phosphorous to the soil. Examples : Super phosphate of lime, triple super phosphate, phosphate slag, Ammoniated phosphates, Nitro phosphate

3. **Potash Fertilizers**: These fertilizers provide potassium to the plant. Examples: potassium chloride, potassium sulphate, Potassium nitrated etc.

4. **NP Fertilizers**: These fertilizers contain two elements i.e., sodium and phosphorus. These are formed by mixing together both the fertilizers. Example: dihydrogen ammoniated phosphate ($NH_4H_2P0_4$), calcium superphasphate [$Ca(H_2P0_4)_2$ $2Ca(N0_3)_2$].

5. **NPK or complete fertilizers**: These of type of fertilizers provide all the three essential elements viz nitrogen, Phosphorus and potassium to the soil. It is obtained by mixing all the three types of fertilizers in suitable propartions.

Nitrogenous fertilizers

1. **Ammonium sulphate or sindri fertilizers $(NH_4)_2S0_4$.** It is prepared by manufactured at **sindri fertilizer factory Bihar**. Hence it is called sindri fertilizers. This fertilizer contains **24-25% ammonia** which is converted to nitrates in the soil by nitrifying bacteria.

   $2NH_3 + H_2O + CO_2 + CaSO_4 \rightarrow (NH_4)_2 SO_4 + CaCO_3$ - ppt

   Ammonia Soluble

2. **Calcium ammonium nitrate (CAN)(Nangal Ferilizer)**
   $[Ca(N0_3)_2 NH_4 N0_3]$. It is manufactured in the following manner.

   (i) Production of ammonia : Haber's process

   (ii) Production of nitric acid: It is obtained by Ostwald's process. This process ammonia is mixed with air in the ratio of 1: 10 by volume. In this process nitric Oxide (NO) is produced.

   $4NH_3 + 5O_2$ (from air) $\rightarrow$ $4NO + 6H_2O$

   (iii) Formation of NH_4NO_3:

   $NH_3 + HNO_3 \rightarrow NH_4NO_3$

   Ammonium nitrate

(iv) **Formation of CAN pellets**: The concentrates solution of NH_4ON_3 is stirred with finally powdered lime stone.

$$CaCO_3 + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O + CO_2$$
$$Ca(NO_3)_2 + NH_4NO_3 \rightarrow Ca(NO_3)_2\ NH_4NO_3$$

(v) CAN is very hygroscopic hence to protect it from atmospheric moisture the pellet of CAN are stirred with concentrated solution of finely powdered soap stone (Sodium silicate). The pellets are then dried and packed in polythene bags.This fertilizers is manufactured in Mangal (Punjab) and Rourkela.CAN **contains 20% nitrogen**. It can be directly assimilated by plants, It is highly soluble in water.

3. **Calcium Cyanamide ($CaCN_2$).** This compound is a derivate of cynamide (H_2CN_2). It is manufactured by the action of air on lime stone and coal. The lime stone is burnt in kilns to obtain lime (CaO). A mixture of lime and coal is heated in an electric furnace at 2500°C to produce calcium carbide (CaC_2) It is finely powdered and then heated in a cylindrical electric furnace at 1000°C in the atmosphere of nitrogen, when $CaCN_2$ is produced.

$$CaCO_3 \xrightarrow{\text{Heat}} CaO + CO_2$$
Lime stone

$$CaO + 3C \xrightarrow[2500°C]{\text{Heat}} CaC_2 + CO$$

$$CaC_2 + N_2 \xrightarrow[1000°C]{\text{Heat}} CaCN_2 + C + \text{heat}$$
Grey
Calcium Cynamide

It is sparingly soluble in water. This ammonia is converted into nitrates by nitrifying bacteria.

4. **Urea (carbamide NH_2CONH_2).** It is an excellent nitrogenous fertilizer and is manufactured by reacting ammonia and carbon-di-oxide.

$$CO_2 + 2NH_3 \rightarrow NH_2COONH_4$$
Ammonium Carbamate

$$NH_2\ COONH_4 \rightarrow NH_2CONH_2 + H_2O$$
Urea

Urea separate as dry powder and contains 47% of nitrogen. Urea has the higher nitrogen content than other fertilizers. It cost of production is less and it can be used in all types of crops and soils.

Phosphate Fertilizers

Super phosphate of lime [$Ca(H_2PO_4)_2 + 2(CaSO_4\ 2H_2O)$].

It is a mixture of calcium dihydrogen phosphate $Ca(H_2PO_4)$ and dihydrate calcium sulphate (gypsum) $CaSO_4\ 2H_2O$. It contains about **16-20 % of P_2O_5**.

$$Ca_3(PO_4)_2 + 2H_2SO_4 + 4H_2O \rightarrow Ca(H_3PO_4)_2 + 2(CaSO_4.2H_2O) + \text{heat}$$

Calcium di hydrogen + gypsum Phosphate

Supper Phosphate of Lime

1. **Double and Triple Superphosphates**

   Triple phosphate is prepared by treating rock phosphate with phosphoric acid in a mixer.

   $$Ca_3(PO_4)_2 + 4H_3PO_4 \rightarrow 3CaH_4(PO_4)_2$$

2. **Phosphatic Slag**

   This Slag is obtained as a byproduct in the manufacture of steel and is a double salt of tricalcium phosphate and calcium silicate.

3. **Ammoniated phosphate**

   It is prepared action of calcium phosphate, sulphuric acid and ammonium sulphate. It contains about 12% of nitrogen and **50.5% of P_2O_5.**

   $$Ca_3(PO_4)_2 + (NH_4)2SO_4 + 2H_2SO_4 \rightarrow 2NH_4H_2PO_4 + 3CaSO_4$$

Potash fertilizers

1. **Potassium chloride**. It is found in nature as Sylvine (KCl) and carnallite (KCl.MgCl. $6H_20$). It is extracted from carnallite by boiling with the mother liquor from previous operation. Carnallite dissolves where as other impurities are not dissolved and can be filtered off. It is a white crystalline solid and is fairly soluble in water.

2. **Potassium sulphate (K_2SO_4)**. It is manufacture from naturally occurring mineral eg. schonite.

   $$K_2SO_4.MgSO_4.6H_2O + 2KCl \rightarrow 2K_2SO_4 + MgCl_2 + 6H_2O$$

3. **Potassium nitrate or Nitre or Indian- Saltpetre (KNO_2)**: Crude Nitre occurs as an efflorescence on the surface of the earth in tropical countries. It is obtained from a mixture of child % petre ($NaNO_2$) and potassium chloride (KCl).

   $$NaNO_2 + KCl \rightleftharpoons KNO_2 + NaCl$$

Ill Effects Of Fertilizers

1. **Micronutrient loss and imbalance**

   Most of the chemical fertilizers used in modern agriculture have **Nitrogen, Phosphorous and Potassium** which are essential **primary macronutrients**. **Calcium , Magnesium and Sulphur** are **secondary macronutrients**. Excessive use of these fertilizers cause deficiency [of **micro nutrients** viz., zinc, copper molybdenum, boron etc., in the soil which affect the productivity if the soil.

2. **Nutrient Toxicity**

Higher doses of fertilizers produces toxicity which jffect the normal growth and development of plants

3. **Deteriorates soil Quality**

Indiscriminate and unscientific use of these fertilizer can deteriorate the soil quality.

4. **Impairs water quality**

These fertilizers applied in the field otter, leach deep into the soil and ultimately contaminate the ground water. For example: From nitrogenous fertilizers the nitrates get concentrated in the water and if the concentration **exceeds 25 mg/**l they became the cause of serious health hazard called **"Blue baby syndrome" or metha emoglobinemia.**

5. **Causes Environmental Pollution**

Excessive uses of fertilizers have caused irrepairable damage to the environment. The unused quantity of fertilizers escapes into the hydrosphere or atmosphere. The applied nitrogen escapes into the atmosphere in the form of harmful gases like ammonia, nitrous oxide etc.

6. **Effect of fertilizers on crop yield and quality**

Excessive nitrogen decreases the phosphate content in leaves and grain. Excessive amount of nitrate fertilizers can cause acute poisoning in livestock. Sodium nitrate fertilizers contain sodium per chlorate as an impurity which has strong adverse effect on germination of several crops. Sodium nitrate fertilizers scorches the young leaves of vegetable crops and potato.

7. **Eutrophication**

Excessive and prolonged use of nitrogen and phosphorous fertilizers in the field causes water pollution. The excessive fertilizers are washed off with water and reach water bodies causing over nourishment of these water bodies like lakes. This process is known as eutrophication (eu = more, trophic = nutrition) Due to eutrophication the lakes get invaded by **algal blooms.** These cause diminished oxygen content in the water and it affects the aquatic life severely.

5. PESTICIDES

Pesticides are legally classed as "Economic poisons" and are defined-., as "any substance used for controlling, preventing, destroying, repelling or mitigating any pest"

Lists the various pesticides

S.No	Pesticide Class	Functions
1	Insecticide	Controls Insects
2	Herbicide	Kills Weeds
3	Fungicide	Kills Fungi
4	Rodenticide	Kills Rodents
5	Bactericide	Kills Bacteria
6	Algicide	Kills Algae
7	Molluscicide	Kills Snails,Slugs, Mussels,Oyesters
8	Avicide	Controls or repels birds
9	Slimicide	Controls Slimes
10	Piscicide	Controls Fish
11	Ovicide	Destroys Eggs

Insecticides

The control of insect pests affecting agricultural crops, domestic animals and man has been of considerable economic importance to mankind since the beginning of civilization.

1. **The Arsenic Compounds**
   Arsenic Oxides: Arsenic tri oxide As_2O_3, Arsenic pentoxide or Arsenic acid As_2O_5.
   Calcium Arsenates: $Ca_3 (AsO_4)_2]_3 Ca(OH)_2$
   Lead Arsenates: $PbHASO_4$
   Magnesium Arsenates: Mono magnesium ortho Arsenate $MgH_4(AsO_4)_2$, Secondary magnesium ortho Arsenate $MgHAsO_4$ and Tri magnesium ortho Arsenate $Mg_2(AsO_4)_2$.

2. **Fluorine Compunds**
   Sodium Fluoride(NaF): The first Fluorine compound used against cockroaches. It is also used as **Herbicide.**

Zinc Fluoride (ZnF_2): Used as wood Preservative.

Calcium Fluorspar, magnesium, Strontium, Copper, barium and lead fluorides are tested against **mosquito larvae**.

- Sodium and Potassium fluosilicate Na_2SiF_6 and K_2SiF_6 areused against **mosiquito larvae.**
- Sodium aluminum fluosilicate, Sodium fluo aluminates Na_3AlF_6

3. **Boron Compounds.**
   - **(i)** **Boric acid (H_3BO_3)** has been used as an ingredient of cock roach baits and to kill housefly larvae in manure.
   - **(ii)** **Borax($Na_2B_4O_7.10H_2O$)**: It is used as fly preventive in manure and ant poison
   - **(iii)** Barium and Calcium borates.

4. **Mercury Compounds**

   Metallic mercury has been found to function as a fumigant.
   - **(i)** **Mercuric chloride $HgCI_2$** It has been used as fungicide and Bacteriacide.
   - **(ii)** **Mercuric oxide HgO**
   - **(iii)** **Ethyl mercuric chloride(C_2H_5 HgCl),Ethyl mercuric Iodide – (C_2H_5HgI)** and **Ethyl mercuric Phosphate .**
   - **(iv)** **Phenyl mercuric salts (C_6H_5HgX):** Acetate, Benzoate, Phthalate, Salicylate, Gluconate.
   - **(v)** **Hydroxy mercuri chlorophenol, Hydroxy mercuricresol**.

5. **Copper Compounds**

   (i)Bordeaux mixture($CuSo_4$+ $Ca(OH)_2$)

   Solution made up of **copper sulphate, quick lime and water** in fixed ratios. It is used as Fungicide.

   (ii) Burgundy mixture:

   It is known as soda Bordeaux and is prepared by the reaction of copper sulphate, pentohydrate and sodium carbonate solution.

6. **Suphur Compounds**

   'Sulphur dioxide (S02) is used as household fumigant.

Some Important Herbicides

Some Important Herbicides are **2, 4 D** (2, 4 dichlorophenoxy acetic acid), **2, 4, 5-T** (2, 4, 5 tri-chlorophenoxy acetic acid) ,atrazine, picioram, propazine.

Some Important Rodenticides

Some Important Rodenticides are Strychnine, Arsenic, Zinc Phosphate, warparin, sodium fluoro acetate, thalium phosphorus, ANTU (alpha naphthyl urea) and Norbromide.

Health & Hygiene & Human Diseases

6th Term I
Unit 6 – Health & Hygiene

- As defined by World Health Organization (WHO), it is a "State of complete physical, mental, and social well being, and not merely the absence of disease or infirmity." Health is a dynamic condition resulting from a body's constant adjustment and adaptation in response to stresses and changes in the environment for maintaining an inner equilibrium called homeostasis.

- Hygiene is a science of the establishment and maintenance of health conditions or practices (as of cleanliness) conducive to health has poor personal hygiene. Brushing your teeth regularly is an important part of good oral hygiene. Hygiene is the practice of keeping yourself and your surroundings clean, especially in order to prevent illness or the spread of diseases.

Components of Food

- The Chemical constituents of food which give us energy, help to build our body and protect us from diseases are called Nutrients.

- Carbohydrate
- Proteins
- Fats
- Vitamins
- Minerals
- Water

Carbohydrates

Carbohydrates are energy giving component of the food.

S.No	Form of Carbohydrates	Sources
1	Sugar	Fruits, Honey, Cane Sugar, Sugar Beet
2	Starch	Rice, Wheat, Maize, Potato, etc.
3	Dietary fibre	Whole grain, nuts,etc.

Fats

- Fat is also an energy-giving food and provides more energy than Carbohydrates. Some important sources of fats are butter, ghee, milk, cheese, paneer, nuts, meat, fish, egg yolk etc. Apart from giving energy, they insulate our body and protect the cells

PROTEIN

Body Building Foods

- Proteins are necessary for our growth and repair, as well as for regulating various body functions such as digestion. The sources of proteins are pulses, eggs, fish, milk, chicken, soya bean, nut, grams etc, Proteins are body building foods.

Soyabean is the highly rich source of protein

Vitamins

- Vitamins are required for carrying out various biochemical reactions in our body. Fruits, vegetables, grains, meat products are good sources of vitamins. Vitamins are called as protective food. There are six major vitamins A, B, C, D, E and K. Vitamins B and Vitamins C are water soluble, Vitamins A, D, E and K are fat soluble.

Vitamin	**Found abundantly in**	**Disease we get if deficient in this**	**Symptoms**
Vitamin A	Fish oil, egg, milk, ghee, carrot, corn, Yellow fruits, greens	Night blindness	Poor vision, difficulty in seeing in dim light
Vitamin B	Whole grain, unpolished rice, milk, fish, meat, peans, lentils Green Vegetables	Beriberi	Nervous weakness, fatigue.
Vitamin C	Oranges, Gooseberry, Greenchilly, Tomato	Scurvy	Bleeding gums
Vitamin D	Fish oil, milk and eggs. It is also made in our skin using sunlight	Rickets	Weak, flexible bones.
Vitamin E	Vegetable oils, Green Vegetables, whole wheat, Mango, apple, greens	Nervous weakness, dimming of eyesight	Childlessness, lack of resistance power to illnesses
Vitamin K	Green Vegetables, Tomato, cabbage, eggs, milk products.	Weakness of the bones, teeth etc.	Even a small cut bleeds profusely.

Gooseberries contains nearly 20 times the vitamin C than Orange

Minerals

- Mineralsare required for growth as well as for the regulation of normal body function.Green leafy vegetables like spinach, pulses, eggs, milk, fish and fruits are important sources of minerals in our diet. Minerals are also a protective foods.

Minerals	**Functions**
Calcium	Strong bones and teeth, clotting of blood
Phosphorus	Strong bones and teeth
Iodine	Synthesis of thyroid hor- mone
Iron	Formation of haemoglobin and brain development

80% of the world production of Moringa Leaves is in India. The Major countries which import Moringa Leaves are China, US, Germany, Canada, South Korea and European countries

Water

- Our body needs an adequate supply of water is order to maintain good health. Any human being should take minimum eight tumblers (2 Litres) of water every day.

Health

- Health is a state of complete physical, mental and social well-being and not merely absence of diseases. Eating a healthy diet keeps you physically and mentally fit. When you are physically healthy, you feel confident you are more outgoing and have a greater capacity for enjoying life.

- Unhealthy food choices lead to obesity and illness, preventing you from socializing with friends and family. So choose your diet carefully.

Balanced Diet

- A diet should contain adequate amount of all the necessary nutrients required for healthy growth and activity.

- An increased capacity to work
- Good physical and mental health
- Increased capacity to resist diseases.
- Help in proper growth of the body.

- A balanced diet contains sufficient amount of various nutrients to ensure good health. Food should also provide the appropriate amount of energy and adequate amount of water.

Malnutrition:

- Malnutrition occurs when all the nutrients that the body needs are not obtained in the proper proportions from the diet. The word malnutrition refers to the condition that results when a person does not take a balanced diet. Malnutrition leads to deficiency disease. The diseases that are caused due to lack of Nutrients in the diet are called Deficiency Diseases.

India has the second highest number of obese children in the world after China, according to a study that has found that 14.4 million children in the country have excess weight.

Protein and Mineral Deficiency Diseases

Protein Diseases	**Symptoms**
Kwashiorkar	Stunted growth, swelling of face and limbs, Diarrhoea.
Marasmus	Skinny appearance, slow body growth.

Mineral	**Deficiency Disease**
Calicum	Rickets
Phosphorus	Osteomalatia
Iodine	Cretinism (in child) Goitre (in adult)
Iron	Anaemia

Physical Exercise and Rest

- Physical exercise is any bodily activity that enhances or maintains physical fitness and overall health and wellness. It is performed for various reasons, including

- increase in growth and development,
- strengthening muscles and the cardiovascular system,
- developing athletic skills, weight loss or maintenance, and enjoyment.

- Physical exercise may help to decrease some of the effects of childhood and adult obesity.

Deep sleep seems to be one of the most critical time for body repair

REST

- Proper amount of rest is essential for physical and mental health. Rest is as important as nutrition and physical activity for growth and development and good health.

Personal Cleanliness

- Hygiene is a set of practices performed to preserve health. According to the World Health Organization (WHO), "Hygiene refers to conditions and practices that help to maintain health and prevent the spread of diseases."

- **Personal hygiene** involves those practices performed by an individual to care for one's bodily health and well being, through cleanliness. It includes such personal habit choices as how frequently to bathe, wash hands, trim fingernails, and change clothing. It also includes attention to keep surfaces in the home and workplace, including bathroom facilities, clean and pathogen-free.

Introduction of Microbes

- The diseases or conditions caused by microorganism due to the negligence of personal hygiene.

- Diarrhoea
- Tooth decay
- Athlete's foot(Madurai's foot)
- Dandruff.

Most of the microbes belong to four major groups:

- Bacteria
- Virus
- Protozoa
- Fungi

Bacteria

- Bacteria are very small prokaryotic microorganisms.
- Bacterial cells do not have nucleus and do not usually have membrane bound organelles.

- Bacteria can exist either as independent organisms or as parasites
- They invade tissues
- They produce pus or harmful wastes

Bacterial Diseases

S.No	Bacterial diseases	Mode of transmission
1	Cholera	Contaminated water
2	Pneumonia	Inhalation of airborne droplets from a sneeze or cough
3	Tetanus	Contamination of wounds with the bacteria.
4	Tuberculosis	Inhalation of airborne droplets from sneeze or cough
5	Typhoid	Contaminated food or water

Disease
Disease is a definite pathological process having a characteristic set of signs and symptoms.
Disorder
Disorder is a derangement or abnormality of function.

Virus

- Virus is an acellular agent that replicates only inside the cells of other living organisms. Virus can infect all types of life forms plant, animals and microorganisms. They invade living normal cells and use their cell machinery to multiply. They can kill damage or change the cells and make you sick.

Diseases Caused By Virus

- Common cold
- Influenza
- Hepatitis
- Polio
- Smallpox
- Chicken pox
- Measles

Microscopes help to study the structure of the microorganisms

7th Term I

Unit 6 – Health & Hygiene

- Health is the best wealth. If you have good health, you will have a sound mind and you will gain good knowledge and wealth also. To maintain good health, you should follow good hygiene, eat nutritious food, do exercise, take rest and have a sound sleep.

- It is also refers to a state of a sound mind and body free from any sickness or ailment, stress and problems. In simple words, health refers to the physical, emotional and psychological well-being of a person.

- Hygiene refers to the good habits and their practices which is followed to prevent diseases, maintain good health, especially through cleanliness, consumption of safe drinking water and proper disposal of sewage. It refers to all those activities that are done for improving and maintaining good health and sound mind.

Cleanliness

- Cleanliness refers to the maintenance of personal and environmental hygiene. In simple words, It refers to the state of being clean which is essential for good health. To protect us from diseases it is essential to maintain good health by taking regular bath, cleaning the clothes and surroundings and also avoiding unhygienic food consumption.

- Personal hygiene is defined as "the branch of health which is concerned with the individual's adjustment to the physiological needs of the body and mind for the attainment of the maximum level of health, it also refers to the cleaning and grooming of the body.

- Colds and the flu are common communicable diseases. It is caused not only by bacteria but also by virus. When you have cold and flu, you may also have running nose, cough, sore throat, and sometimes fever or pain in the joints. For some, this condition may also lead to mild diarrhoea.

- Secretions oozing out from the nose may contains the bacteria or virus. When the patient touch the nose and some other object or someone else the virus is transferred. When the patient sneezes or coughs the virus comes out with the droplets and become airborne. Hence it is a good practice for the patientwith cold and flu to use a handkerchief to blow the noses and also wash the hands often to ensure that they do not accidentally spread the virus to others.

Community Hygiene

A community is formed by a group of people living together in a particular area. If the people in a community wish to lead a healthy life, they should maintain basic community hygiene. It can be done by adopting the following measures.

- The surroundings should be kept clean.
- Drains should be covered properly.
- The domestic wastes should be segregated and properly disposed off safely in separate dust bins provided by the Government (Green and Blue).
- Used water from houses should not be let out into open drains or open areas

Dengue is spread by mosquitoes of Aedesaegypti caused by DEN-1, 2 virus belonging to the type- flavivirus. It decrease counting of the blood platelets of human blood and it has a maximum flight range of 50–100 meters in and around the places.

Care of the body

- A human body is a massive miracle. It consists of organs and systems, which functions day in and out. Our body in compared to a machine. The human body systems work well with proper maintenance and guidance. For smooth functioning, all the parts of the body should work in unison. The digestive system, circulatory and muscular system is the core systems that should be in synchronization and functioning well. So keep them well by proper care.

Dental Care

- Dental care or broadly speaking oral hygiene is an important aspect of the personal health of an individual. Good oral hygiene implies sound teeth and healthy gums with healthy surrounding tissues. The physical act of chewing food promotes saliva and gastric secretions which helps digestion. The act of chewing and tasting is called 'mastication'. It gives pleasure and emotional satisfaction of eating food. Teeth is essential for good appearance and clear speech also.
- When you brush two times a day, it will prevent the formation of tartar and plaque on your teeth and gums.
- When you Floss, it will remove food particles, plaque, and bacteria which build up between your teeth. When you start flossing, your gums may bleed a little bit, but after few days that will be stopped. It should be started only with proper medical guidance.

Diseases affecting the teeth

- Diseases affecting the teeth and gums, their causative agents and remedial measure are given below:

S.No	Name of the Diseases	Causative Agents	Impacts/ Consequences	Remedial measures
1	Bleeding Gums	Vitamin C deficiency	Bleeding of the gums	Eating citrus fruits.
2	Tooth decay	Bacteria in plaque	Bacteria produce acids	Brushing and flossing the teeth can prevent decay.
3	Periodontitis	Tobacco chewing	Severe form of gum disease ruin the bones, gums, and other tissues.	Chewing type of tobacco should be avoided. Eat a well – balanced diet.

Eye Care

- Eyes are an important organ of our body. They are considered as "windows to the world". Eyesight is the most important sense. 80% of what we perceive comes through the sense of sight. The protection of the eyes, can reduce the odds of blindness and vision loss. we protection of our eye from the diseases, surroundings, climate condition.

Diseases affecting Eye

Disease affecting the eye and their remedial measure are given below:

Hair Care

- The condition of the hair reflects to some extent the nutritional status and general health of the body. Thin, sparse hair and the loss of hair indicates a poor nutritional status. The deficiencies in diet, physical and mental illness of various kinds may also leads to premature graying of hair.

- The hair follicles from which the hair grows produce oil which keeps the hair smooth. The sweat and the dead skin cells come off the scalp.

- The oil, sweat and dead cells all add together and can make the hair greasy and look dirty unless it is washed regularly.

S.No	Name of the Disease	Causative Agents	Impacts/ Consequences	Remedial measures
1	Night Blindness	A lack of vitamin A, a disorder of the cells in your retina	Makes it hard to see well at night or in poor light.	Eat food rich in anti – oxidant, vitamins and minerals.
2	Conjunctivitis (Pink eye)	Caused by a virus and	One or both eyes can be affected. Highly	Antibiotic eye drops or

		bacteria	contagious; can be spread by contamination and sneezing	ointments, home remedy.
3	Color blindness	Genetic condition	Difficulty distinguishing between colours Inability to see shades or tones of the same colour.	There is no known cure for colour blindness. contact lenses and glasses with filters

To keep the hair clean and healthy:

- The regular hair wash and massage of the scalp will remove the dead skin cells, excess oil and dust.

- Rinsing the hair well with clear water and using good toothed comb for hair dressing is highly essential for their maintenance.

Diseases

- A disease is the functional or physical change from a normal state that affects the health of a person by causing disability or discomfort. The following are reasons that could leads to the development of disease in an individual.

- Infection caused by disease-causing microbes
- Lack of balanced diet
- Poor lifestyle and unhealthy habits
- Malfunctioning of one or more body parts or organs.

Different kinds of sickness and their causes

- The prevention and treatment of sickness can be considered in two groups for their better understanding. They are, communicable and non-communicable disease.

Communicable Diseases

- Communicable diseases are those that spread from one person to another. Healthy persons must be protected from people with communicable diseases. Diseases spread through contaminated air, water, food or vectors (insects and other animals).

Diseases Caused by Bacteria

- Communicable disease (like tuberculosis, Cholera and Typhoid), which are caused by microbes and spread through air, water and some other organisms also.

Tuberculosis:

- TB is caused by Mycobacterium tuberculae and spreads from one person to another person through air by spitting and prolonged contact with sharing materials of the patient. The symptoms are fever, weight loss, chronic cough, bloody spitting and difficulty in breathing.

Prevention and treatment

- BCG vaccination,
- Giving special attention to the patient,
- Regular medication like DOT

Cholera:

- Cholera is caused by Vibrio cholera and spread through the consumption contaminated food or water. The symptoms of Cholera is Vomiting, severe diarrhea and cramps in legs

Prevention and treatment

- Good hygienic practices like, washing hands before eating.
- Avoid eating uncovered food from street vendoers.
- Drinking boiled water.
- Getting Vaccination against cholera

Typhoid:

- Typhoid is caused by Salmonella typhi and spreads by contaminated food and water. The symptoms are Anorexia, headache, rashes on abdomen, dysentery and high fever up to 1040F.

Prevention and treatment

- Drinking boiled clean water
- Proper disposal of sewage
- Vaccination

Disease Caused by Virus

- Viral diseases are extremely widespread infections caused by many type of viruses. In this lesson you will learn about some disease caused by viruses like, Hapatitis, Chickenpox and Rabies.

Hepatitis

- Hepatitis is one of the most dangerous and fatal diseases caused by Hepatitis virus- A, B, C, D, E. Its mode of transmission is Contaminated water, sharing of needles and blood

transfusion. The symptoms of hepatitis is loss of appetite, (Anorexia), vomiting, eyes and urine in yellow color.

Prevention and treatment

- Drinking boiled water,
- Proper cleaning of hands

Chickenpox

- Chickenpox (chicken pox), also known as varicella, is a highly contagious infection caused by the varicella zoster virus. . This disease spreads through air and contact with an infected person. Its symptoms is appearance of rashes on the whole body, fever, headache and tiredness.

Prevention and treatment

- The chickenpox (varicella) vaccine is the best way to prevent chickenpox
- Special attention should be given to the infected persons

Rabies

- Rabies is a fatal disease. Which is transmitted by the bite of the infected dog, rabbit, monkey, cat etc. The virus present in the saliva of dog enters the brain via neurons. The symptoms of rabies is hydrophobia (extreme fear for water), fever for 2 – 12 weeks and exaggerations in behavior.

Prevention and treatment

- In early stages rabies is very difficult to detect
- After an animal is bitten it usually takes two to twelve weeks to shows any symptoms and it may take as long as two years also.
- Fatality can be prevented by timely vaccination before the onset of symptoms.

Vaccine
A vaccine is a biological preparation that provides active acquired immunity to a particular disease. Vaccines like (BCG, Polio, MMR) are given at early child wood to protect from other diseases

Non-Communicable diseases

- Communicable diseases do not spread from person to person. They are caused by other factors. Therefore, it is important to know which sickness are communicable and which are not. They are never caused by germs, bacteria, or other living organisms that infect the body. Antibiotics, or medicines that fight against germs do not help to cure non-communicable diseases.

Problems caused by wearing out of body parts:

- Rheumatism, heart attack, epileptic seizures, stroke, migraine headach. Cataract and cancer

Problems caused by external harmful agents entering the body:

- Allergies, asthma, poisons, snakebite, cough from smoking, stomach ulcer, alcoholism.

Problems caused by a lack of trace elements in the body:

- Anemia, pellagra, night blindness and xerophthalmia, goiter and hypothyroidism.

Problems caused by Malnutrition.

- Nutritious food is needed for a person to grow well, work hard, and stay healthy. Many common sicknesses are caused by malnutrition.

Leucoderma is a non – communicable diseases caused by partial or total loss of pigmentation in the skin. (melanin pigment). This condition affects any age, gender and ethnicity. There is no cure. It does not spread by touching, sharing food and sitting together.

Specific health problems of children

Anaemia

- It is caused by eating food with less iron content and can also caused due to feeding some other foods instead of breast milk. Severe anemia in children may leads to hookworm infection, chronic diarrhoea and dysentery. In recent day school going children, especially the girls are affected by anemia. The Government of Tamil Nadu provides weekly iron folic tablets to all the girls in the schools of all areas.

The signs of anemia are:

- Pale or transparent skin, The inner surface of eye lids are pale, white fingernails, pale gums, weakness and fatigue.

- In severe cases, face and feet may be swollen, the heartbeat is rapid and with shortness of breath.

- Children and women who eats mud are usually anemic.

Consuming iron containing food Sources

- **Food –** Moringa leaves, Dates, Liver (Sheep and Chicken), Green, green leafy vegetables like beans, peas, lentils and Greed banana.

- **Pills** - Cod liver oil tablet, Ferrous sulfate

As a general rule, iron supplements should be given orally, not to be injected, because it leads to dangerous

Safety and First Aid

- First aid is the immediate treatment given to the victim of trauma or sudden illness before medical help is made available.

The first aid is

- To save the life
- To prevent further bleeding and determine the condition of the patient
- To relieve the pain
- To provide a medical care available at the earliest

Burns

- The tissue damage caused by heat, chemical, electricity, sunlight or nuclear radiation is known as Burns. Mostly burns are caused by scalds, building fires, flammable liquid and gases. There are three types of burns, according to degree of burning.

- First-degree burns affect only the outer layer (called the epidermis) of the skin
- Second-degree burns damage the epidermis and the layer beneath it (called the dermis)
- Third-degree burns involve damage or complete destruction of the skin to its full depth and damage to underlying tissues also. People who experience such burns often require skin grafting.

First Aid for Burning

- In case of minor burns, the affected area should be washed with cold water and an antiseptic cream should be applied. In case of severe burns, where deeper layers of tissues get destroyed and blisters appear, use of water should be avoided. The burnt area should be covered with a clean non- sticking cloth or bandages. Larger burns need immediate medical attention.

Cut and Scratches

- Cuts and scratches are areas of damage on the surface of the skin. A cut is a line of damage that can go through the skin and into the muscle tissues below, whereas a scratch is surface damage that does not penetrate the lower tissues.

- Cuts and scratches may bleed or turn red, become infected and leave scars.

First aid for cuts

- For minor cuts, the affected area should be washed with cold running water and cleaned with an antiseptic liquid. Then apply an antiseptic cream on the wound and sterilized bandage should be tied to prevent infection. If the cut is deep, a clean cotton pad should be placed on the cut and pressed, and the injured person should be taken to a doctor immediately.

Basic cleanliness and protection.

- The most important thing is to help anybody, but you must also protect yourself from HIV and other blood-borne diseases when you help someone who is bleeding. You should wear gloves or a clean plastic bag on your hands.

- Be careful not to prick yourself with needles or other sharp objects around the person you are helping.

Unit.6. Microorganisms

Introduction

Microorganisms are too small in size that they cannot be seen through naked eye. These organisms can be seen only with the help of a microscope, therefore they are also known as microbes. The science that deals with the study of microorganisms is known as microbiology.

Microorganisms occur everywhere. They are found in air, water (ponds, lakes, rivers and oceans), soil and even inside our bodies. Some of them can even survive in severely adverse conditions, such as hot springs, deserts, snow and deep oceans. They remain inactive under unfavourable conditions and become active during favourable conditions.

Microorganisms can be studied under five categories. They are:

- Virus • Bacteria
- Fungi • Algae
- Protozoa

VIRUS

A virus is a tiny, particle made up of genetic material and protein. They are intermediate between living and non living things. Virus means 'poison' in Latin. Viruses are intracellular obligatory parasites. The study of virus is called 'virology'. Viruses are 10,000 times smaller than bacteria. Viruses have different shapes. They can be rod shaped, spherical or of other shapes.

Virus structure

A virus contains a core DNA or RNA. Surrounding that core is a protein coat. In some viruses, the protein coat is covered by an envelope made of proteins, lipids, and carbohydrates. The envelope has spikes that help the virus particles attach to the host cells. Virus shows both living and non living characters:

Living characters

- They respond to heat, chemicals and radiations.
- They reproduce inside the host cells and produce copies of themselves.
- They show irritability.

Non-Living characters:

- They are inactive when present freely in the environment.
- They can be crystallized and stored for a very long time, like other non-living things.
- The metabolic machinery, cytoplasm is absent.

Viruses cause many diseases to plants, animals and human beings.

BACTERIA

Bacteria are single-celled prokaryotes (cells without nuclei). They are considered to be the first living organisms on earth. Bacteria are grouped under the kingdom Monera. The study of Bacteria is called Bacteriology. The size of bacteria range from 1µm to 5µm (micrometer). Bacteria are of two types based on respiration

- Aerobic bacteria (requires oxygen).
- Anaerobic bacteria (Does not requires oxygen).

Cell structure:

A bacterium has an outer covering known as the cell wall. Nuclear material is represented by a nucleoid without nuclear membrane. An extra chromosomal DNA called plasmid is present in the cytoplasm. Protein synthesis is carried out by 70S ribosomes. Other cell organelles (mitochondria, Golgi body endoplasmic reticulum etc.,) are absent. Flagella aids in locomotion.

Bacteria are described according to the shape of their cells. They are:

- Bacilli - Rod shaped bacteria. Eg. Bacillus anthracis
- Spirilla - Spiral shaped bacteria. Eg. Helicobacter pylori
- Cocci - Spherical or ball shaped bacteria. They can stick together in pairs (diplococcus); form a chain (streptococcus) eg. Streptococcus pneumoniae or occur in bunches (staphylococcus).
- Vibrio - comma shaped bacteria. Eg.Vibrio cholera.

Bacteria are also classified according to the number and arrangement of flagella, which are as follows:

- Monotrichous - Single flagella at one end. Eg. Vibrio cholera
- Lophotrichous - Tuft of flagella at one end. Eg.Pseudomonas.
- Amphitrichous - Tuft of flagella at both ends. Eg.Rhodospirillumrubrum.
- Peritrichous - Flagella all around. Eg.E.coli.
- Atrichous - Without any flagella. Eg.Corynebacteriumdiptherae.

Bacteria get their food in many ways. Photosynthetic bacteria make their own food. (Eg.Cyanobacteria). Bacteria that live in harsh environment use chemicals (Ammonia, hydrogen sulphide) to produce their food instead of utilizing energy from the sun. This process is called chemosynthesis. Some bacteria exhibit symbiotic relationship (eg. E.coli lives in the intestine of man). Bacteria reproduces by fission (binary and multiple fission).instead of utilizing energy from the sun. This process is called chemosynthesis. Some bacteria exhibit symbiotic relationship (eg. E.coli lives in the intestine of man). Bacteria reproduces by fission (binary and multiple fission).

FUNGI

Fungi are group of eukaryotic organisms that lack chlorophyll. They grow in dark environments. They may be either unicellular (eg. Yeast) or multicellular (eg.Penicillium). They are found in all kinds of habitats. They are included under kingdom Fungi. The study of fungi is called mycology. Some fungi are macroscopic (eg. Mushroom). There are around 70,000 species of fungi, living in the world.

Cell structure:

Unicellularfungi (eg. Yeast)

Yeasts are found freely in the atmosphere. Yeast grows in all kinds of media containing sugar. The cell is ovoid in shape, containing cellwall and a nucleus. The cytoplasm is granular, and has vacuoles, organelles, glycogen an oil globules. Yeast aids in fermentation with the help of the enzyme zymase. Yeast respires anaerobically. Yeast reproduces by budding.

Multicellular fungi (eg. Mushroom)

Mushrooms are found growing on wet soil in shaded places during the rainy season, such as at the roots of the trees. The umbrella shaped structure that grows above the soil is known as the fruiting body. There are small slit like structures under the umbrella which are known as gills. The gills contain spores.

The mycelium is located underneath the fruiting body, in the top layer of the soil. Mycelium in turn is made up of thread-like structures called hyphae. Walls of the hyphae are made up of chitin and cellulose. Hyphae help in transport of nutrients for the growth of mushroom. Reproduction is by the method of fragmentation and spore formation.

Fungi are either saprophytes (i.e., derives nutrition from the remains of dead and decomposing plants and animals) eg. Rhizopus, Penicillium, Agaricus, or parasites (ie. derives nutrition from the living cells of the host) eg. Puccina, Albugo, Ustilago, or symbionts(ie., fungus in the roots of vascular plant) eg. Mycorrhiza.

ALGAE

Algae are very simple plant like eukaryotic organisms. Algae are found in moist habitats. Algae are rich in chlorophyll and can be seen as thin film on the surface of lakes and ponds, therefore they are known as 'grass of water'. They are autotrophic and manufacture their own food with the help of chloroplast. Chloroplast contain chlorophyll (green) pigments for photosynthesis. The study of algae is called algology (phycology).

Their size varies from 1 micron to 50 meter. Algae may be unicellular, microscopic (eg. Chlamydomonas) or multicellular and macroscopic (eg.Sargassum).Unicellular algae exhibits variety of shapes (i.e., spherical, rod, spindle), where as multicellular algae are in the form of filaments and branches.

Cell structure (Eg. Chlamydomonas)

Chlamydomonas is a simple, unicellular, motile fresh water algae. They are oval, spherical or pyriform in shape. The pyriform (pear shape) is a common one found in ponds, ditches and water tanks. They have a narrow anterior end and a broad posterior end.

The cell is surrounded by a thin and firm cell wall made of cellulose. The cytoplasm is seen in between the cell membrane and the chloroplast. The cell contains large dark nucleus lying inside the cavity of the cup shaped chloroplast. The anterior part of the cell bears two flagella which helps in locomotion. Two contractile vacuoles are seen at the base of each flagellum. The anterior side of the chloroplast contains a tiny red coloured eyespot. Chlamydomonas exhibits sexual and asexual modes of reproduction.

Some algae have other photosyntheticpigments like fucoxanthin (brown), xanthophylls (yellow), phycoerythrin (red), phycocyanin (blue).

6.5 PROTOZOA

A protozoan (in Greek protos = first and zoon = animal) is a single-celled eukaryote. They are included under the kingdom Protista. The study of protozoa is called Protozoology. They are found in ponds, ocean, in moist soil, and in the cells and tissues of plants and animals causing diseases. They range from 2-200 microns. Protozoans have

specialized organelles. These organelles are used for movement, feeding, and other functions. The types of protozoans are as follows:

- Ciliates - presence of cilia for locomotion (eg. Paramecium)
- Flagellates - presence of flagella for locomotion (eg. Euglena)
- Pseudopods - presence of pseudopodia for locomotion (eg. Amoeba)
- Sporozoans - parasites(eg. Plasmodium)

Cell structure (Eg. Amoeba)

Amoeba is a unicellular microscopic organism. It is found in ponds. Amoeba is irregular in shape. It has cell membrane, cytoplasm and nucleus. It is a protozoan that move by means of pseudopodia (in Latin, "false feet.") Pseudopodia are the extended part of cell membrane. It helps to catch its prey (algae). The body 'flows' around the food particle and engulfs it forming food vacuoles. Contractile vacuoles are seen in the cytoplasm that help in excretion. Amoeba reproduces by means of fission and sporulation.

USES OF MICROORGANISMS IN MEDICINE, AGRICULTURE, INDUSTRY AND DAILY LIFE

Medicine

We obtain antibiotics and vaccines from microbes.

1. Antibiotics

The word 'Anti' means 'against'. Antibiotic is a substance produced by living organisms which is toxic for other organisms. Sir Alexander Fleming was the first person to discover the antibiotic Penicillin in the year 1928. The antibiotic Penicillin was obtained from the fungi Penicilliumchrysogenum. It is used to treat diseases such as tetanus, diphtheria. Antibiotic Streptomycin is obtained from Streptomyces bacteria to cure various bacterial infections eg. Plague.

2. Vaccines

Vaccines are prepared from dead or weakened microbes. Edward Jenner was the first person to discover small pox vaccine. He coined the term vaccination. When the vaccine is injected to the body of a patient, the body produces antibodies to fight against the germs. These antibodies remain inside the body and protects from future invasion of the germs. These antibodies remain inside the body and protects from future invasion of the germs. Therefore vaccination is otherwise called as immunization.

Eg.MMR vaccine for Measles, Mumps, Rubella.BCG (BacilleCalmette Guerin) vaccine for Tuberculosis.

Agriculture

1. Natural Fertilizer

Microorganisms are called as decomposers because they act upon degradable wastes. During the process, nitrates and other inorganic nutrients are released into the soil, making the soil fertile. This compost is called as natural fertilizer.

2. Nitrogen Fixation:

Rhizobium bacteria living in the root nodules of leguminous plants enrich the soil

by fixing the atmospheric nitrogen as nitrates which are essential for the growth of plants. Some free living bacteria in soil, cyanobacteria Nostoc can also fix nitrogen biologically.

3. Biocontrol Agents:

Microbes are used to protect the crops from pests. For example,

- Bacillus thuringiensis (Bt cotton) helps to control insects.
- Trichoderma (Fungi) helps to protect roots and control plant pathogens.
- Baculoviruses (Virus) attack insects and other arthropods.

INDUSTRY

1. Sewage Treatment

Aerobic microbes are allowed to grow in the primary effluent during the secondary stage of waste water treatment. These microbes consume the major part of the organic matter in the effluent eg. Nitrobactersps. In the anaerobic treatment of sewage Methanobacterium is used.

2. Production of Biogas

Human and animal faecal matter and plant wastes are broken down by anaerobic bacteria to produce methane (biogas) along with carbon dioxide and hydrogen. These bacteria are called as methanogens.

3. Production of Alcohol and Wine

Alcoholic drinks are prepared by fermentation process using yeast. Sugars in grapes are fermented by using yeast. Beer is produced by the fermentation of sugars in rice and barley.

4. Microbes in Retting and Tanning Process

A. Retting

Flax plants are tied in bundles and kept in water. Bacteria loosen the supporting fibres of the stem by acting on the stem tissues. This process is known as retting. Linen thread is made from these fibreseg. Pseudomonas aeruginosa.

B. Tanning

In Tanning industry bacteria act upon the skin of animals and makes it soft and therefore it becomes pliable.

In Daily Life

1. Making of Bread

Yeast is used in bakeries to make bread and cakes. They are added to the dough to produce carbon dioxide which makes the dough rise. Bread and cakes are soft due to carbon dioxide gas. Chlorella (green algae) is rich in proteins and vitamins is added to the dough which enrich the bread with nutrients.

2. Preparation of Curd and Cottage Cheese

Lactose in the milk gets turned into Lactic acid by the action of Lactobacillus (bacteria). Therefore the milk becomes thick (curd). It gives the sour taste. When curd is processed cottage cheese (panneer) is obtained.

3. In Human Intestine

• Lactobacillus acidophilus that lives in the human intestine helps in digestion of food and fight against harmful disease causing organisms.

• E.coli bacteria in human intestine help in synthesizing vitamin K and vitamin B complex.

HARMFUL MICROORGANISMS

A few microorganisms are harmful to humans, animals and plants. They cause diseases and hence they are called as pathogens. Pathogens enter into the body through cuts and wounds in the skin, mouth or nose and cause diseases. Viruses causing 'flu' are spread through air. When the patient sneezes droplets containing viruses spread in air and it gets entered to another person when he breathes. Let us study about some of the diseases caused by the microorganisms in humans, animals and plants.

SI No.	Human Diseases	Causative microorganisms	Mode of transmission	Symptoms	Preventive measures/ Treatment
1.	Tuberculosis	Mycobacterium tuberculosis (Bacteria)	Through air and sputum of infected person	Persistent cough, blood mucus, loss of weight, breathlessness	BCG Vaccine
2.	Cholera	Vibrio cholera (Bacteria)	By files and bycontaminated food and water	Watery diarrhea, vomiting rapid dehydration	Anticholera vaccine, maintaining personal hygiene.
3.	Common cold	Influenza (virus)	Through air	Running nose, sneezing	Isolation of patient
4.	Rabies	Rhabdoviridae (virus)	Animal bite	Fever, hallucination paralysis inability to swallow	Anti- rabies vaccine
5.	Amoebic dysentery	Entamoebahistolytica (Protozoa)	Food water and flies	Severe diarrhea and blood in stool	Proper sanitation to be followed and metronidazole antibiotic to be administered

6.	Malaria	Plasmodium (Protozoa)	Female Anopheles mosquito	Nausea, vomiting High fever	Antimalarial drugs like quinine, choroquine to be taken and also usage of mosquito repellents and nets.

Diseases Caused By Microorganisms In Animals

Animal Diseases	**Causative microorganisms**	**Mode of transmission**	**Symptoms**	**Preventive measures/ Treatment**
Anthrax (cattle) also affects humans	Bacillus anthracis (Bacteria)	Through contaminated soil and food	Difficulty in breathing, unconsciousness, loss of appetite	Anthrax Vaccine
Foot and mouth disease	Aphthovirus (virus)	Through air and animal vectors	Fever, blishters in mouth, weight loss decreased milk production	FMD vaccine

Diseases Caused By Microorganisms In Plants

Plant Diseases	Causative micro organisms	Mode of transmission	Symptoms	Preventive measures Treatment
Citrus canker	Xanthomonasaxonopodis (Bacteris)	Air, water	Lesion son leaves, stems and fruit	Copper based bactericides can be used
Potato blight disease	Phytophthorainfestans (Fungi)	Air	Brown lesions on the surface of tubers	Fungicide are used

MICROBES IN FOOD PROCESS

For food processing, commonly used microorganisms are yeast, bacteria, and moulds. Fermentation process which is carried out by microorganisms results in the production of organic acids, alcohol and esters. They help to preserve food and generate distinctive new food products.

1. Food Preservation:

Two techniques are followed in food preservation. They are;

- Traditional techniques

• Modern techniques

A) Traditional techniques:

***Fermentation:** Fermentation is the microbial conversion of starch and sugars into alcohol. It makes foods more nutritious and palatable.

* **Pickling:** Pickling is a method of preserving food in an edible antimicrobial liquid. It is of two types:

a) Chemical pickling:

Food is placed in an edible liquid that kills bacteria and other microorganisms. Eg.Vinegar, alcohol, vegetable oil. (pickling agents)

B) Fermentation pickling:

Bacteria in the liquid produce organic acid as preservation agent that produces lactic acid due to the presence of Lactobacillus.

***Boiling:** Boiling liquid food items kill all the microbes. Eg.Milk and Water.

***Sugaring:** Sugar is used to preserve fruits in an antimicrobial syrup with fruit such as apples, pears, peaches, plums or in a crystallized form, therefore the product is stored in dry condition.

B) Modern techniques:

***Pasteurization:** It is a process for preservation of liquid food. This method was invented by Louis Pasteur in 1862. Milk is heated up to 70^{o}c to kill the bacteria and it is cooled to 10^{o}c to prevent the growth of remaining bacteria. Then milk is stored in sterilized bottles in cold places.

2. Food Production:

***Probiotics:** Probiotics are live food supplements used in yoghurt and other fermented milk products. Eg.Lactobacillus acidophilus and Bifidobacteriumbifidum. These bacteria improve the microbial spectrum in the gut and thus contribute to the following effects:

• Decrease the risk of colon cancer
• Decrease cholesterol absorption
• Prevent diarrheal diseases by increasing the immunity power.

RELATIONSHIP BETWEEN MAN AND MICROBES-BALANCES, IMBALANCES AND USES

Thousands of bacteria, fungi and other microbes that live in our gut are essential contributors to a good health. They break down toxins, manufacture some vitamins and essential amino acids and form a barrier against invaders. Gut microbes are the bacteria in human gut. It is one of the most important allies in our overall health and well being. Gut ensures that the body is absorbing all the important nutrients, to function at its highest level. Many different aspects of health are attached to it.

PRIONS

The word prion is derived from "protinaceous infectious particle". Prions have neither DNA or RNA to transmit infection. A prion is a mutted form of a usually harmless protein. Prions cause diseases by affecting brain or neural tissue. Eg.Creutzfeldt-Jackob disease. Another example is Kuru- associated with cannibalism.

VIRIONS

Virion is an entire virus particle consisting of an outer protein shell called a capsid and an inner core of nucleic acid (RNA or DNA). If the virus is found outside the cell (extracellular) it is known as virion. Virion has the capacity to infect the living tissue.

9th Full Book

Unit 21- Nutrition & Health

Introduction

- Food is the basic necessity of life. Food is defined as any substance of either plant or animal origin consumed to provide nutritional support for an organism. It contains essential nutrients that provide energy, helps in normal growth and development, repair the worn out tissues and protect the body from diseases. Food contamination with microorganisms is a major source of illness either in the form of infections or poisoning. Food safety is becoming a major concern these days.

- Adulteration of foodstuffs is commonly practiced in India by traders. Food is contaminated or adulterated from production to consumption for financial gain. The physiological functions of a consumer are affected due to either addition of a deleterious substance or the removal of a vital component. Food laws have come into existence to maintain the quality of food produced in our country.

Classes of Nutrients

Nutrients are classified into the following major groups as given below.

- Carbohydrates
- Proteins
- Fats
- Vitamins
- Minerals

Carbohydrates

- Carbohydrates are organic compounds composed of carbon, hydrogen and oxygen. Carbohydrate is an essential nutrient which provides the chief source of energy to the body. Glucose, sucrose, lactose, starch, cellulose are examples for carbohydrates.

- Carbohydrates are classified as monosaccharide (Glucose), disaccharide (Sucrose) and polysaccharide (Cellulose). The classification is based on the number of sugar molecules present in each group.

Proteins

- Proteins are the essential nutrients and also the building blocks of the body. They are essential for growth and repair of body cells and tissues. Proteins are made of amino acids.

- Essential amino acids are those that cannot be biosynthesized by the body and must be obtained from the diet. The nine essential amino acids are phenylalanine, valine, threonine, tryptophan, methionine, leucine, isoleucine, lysine and histidine.

Fats

- Fat in the diet provides energy. They maintain cell structures and are involved in metabolic functions.

- Essential fatty acids cannot be synthesized in the body and are provided through diet. Essential fatty acids required in human nutrition are omega fatty acids.

Vitamins

- Vitamins are the vital nutrients, required in minute quantities to perform specific physiological and biochemical functions.

Human skin can synthesize Vitamin D when exposed to sunlight (especially early morning). When the sun rays falls on the skin dehydrocholesterol is converted into Vitamin D. Hence, Vitamin D is called as Sunshine vitamin. Vitamin D improves bone strength by helping body to absorb calcium.

Minerals

- Minerals are inorganic substances required as an essential nutrient by organisms to perform various biological functions necessary for life. They are the constituents of teeth, bones, tissues, blood, muscle and nerve cells.

- The macrominerals required by the human body are calcium, phosphorus, potassium, sodium and magnesium. The microminerals required by the human body also called trace elements are sulfur, iron, chlorine, cobalt, copper, zinc, manganese, molybdenum, iodine and selenium.

Dietary sources of major foodstuffs

Major food Stuffs	Dietary sources	Daily requirements (grams)
Carbohydrates	Honey, Sugarcane, fruits, whole grains, starchy vegetables, rice	150-200
Proteins	Legumes, pulses , nuts, soya bean, green leafy vegetables, fish, poultry products, egg, milk and dairy products	40
Fats	Egg Yolk, saturated oil, meat	35

Vitamins-Dietary sources, Deficiency disorders and Symptoms

Vitamins	Dietary sources	Deficiency disorders	Symptoms
Fat Soluble Vitamins			
Vitamin A(Retinol)	Carrot, Papaya, leafy vegetables, fish liver oil, egg yolk, liver, dairy products	XerophthalmiaNyctalopia (Night blindness)	Dryness of Cornea unable to see in the night (dim light) scaly skin.
Vitamin D (Calciferol)	Egg, liver, dairy products, Fish, Synthesized by the skin in sunlight	Rickets (in children)	Bow legs, defective ribs, development of pigeon chest.
Vitamin E (Tocopherol)	Whole Wheat, meat, vegetable oil, milk.	Sterility in rats, Reproductive abnormalities	Sterility
Vitamin K (Derivative of Quinone)	Leafy vegetables, Soyabeans, milk	Blood Clotting is prevented	Excessive bleeding due to delayed blood clotting.
Water Soluble Vitamins			
Vitamin B1 (Thiamine)	Whole grains, Yeast, eggs, liver, sprouted pulses	Beriberi	Degenerative changes in the nerves, muscles become weak, Paralysis.
Vitamin B2 (Riboflavin)	Milk, eggs, liver, green vegetables, whole grains	Ariboflavinosis (Cheilosis)	Irritation in eyes, dry skin, inflammation of lips, fissures in the corners of the mouth.
Vitamin B3 (Niacin**)**	Milk, eggs, liver, lean meat, ground nuts, bran	Pellagra	Inflammation of skin, loss of memory, diarrhoea
Vitamin B6 (Pyridoxine)	Meat, fish, eggs, germs of grains and cereals, rice polishings.	Dermatitis	Scaly skin, nervous disorders.
Vitamin B12 (Cyanocobalamine)	Milk, meat, liver, pulses, cereals, fish	Pernicious anaemia	Decrease in red blood cell production, degeneration of spinal cord.
Vitamin C (Ascorbic acid)	Leafy vegetables, sprouts, citrus fruits like gooseberry (Amala), lemon, orange	Scurvy	Swollen and bleeding gums, delay in healing of wounds, teeth and bones malformed.

Minerals - Dietary sources, Functions and Deficiency disorders

Minerals	Sources	Functions	Deficiency disorders
Macro nutrients			
Calcium	Dairy Products, beans,	Constituent of bones and	Bone deformities,

	cabbage, eggs, fish	enamel of teeth, clotting of blood and controls muscle contraction.	poor skeletal growth, Osteoporosis in adults.
Sodium	Common Salt	Maintains fluid balance and involved in neurotransmission	Muscular cramps, nerve impulses do not get transmitted.
Potassium	Banana, Sweet Potato, nuts, whole grains, citrus fruits	Regulates nerve and muscle activity	Muscular fatigue, nerve impulses do not get transmitted.
Micro nutrients			
Iron	Spinach, dates, greens, broccoli, whole cereals, nuts, fish, liver	Important component of haemoglobin	Anaemia
Iodine	Milk, Seafood, Iodised salt	Formation of thyroid hormones.	Goitre

Protein Energy Malnutrition (PEM)

- Absence of certain nutrients in our daily diet over a long period of time leads to deficiency diseases. This condition is referred as Malnutrition. Deficiency of proteins and energy leads to severe conditions like: Kwashiorkar and Marasmus.

- **Kwashiorkar:** It is a condition of severe protein deficiency. It affects children between 1-5 years of age, whose diet mainly consists of carbohydrates but lack in proteins.

- **Marasmus:** It usually affects infants below the age of one year when the diet is poor in carbohydrates, fats and proteins.

Food Hygiene

- Poor personal hygiene may allow pathogenic microorganisms to cause food spoilage Food spoilage is an undesirable change in the normal state of food and is not suitable for human consumption. Signs of food spoilage include a changes in appearance, colour, texture,odour and taste. Factors responsible for Food Spoilage are given below.

- Internal **factors:** It include enzymatic activities and moisture content of the food.

- **External factors:** It include adulterants in food, contaminated utensils and equipment, unhygienic cooking area and lack of storage facilities.

Food Preservation

- Food preservation is the process of prevention of food from decay or spoilage, by storing in a condition fit for future use. Food is preserved to:

- increase the shelf life of food
- retain the colour, texture, flavour and nutritive value
- increase food supply
- decrease wastage of food

Methods of Food Preservation
The various method of food preservation are explained below

- Drying**:** Drying is the process of preservation of food by removal of water/moisture content in the food. It can be done either by sun-drying, (e.g. cereals, fish) or vacuum drying (e.g. milk powder, cheese powder) or hot air drying (e.g. grapes, dry fruits, potato flakes). Drying inhibits the growth of microorganism such as bacteria, yeasts and moulds.

- Smoking**:** In this process, food products like meat and fish are exposed to smoke. The drying action of the smoke tends to preserve the food.

- Irradiation**:** Food irradiation is the process of exposing food to optimum levels of ionizing radiations like x-rays, gamma rays or UV rays to kill harmful bacteria and pests and to preserve its freshness.

- Cold **storage:** It is a process of storing the perishable foods such as vegetables, fruits and fruit products, milk and milk products etc. at low temperature. Preserving the food products at low temperature slows down the biological and chemical reactions and prevents its spoilage.

- Freezing**:** Freezing is one of the widely used methods of food preservation. This process involves storing the food below 00C at which microorganisms cannot grow, chemical reactions are reduced and metabolic reactions are also delayed.

Pasteurization: Pasteurization is a process of heat treatment of liquid food products. e.g. For preservation of milk and beverages. This process also involves boiling of milk to a temperature of 63°C for about 30 minutes and suddenly cooling to destroy the microbes present in the milk.

Bananas are best stored at room temperature. When it is kept in a refrigerator, the enzyme responsible for ripening becomes inactive. In addition, the enzyme responsible for browning and cell damage becomes more active thereby causing the skin colour change from yellow to dark brown

- Canning**:** In this method of food preservation, most vegetables, fruits, meat and dairy products, fruit juices and some ready-to-eat foods are processed and stored in a clean, steamed air tight containers under pressure and then sealed. It is then subjected to high temperature and cooled to destroy all microbes.

Addition of Preservatives

- Food can be preserved by adding natural and synthetic preservatives.

Natural preservatives

- Some naturally available materials like salt, sugar and oil are used as food preservatives.

- Addition **of salt:** It is one of the oldest methods of preserving food. Addition of salt removes the moisture content in the food by the process of osmosis. This prevents the growth of bacteria and reduces the activity of microbial enzymes. Meat, fish, gooseberry, lemon and raw mangoes are preserved by salting. Salt is also used as a preservative in pickles, canned foods etc.

- Addition **of sugar:** Sugar/Honey is added as a preservative to increase the shelf life of fruits and fruit products like jams, jellies, squash, etc. The hygroscopic nature of sugar/honey helps in reducing the water content of food and also minimizing the process of oxidation in fruits.

- **Addition of oil:** Addition of oil in pickles prevents the contact of air with food. Hence microorganisms cannot grow and spoil the food.

Synthetic preservatives

- Synthetic food preservatives like sodium benzoate, citric acid, vinegar, sodium meta bisulphate and potassium bisulphate are added to food products like sauces, jams, jellies, packed foods and ready- to- eat foods. These preservatives delay the microbial growth and keep the food safe for long duration.

Food Adulteration

- Adulteration is defined as the addition or subtraction of any substance to or from food, so that the natural composition and the quality of food substance is affected. Adulterant is any material which is used for the purpose of adulteration.

- Some of the common adulterated foods are milk and milk products, cereals, pulses, coffee powder, tea powder, turmeric powder, saffron, confectionary, non-alcoholic beverages, spices, edible oils, meat, poultry products etc. The adulterants in food can be classified in three categories:

- Natural adulterants
- Incidental/unintentionally added adulterants
- Intentionally added adulterants.

Natural adulterants

- Natural adulterants are those chemicals or organic compounds that are naturally present in food. e.g. toxic substances in certain poisonous mushrooms, Prussic acid in seeds of apples and cherry, marine toxins, fish oil poisoning, environmental contaminants.

Incidental/unintentionally added adulterants

- These types of adulterants are added unknowingly due to ignorance or carelessness during food handling and packaging. It includes:

- Pesticide residues
- Droppings of rodents, insects, rodent bites and larva in food during its storage
- Microbial contamination due to the presence of pathogens like Escherichia coli, Salmonella in fruits, vegetables, ready-to-eat meat and poultry products.

Intentionally added adulterants

- These adulterants are added intentionally for financial gain and have serious impact on the health of the consumers. These types of adulterants include:

- Additives and preservatives like vinegar, citric acid, sodium bicarbonate (baking soda), hydrogen peroxide in milk, modified food starch, food flavours, synthetic preservatives and artificial sweeteners.

- Chemicals like calcium carbide to ripen bananas and mangoes.

- Non certified food colours containing chemicals like metallic lead are used to give colours to vegetables like green leafy vegetables, bitter gourd, green peas etc. These colours are added to give a fresh look to the vegetables.

- Edible synthetic wax like shellac or carnauba wax is coated on fruits like apple, pear to give a shining appearance.

Health Effects of Adulterated Foods

- Consumption of these adulterated foods may lead to serious health effects like fever, diarrhoea, nausea, vomiting, gastrointestinal disorders, asthma, allergy, neurological disorder, skin allergies, immune suppression, kidney and liver failure, colon cancer and even birth defects.

Food Quality Control

- The government always ensures that pure and safe food is made available to the consumers. In 1954, the Indian Government enacted the Food Law known as Prevention of Food Adulteration Act and the Prevention of Food Adulteration Rules in 1955 with

the objective of ensuring pure and wholesome food to the consumers and protect them from fraudulent trade practices.

- Minimum standards of quality for food and strict hygienic conditions for its sale are clearly outlined in the Act

A slogan From farm to plate, make food safe was raised on World Health Day (7th April 2015) to promote and improve food safety.

Food Quality Control Agencies

- ISI, AGMARK, FPO, FCI and other health departments enforce minimum standards for the consumer products. FCI (Food Corporation of India) was set up in the year 1965 with the following objectives:

- Effective price support operations for safeguarding the interest of farmers.
- Distributing food grains throughout the country.
- Maintaining satisfactory levels of operational and buffer stock of food grains to ensure national security.
- Regulate the market price to provide food grains to consumers at reliable price.

10th Full Book

Unit 21 – Health & Disease

Introduction

- Abuses occur in a variety of forms and are deeply rooted in cultural, social and economic practices. Solving this global problem however requires a much better understanding of its occurrence, causes and consequences with context to sexual and childhood abuse, this is followed by substance abuse. Are people leading healthier lives in today's modern world than their generations did in the past? For instance, smoking cigarettes, alcohol addiction, use of drugs, eating high fat and cholesterol rich diets, excessive intake of junk foods, reduced physical activity are some of the risk factors for illness and early death. The role of behaviour in health has been receiving increased attention in countries around the world. The health habits of the individuals and their behaviour influence the development of chronic and fatal diseases such as diabetes, obesity, heart disease, cancer and AIDS. These conditions can be substantially reduced by adopting lifestyles that promote wellness and protect their health by taking nutritious diet, regular exercise and by avoiding drugs, alcohol and smoking.

Abuse and Types of Abuse

- Abuse refers to cruel, violent, harmful or injurious treatment of another human being. It includes physical, emotional or psychological, verbal, child and sexual abuses. Abuse can occur within the family and with people who are not associated with the family.

- These days the use of drugs, alcohol and tobacco has been increasing especially among teenagers and adolescents for adventure, excitement, curiosity and experimentation

Child Abuse

- Child abuse constitutes all forms of physical or emotional ill treatment, sexual abuse, exploitation resulting in child's ill health, survival and development. Physical abuse of a child is defined as those acts that cause physical harm such as threatening, beating, kicking and hitting the child.

Sexual Abuse

- Sexual harassment is a form of power and dominance of one person over another, which can result in harmful consequence tothe victim. It refers to inappropriate or forced sexual contact. Adolescent girls and women encounter sexual harassment in different forms. Sexual abuse is more common at work places. Verbal remarks, comments, gestures and looks are the most common forms of abuse. This results in psychological distress, physical illness and eating disorders in the affected individuals.

Child Sexual Abuse

- Children are considered soft targets for sexual abuse because they may not realize that they are being abused. Commonly, abusers are persons well known to the child, may

even be living in the same locality. Abusers also bribe (use chocolates and toys) to lure children and take advantage of the child's innocence.

- Sexually abused children show symptoms of genital injury, abdominal pain, frequent urinary infection and behavioural problems.

Approaches for Protection of an Abused Child

- Measures adopted for monitoring and assessment of abused child who have undergone signs and symptoms of distress are:

  - ✓ **Child Helpline:** The Child Helpline provides a social worker who can assist the child by providing food, shelter and protection.

  - ✓ **Counselling the child:** Psychologists and social workers should provide guidance, counselling and continous support to a victimized child.

  - ✓ **Family support:** The victimized child should be supported by the family members. They should be provided with proper care and attention to overcome their sufferings.

  - ✓ **Medical care:** A child victim of sexual offences should receive medical care and treatment from health care professionals to overcome mental stress and depression.

  - ✓ **Legal Counsel:**The family or the guardian of the child victim shall be entitled to free assistance of a legal counsel for such offence.

  - ✓ **Rehabilitation:** Enrolling in schools and resuming their education is an important step towards rehabilitation of the child. It is essential that the child's life is gradually returned to normal after the incidence of abuse.

  - ✓ **Community based efforts:** Conducting awareness campaign on child abuse and its prevention.

Prevention of child sexual abuse

- The most important social policy proclaimed universally is the prevention of child abuse. Taking steps to prevent childhood sexual abuse is parental and institutional responsibility. Instructions to be given by parents and teachers to the child are.

- ➢ Do not talk to any suspected person or strangers and to maintain a distance.

- ➢ Not to be alone with unknown person.

- ➢ To be careful while travelling alone in public or private transport.

- Not to receive money, toys, gift s or chocolates from known or unknown person to them without the knowledge of their parents.

- Not to allow known or unknown person to touch them.

- It is the responsibility of every individual living in a society to ensure a safe and protected environment for our children to enable them to live with dignity and free from any form of violence.

Drug, Alcohol and Tobacco Abuse

- The physical and mental dependency on alcohol, smoking and drugs is called addiction. The addictive potential of these substances pulls an individual into a vicious cycle leading to regular abuse and dependency. This is of serious concern because abuse of tobacco, alcohol or drugs produce many harmful effects in an individual, to the family and even to the society. This dangerous behavior pattern among youth can be prevented through proper guidance.

Drug Abuse

- Drugs are normally used for the treatment of disease on advice of a physician and withdrawn after recovery. A person who is habituated to a drug due to its prolonged use is called drug addict. This is called drug addiction or drug abuse.

- A drug that modifies the physical, biological, psychological or social behaviour of a person by stimulating, depressing or disturbing the functions of the body and the mind is called addictive drug. These drugs interact with the central nervous system and affect the individual physically and mentally.

Types of Drugs

- There are certain drugs called psychotropic drugs which acts on the brain and alter the behaviour, consciousness, power of thinking and perception. They are referred as mood altering drugs.

Drug Dependence

- Persons who consume these drugs become fully dependent on them, they cannot live without drugs. This condition is referred as drug dependence.
- **Physical and mental dependence**
- Dependence on the drug for normal condition of well being and to maintain physiological state.

- **Psychological dependence** is a feel that drugs help them to reduce stress.

- International Day against Drug Abuse and Illicit Trafficking - June 26.

- Narcotic Drugs and Psychotropic Substances Act was introduced in 1985.

Behavioural Changes of Drug Users

- Adverse effects of drug use among adolescents are

- Drop in academic performance, absence from school or college.

- Lack of interest in personal hygiene, isolation, depression, fatigue and aggressive behaviour.

- Deteriorating relationship with family and friends.

- Change in food and sleeping habits

- Fluctuation in body weight and appetite

- Always looking out for an easy way to get money for obtaining drugs.

- Prone to infections like AIDS and Hepatitis-B.

World Health Organization (WHO) 1984 suggested the use of the term drug dependence in place of drug addiction or drug abuse

Drug De-addiction

- Management of de-addiction is a complicated and difficult task. The path to recovery of drug addicts is long and often slow.

- Family members, friends and society on the whole have a very important role to play.

  - ✓ **Detoxification:** The first phase of treatment is detoxification. The drug is stopped gradually and the addict is helped to overcome the withdrawal symptoms. The addict undergoes severe physical and emotional disturbance. This is taken care by specific medication.

  - ✓ **Psychotherapy:** Individual and group counselling is given by psychologists and counsellors. The treatment includes efforts to reduce the addict's stress, taught new ways to solve everyday's problems, adequate diet, rest and relaxation.

  - ✓ **Counselling to family members:** Social workers counsell family members in order to change the attitude of rejection so that the addict is accepted by the family and the society.

- ✓ **Rehabilitation:** They are given proper vocational training so that they can lead a healthy life and become useful members of the society.

Tobacco Abuse

- Tobacco is obtained from the tobacco plant Nicotianatobaccum and Nicotianarustica. The dried and cured leaves of its young branches make the commercial tobacco used worldwide. Addiction to tobacco is due to 'nicotine' an alkaloid present in it. Nicotine is a stimulant, highly harmful and poisonous substance.

Tobacco Use

- Tobacco is used for smoking, chewing and snuffing. Inhaling tobacco smoke from cigars, cigarettes, bidis, pipes, hukka is called smoking. Tobacco in powder form is chewed with pan. When powdered tobacco is taken through nose, it is called snuffing.

Smoking Hazards and Effects of Tobacco

- When smoke is inhaled, the chemicals get absorbed by the tissues and cause the following harmful effects

- ➢ **Benzopyrene** and **polycyclic hydrocarbons** present in tobacco smoke is carcinogenic causing lung cancer.

- ➢ Causes inflammation of throat and bronchi leading to conditions like bronchitis and pulmonary tuberculosis.

- ➢ Inflammation of lung alveoli, decrease surface area for gas exchange and cause emphysema.
- ➢ Carbon monoxide of tobacco smoke binds to haemoglobin of RBC and decreases its oxygen carrying capacity causing hypoxia in body tissues.
- ➢ Increased blood pressure caused by smoking leads to increased risk of heart disease.
- ➢ Causes increased gastric secretion which leads to gastric and duodenal ulcers.
- ➢ Tobacco chewing causes oral cancer (mouth cancer).

Prevention of Smoking

- Knowing the dangers of smoking and chewing tobacco adolescents and the old people need to avoid these habits. Proper counselling and medical assistance can help an addict to give up the habit of smoking.

Alcohol Abuse

- The consumption of alcohol is a social evil practiced by the wealthier and poorer sections of the society. The dependence of alcohol is called alcoholism and the addict is termed as

alcoholic. It is called alcohol abuse. Drinking of alcohol impairs one's physical, physiological and psychological functions.

Harmful Effects of Alcohol to Health

- Prolonged use of alcohol depresses the nervous system, by acting as a sedative and analgesic substance. Some of the harmful effects are

➢ Nerve cell damage resulting in various mental and physical disturbances

➢ Lack of co-ordination of body organs

➢ Blurred or reduced vision, results in road accidents

➢ Dilation of blood vessels which may affect functioning of the heart

➢ Liver damage resulting in fatty liver which leads to cirrhosis and formation of fibrous tissues

➢ Body loses its control and consciousness eventually leading to health complications and ultimately to death.

Rehabilitation Measures for Alcoholics

✓ **Education and counselling:** Education and proper counselling will help the alcoholics to overcome their problems and stress, to accept failures in their life.

✓ **Physical activity:** Individuals undergoing rehabilitation should be channelized into healthy activities like reading, music, sports, yoga and meditation.

✓ **Seeking help from parents and peer groups:** When a problematic situation occurs, the affected individuals should seek help and guidance from parents and peers. This would help them to share their feeling of anxiety, wrong doing and get rid of the habit.

✓ **Medical assistance:** Individual should seek help from psychologists and psychiatrists to get relieved from this condition and to lead a relaxed and peaceful life.

- Alcohol de-addiction and rehabilitation programmes are helpful to the individual so that they could get rid of the problem completely and can lead a normal and healthy life.

Diseases and Disorders due to Lifestyle Modifications

- Diseases are prevalent in our society due to our improper way of living, conditions of stress and strain. These diseases are non-communicable and affect the person who are suffering from particular symptoms. It is an impairment of the body tissue or organ,

disturbances in metabolic function which require modification of an individual's normal life.

Diabetes Mellitus

- Diabetes mellitus is a chronic metabolic disorder. In Greek (Diabetes – running through; mellitus- sweet). It is characterised by increased blood glucose level due to insufficient, deficient or failure of insulin secretion. This is the most common pancreatic endocrine disorder. The incidence of Type-1 and Type-2 diabetes is increasing worldwide.

Type-1 Insulin Dependent Diabetes Mellitus (IDDM)

- IDDM accounts for 10 to 20% of the known diabetics. The condition also occurs in children (juvenile onset diabetes) and young adults, the onset is usually sudden and can be life threatening. This is caused by the destruction of β-cells of the pancreas. It is characterized by abnormally elevated blood glucose levels (hyperglycemia) resulting from inadequate insulin secretion.

Causes: Genetic inheritance and environmental factors (infections due to virus, acute stress) are the cause for this condition.

Type-2 Non-Insulin Dependent Diabetes Mellitus (NIDDM)

- This is also called as adult onset diabetes and accounting for 80 to 90% of the diabetic population. It develops slowly, usually milder and more stable. Insulin production by the pancreas is normal but its action is impaired. The target cells do not respond to insulin. It does not allow the movement of glucose into cells.

Causes: The causes are multifactorial which include increasing age (affecting middle aged and older people), obesity, sedentary life style, overeating and physically inactive.

Symptoms: Diabetes mellitus is associated with several metabolic alterations.The most important symptoms are

- Increased blood glucose level (Hyperglycemia)
- Increased urine output (Polyuria) leading to dehydration
- Loss of water leads to thirst (Polydipsia) resulting in increased fluid intake
- Excessive glucose excreted in urine (Glycosuria)
- Excess hunger (Polyphagia) due to loss of glucose in urine.
- Fatigue and loss of weight

According to WHO recommendation, if the fasting blood glucose is greater than 140 mg/dl

or the random blood glucose is greater than 200 mg /ml on more than two occasions, diagnosis for confirming diabetes is essential.

Prevention and Control of Diabetes

- Diet, hypoglycemic drugs, insulin injection and exercise are the management options based on the type and severity of the condition. The overall goal of diabetes management is to maintain normal blood glucose level.

Differences between Type-1 and Type-2 Diabetes Mellitus

Factors	Type-1 Insulin Dependent Diabetes Mellitus (IDDM)	Type-2 Non-Insulin Dependent Diabetes Mellitus (NIDDM)
Prevalence	10-20%	80 – 90%
Age of onset	Juvenile onset (<20 Years)	Maturity onset (> 30 Years)
Body Weight	Normal or underweight	obese
Defect	Insulin deficiency due to destruction of β – cells.	Target cells do respond to insulin
Treatment	Insulin administration is necessary	Can be controlled by diet, exercise and medicine

- ✓ **Dietary management:** Low carbohydrate and fibre rich diets are more appropriate. Carbohydrates should be taken in the form of starch and complex sugars. Refined sugars (sucrose and glucose) should be avoided. Diet comprising whole grains, millets (jowar, bajra, ragi), green leafy vegetables, wheat and unpolished rice should be included in diet regularly. Carbohydrates is maintained to about 50- 55% of the total calories. High protein content of 10-15% of the total intake is required to supply essential amino acids. Fat content in the diet should be 15-25% of the total calories. Saturated fat intake should be reduced. Polyunsaturated fatty acid content should be higher.

- ✓ **Management with insulin:** Commercially available insulin preparations (short and long acting) are also used to maintain blood glucose levels.

- ✓ **Physical activity:** Exercise plays an important role in facilitating a good control of diabetes, in addition to strengthening and toning up the muscles.

- ✓ **Education and Awareness:** People with diabetics should be educated on the nature of disease they have and the possibility of complications of the disease, if blood sugar is not kept under control. Instructions regarding diet, exercise and drugs should be explained.

Obesity

- Obesity is the state in which there is an accumulation of excess body fat with an abnormal increase in body weight. Obesity is a complex multifactorial chronic disease

developing from influence of social, behavioural, psychological, metabolic and cellular factors.

- Obesity occurs if intake of calories is more than the expenditure of energy. Over weight and obesity are conditions where the body weight is greater than the mean standard weight for age and height of an individual. Body mass index (BMI) is an estimate of body fat and health risk.

$$\textbf{BMI = Weight (kg) / Height (m)}^{2.}$$

Causes and risk factors: Obesity is due to genetic factors, physical inactivity, eating habits (overeating) and endocrine factors. Obesity is a positive risk factor in development of hypertension, diabetes, gall bladder disease, coronary heart disease and arthritis.

Prevention and Control of Obesity

- **Diet Management:** Low calorie, normal protein, vitamins and mineral, restricted carbohydrate and fat, high fiber diet can prevent overweight. Calorie restriction for weight reduction is safe and most effective.

- **Physical exercise:** A low calorie diet accompanied by moderate exercise will be effective in causing weight loss. Meditation, yoga and physical activity can also reduce stress related to overeating.

Heart Disease

- Cardiovascular disease (CVD) is associated with diseases of the heart and blood vessels. Coronary heart disease (CHD) is the most common form and is caused by deposition of cholesterol in the blood vessels.

- It usually develops slowly over many years beginning from childhood, they may form a fatty streak to a fibrous complicated plaque. It leads to the narrowing of blood vessels leading to atherosclerosis in the large and medium sized arteries that supply the heart muscle with oxygen. It leads to sudden ischemia (deficient blood supply to heart muscle) and myocardial infarction (death of the heart muscle tissue).

- **Risk factors:** Hypercholesterolemia (High blood cholesterol) and high blood pressure (Hypertension) are the major causes and contributing factors for heart disease and if untreated may cause severe damage to brain, kidney and eventually lead to stroke.

- **Causes:** Heredity (family history), diet rich in saturated fat and cholesterol, obesity, increasing age, cigarette smoking, emotional stress, sedentary lifestyle, excessive alcohol consumption and physical inactivity are some of the causes.

- **Symptoms:** Shortness of breath, headache, tiredness, dizziness, chest pain, swelling of leg, and gastrointestinal disturbances.

HDL (High Density Lipoprotein) or "good" cholesterol lowers risk of heart disease while LDL (Low Density Lipoprotein) or "bad" cholesterol increases risk of heart disease.

Prevention and Control of Heart Disease

- **Diet management:** Reduction in the intake of calories, low saturated fat and cholesterol rich food, low carbohydrates and common salt are some of the dietary modifications. Diet rich in polyunsaturated fatty acids (PUFA) is essential. Increase in the intake of fibre diet, fruits and vegetables, protein, minerals and vitamin are required.

- **Physical activity:** Regular exercise, walking and yoga are essential for body weight maintenance

- **Addictive substance avoidance:** Alcohol consumption and smoking are to be avoided.

Cancer

- Cancer causes about 4 million deaths annually throughout the world. In India more than one million people suffer from cancer. Cancer is derived from Latin word meaning crab. The study of cancer is called Oncology (Oncos- Tumor).

- Cancer is an abnormal and uncontrolled division of cells that invade and destroy surrounding tissue forming a tumor or neoplasm (new growth). It is a heterogenous group of cells that do not respond to the normal cell division.

- The cancerous cells migrate to distant parts of the body and affect new tissues. This process is called metastasis. The frequent sites of metastasis are lungs, bones, liver, skin and brain.

Types of Cancers

- Cancers are classified on the basis of the tissues from which they are formed.

➢ Carcinomas arise from epithelial and glandular tissues. They include cancers of skin, lung, stomach and brain. About 85% of the tumours are carcinomas

➢ Sarcomas are occur in the connective and muscular tissue. They include the cancer of bones, cartilage, tendons, adipose tissue and muscles. These form 1% of all tumours.

➢ Leukaemia are characterized by an increase in the formation of white blood cells in the bone marrow and lymph nodes. Leukaemia are called blood cancers. Most common type of cancer which also affect children below 15 years of age.

Carcinogenic Agents

- Cancer causing agents are called carcinogens. They are physical, chemical agents, ionizing radiations and biological agents.

- ✓ **Physical Irritant:** Heavy smoking causes lung cancer and cancers of oral cavity, pharynx (throat) and larynx. Betel and tobacco chewing causes oral cancer. Excessive exposure to sunlight may cause skin cancer.

- ✓ **Chemical agents:** Nicotine, caffeine, products of combustion of coal and oil, pesticides, asbestos, nickel, certain dyes and artificial sweetners induce cancer

- ✓ **Radiations:** Ionizing radiations like X-rays, gamma- rays, radioactive substances and non-ionising radiations like UV rays cause DNA damage leading to cancer.

- ✓ **Biological agents:** Cancer causing viruses are called oncogenic viruses.

Treatment of Cancer

The treatment of cancer involves the following methods:

- **Surgery:** Tumours are removed by surgery to prevent further spread of cancer cells.

- **Radiation therapy:** Tumour cells are irradiated by lethal doses of radiation while protecting the surrounding normal cells.

- **Chemotherapy:** It involves administration of anticancerous drugs which prevent cell division and are used to kill cancer cells.

- **Immunotherapy:** Biological response modifiers like interferons are used to activate the immune system and help in destroying the tumors.

Preventive measures for Cancer

- Cancer control programmes should focus on primary prevention and early detection.

- To prevent lung cancer tobacco smoking is to be avoided and protective measures to be taken against exposure to toxic pollutants of industries. Excessive exposure to radiation is to be avoided to prevent skin cancer.

AIDS (Acquired Immunedeficiency Syndrome)

- AIDS is a severe viral disease and caused by Human Immunodeficiency Virus (HIV). It is a condition in which immune system fails and suppress the body's disease fighting mechanism. They attack the lymphocytes and the affected individual is prone to infectious diseases.

Dr.Suniti Solomon, pioneered HIV research and treatment in India. She set up the first voluntary testing and counselling centre and an AIDS Research group in Chennai during

80's. Her team was the first to document evidence of HIV infection in India in 1985 (First Indian AIDS patient in Chennai).

Transmission of HIV

- AIDS virus has been found in urine, tears, saliva, breast milk and vaginal secretions. The virus is transmitted by an infected patient who comes in contact with blood of a healthy person. HIV/AIDS is not transmitted by touch or any physical contact. It spreads through contact of body fluids or blood.

HIV is transmitted generally by

- Sexual contact with infected person
- Use of contaminated needles or syringes especially in case of intravenous drug abusers
- By transfusion of contaminated / infected blood or blood products
- From infected mother to her child through placenta.

Symptoms and Treatment of AIDS

Symptoms: Infected individuals become immunodeficient. The person becomes more susceptible to viral, bacterial, protozoan and fungal infections. Swelling of lymph nodes, damage to brain, loss of memory, lack of appetite and weight loss, fever, chronic diarrhoea, cough, lethargy, pharyngitis, nausea and headache.

Diagnosis: The presence of HIV virus can be confirmed by Western Blot analysis or Enzyme Linked Immunosorbent Assay (ELISA)

Treatment: Anti-retroviral drugs and immunestimulative therapy can prolong the life of the infected person.

Prevention and Control of AIDS

- The following steps may help in controlling and prevent the spreading of HIV infection

- Screening of blood from blood banks for HIV before transfusion.
- Ensuring the use of disposable needles and syringes in hospitals and clinics.
- Advocating safe sex and advantages of using condoms.
- Creating awareness campaign and educating people on the consequences of AIDS.
- Persons with HIV/AIDS should not be isolated from the family and society.

11th Zoology

Chapter 5 – Digestion and Absorption

Nutrients, Vitamins and Minerals

- Food comprises of macronutrients and micronutrients. The nutrients required inlarger quantities are called macronutrients, whereas those required in small quantities are called micronutrients. Essential nutrients cannot be synthesized by the body; they have to be included in the diet. Macronutrients are lipids, carbohydrates, proteins and the micronutrients are vitamins and minerals. Water plays an important role in the metabolic processes and prevents dehydration of the body.

- Intake of too much of food or lesser amount of food than the basic requirement is called malnutrition. A diet which can provide all the metabolic requirements ofthe body in a right proportion is called balanced diet. That means it shouldcontain carbohydrates and fats for energy yielding, proteins for growth and replacement; and vitamins, minerals and water for physiological regulation.

Vitamins:

- Vitamins are naturally occurring organic substances regularly needed in minutequantities for maintaining normal health as metabolic regulators. The identified vitamins are classified as fat soluble (A,D,E and K) and vitamin B and vitamin C are water soluble. Vitamin A, D, E and K, if consumed beyond required level may cause defects, commonly referred to as hypervitaminosis.

Minerals:

- These are the inorganic chemical elements, i.e., Ca, Fe, I, K, Mg, Na, P, S, etc needed for regulation of various physiological functions. These can be classified into major minerals (Na, P, K, Ca, Mg, S, Cl) and others are trace minerals such as Fe,Cu, Zn, Co, Mn, I, and fluorine. Sodium ions are more abundant than any other cation in the body fluids.

N.I. Lunin discovered vitamins but the name vitamin was given by Dr. Funk (1912).The first vitamin isolated was B1 by Dr.Funk. The first vitamin produced by fermentation process using, Acetobacter bacteria is Vitamin C.

Fat soluble vitamins		
Vitamins	**Functions**	**Symptoms of Deficiency**
A (Retinol)/ Antixerophthalmic vitamin	Plays a vital role in visual perception. Maintenance and growth of epithelial tissue.	Night blindness (Nyctalopia), Xerophthalmia (drying of eyeballs), Bitot's spot in the cornea,

		Dermatosis(dry and scaly skin) and Keratomalacia Atrophy of lacrymal glands and reduction in tear secretion
D (Calciferol)/ Antirachiticvitamin	Promotes intestinal absorption of calcium and phosphorus. Formation of teeth and bones	Rickets in children (softness and deformities of bones and bow legs and pigeon chest) and Osteomalacia in adults (weak and fragile bones, bent, deformed pelvis).
E (Tocopherol) / Antisterility vitamin	Antioxidant It keeps the skin healthy by reduces the process of ageing	Sterility in animals, Ruptured red blood cells
K Anti haemorrahagic vitamin.	1. Required for the synthesis of prothrombin in the liver.	Defect in blood clotting called Haemorrhagic manifestations.

Water Soluble Vitamins

Vitamins	**Functions**	**Symptoms of Deficiency**
B1 (Thiamine)	Involved in carbohydrate metabolism. Act as a coenzyme	**Beriberi:**affects muscular, nervous and cardiovascular system
B2 (Riboflavin)	Acts as coenzyme in oxidation and reduction reactions	Inflammation, soreness and fissures in the corners of the mouth, lips and tongue. Loss of appetite. Skin and eye disorder
B3 (Pantothenic acid)	Acts as coenzyme A and is essential for the metabolism of fats and carbohydrates	Gastrointestinal disorders, anaemia, Burning feet syndrome, etc.
B4 (choline)	Precursor for acetylcholine	Fatty liver
B5 (Niacin / Nicotinic acid)	Derivatives of coenzymes	Pellagra (4D Syndrome) characterized by dermatitis, diarrhoea and dementia (mental deterioration) and death.
B6 (Pyridoxine)	Haemoglobin formation, brain, heart and liver activities	Dermatitis, convulsions, muscular twitching and anaemia
B7 (Biotin) / Vit.H	Acts as a coenzyme in synthesis of fat, glycogen	Dermatitis

	and amino acids	
B9 (Folic acid)	It acts as a co-enzyme for synthesis of nucleic acid and essential for growth and formation of RBC	Megaloblastic anaemia (large, immature, nucleated RBC in blood)
B12 (Cobalamine)	Promotes DNA synthesis. Necessary for maturation of RBC and formation of myelin sheath.	Pernicious anaemia (immature nucleated RBC without haemoglobin). Causes nervous disorder
C (Ascorbic acid)	Acts as an antioxidant. Strengthens the immune system. Necessary for healthy gums and teeth.	Scurvy (Sailor's disease) characterized by spongy and bleeding gums, falling of teeth, fragile bones, delayed wound healing etc. - Infantile scurvy)

Food adulterants cause harmful effects in the form of headaches, palpitations, allergies, cancers and in addition reduces the quality of food. Common adulterants are addition of citric acid to lemon juice, papaya seeds to pepper, melamine to milk, vanillin for natural vanillin, red dyes to chillis, lead
chromate and lead tetraoxide to turmeric powder, etc.,

Caloric value of carbohydrates, proteins and fats

- We obtain 50% energy from carbohydrates 35% from fats and 15% from proteins. We require about 400 to 500 gm of carbohydrates, 60 to 70 gm of fats and 65 to 75 gm of proteins per day. Balanced diet of each individual will vary according to their age, gender, level of physical activity and others conditions such as pregnancy and lactation.

- Carbohydrates are sugar and starch. These are the major source of cellular fuel which provides energy. The caloric value of carbohydrate is 4.1 calories per gram and its physiological fuel value is 4 Kcal per gram.

- Lipids are fats and derivatives of fats, are also the best reserved food stored in our body which is used for production of energy. Fat has a caloric value of 9.45 Kcaland a physiological fuel value of 9 Kcal per gram.

Many research findings have proven that usage of chemical preservatives and artificial enhancers lead to highly harmful effects. It includes heart ailments, hypertension, infertility, gastrointestinal disorders, early puberty in girls, weakening of bones, damage in organs like kidney and liver, chronic obstructive pulmonary diseases, headache, allergies, asthma, skin rashes and even cancer. Remember that nothing will beat and overtake the taste and safety of homemade foods. "East or west home preparation is the best."

- Proteins are source of amino acids required for growth and repair of bodycells. They are stored in the body only to a certain extent; large quantities are excreted as nitrogenous waste. The caloric value and physiological fuel value of one gram of protein are 5.65 Kcal and 4 Kcal respectively. According to ICMR (Indian Council of Medical Research and WHO (World Health Organization), the daily requirement of protein for an average Indian is 1gm per 1 kg body weight.

Nutritional and digestive disorders

- Intestinal tract is more prone to bacterial, viral and parasitic worm infections. Thisinfection may cause inflammation of the inner lining of colon called colitis. The most common symptoms of colitis are rectal bleeding, abdominal cramps, and diarrhoea.

Protein energy malnutrition: (PEM)

- Growing children require more amount of protein for their growth and development.Protein deficient diet during early stage of children may lead to protein energy malnutrition such as Marasmus and Kwashiorkor. Symptoms are dry skin, pot-belly, oedema in the legs and face, stunted growth, changes in hair colour, weakness and irritability. Marasmus is an acute form of protein malnutrition. This condition is due to a diet with inadequate carbohydrate and protein. Such children are suffer from diarrhoea, body becomes lean and weak (emaciated) with reduced fat and muscle tissue with thin and folded skin.

- **Indigestion:** It is a digestive disorder in which the food is not properly digestedleading to a feeling of fullness of stomach. It may be due to inadequate enzyme secretion, anxiety, food poisoning, over eating, and spicy food.

- **Constipation:** In this condition, the faeces are retained within the rectum because of irregular bowel movement due to poor intake of fibre in the diet and lack of physical activities.

- **Vomiting:** It is reverse peristalsis. Harmful substances and contaminated food from stomach are ejected through the mouth. This action is controlled by the vomit centre located in the medulla oblongata. A feeling of nausea precedes vomiting.

- **Jaundice:** It is the condition in which liver is affected and the defective liver fails to break down haemoglobin and to remove bile pigments from the blood. Deposition of these pigments changes the colour of eye and skin yellow. Sometimes, jaundice is caused due to hepatitis viral infections.

- **Liver cirrhosis:** Chronic disease of liver results in degeneration and destruction of liver cells resulting in abnormal blood vessel and bile duct leading to the formation of fibrosis. It is also called deserted liver or scarred liver. It is caused due to infection, consumption of poison, malnutrition and alcoholism.

- **Gall Stones:** Any alteration in the composition of the bile can cause theformation of stones in the gall bladder. The stones are mostly formed of crystallized cholesterol in the bile. The gall stone causes obstruction in the cystic duct, hepatic duct and also hepato-pancreatic duct causing pain, jaundice and pancreatitis.

Appendicitis: It is the inflammation of the vermiform appendix, leading to severe abdominal pain. The treatment involves the removal of appendix by surgery. If treatment is delayed the appendix may rupture and results in infection of the abdomen, called peritonitis.

Hiatus hernia (Diaphragmatic hernia): It is a structural abnormality in which superior part of the stomach protrudes slightly above the diaphragm. The exact cause of hiatus hernias is not known. In some people, injury or other damage may weaken muscle tissue, by applying too much pressure (repeatedly) on the muscles around the stomach while coughing, vomiting, and straining during bowel movement and lifting heavy object. Heart burn is also common in those with a hiatus hernia. In this condition, stomach contents travel back into the oesophagus or even into oral cavity and causes pain in the centre of the chest due to the eroding natureof acidity.

Diarrhoea: It is the most common gastrointestinal disorder worldwide. It is sometimes caused by bacteria or viral infections through food or water. When the colon is infected, the lining of the intestine is damaged by the pathogens, thereby the colon is unable to absorb fluid. The abnormal frequency of bowel movement and increased liquidity of the faecal discharge is known as diarrhoea. Unless the condition is treated, dehydration can occur. Treatment is known as oral hydration therapy. This involves drinking plenty of fluids – sipping small amounts of water at a time to rehydrate the body.

Peptic ulcer: It refers to an eroded area of the tissue lining (mucosa) in the stomachor duodenum. Duodenal ulcer occurs in people in the age group of 25 - 45 years. Gastric ulcer is more common in persons above the age of 50 years. Ulcer is mostly due to infections caused by the bacterium Helicobacter pylori. It may also be caused due to uncontrolled usage of aspirin or certain antiinflammatory drugs. Ulcermay also be caused due to smoking, alcohol, caffeine and psychological stress.

Obesity: It is caused due to the storage of excess of body fat in adipose tissue. It may induce hypertension, atherosclerotic heart disease and diabetes. Obesity may be genetic or due to excess intake of food, endocrine and metabolic disorders. Degree of obesity is assessed by body mass index (BMI). A normal BMI range for adult is 19- 25; above 25 is considered as obese. BMI is calculated as body weight in Kg, divided by the square of body height in meters. For example, a 50 Kg person with a height of 160 cms would have a BMI of 19.5.
That is BMI = 50/1.62 = 19.5

Nobel Prize for the year 2005 was awarded to Robin Warren and Barry Marshall for the discovery of Helicobacter pylori which causes peptic ulcer

12th Zoology

Unit 7 – Human Health and Diseases

Common diseases in human beings

- Disease can be defined as a disorder or malfunction of the mind or body. It involves morphological, physiological and psychological disturbances which may be due to environmental factors or pathogens or genetic anomalies or life style changes. Diseases can be broadly grouped into infectious and non infectious types. Diseases which are transmitted from one person to another are called infectious diseases or communicable diseases. Such disease causing organisms are called pathogens and are transmitted through air, water, food, physical contact and vectors. The disease causing pathogen may be virus, bacteria, fungi, protozoan parasites, helminthic parasites, etc., Infectious diseases are common and everyone suffers from such diseases at some time or the other. Most of the bacterial diseases are curable but all viral diseases are not. Some infectious disease like AIDS may be fatal.

- Non-infectious diseases are not transmitted from an infected person to a healthy person. In origin they may be genetic (cystic fibrosis), nutritional (vitamin deficiency diseases) and degenerative (arthritis, heart attack, stroke). Among non - infectious diseases, cancer is one of the major causes of death.

Bacterial and viral diseases Bacterial diseases

- Though the number of bacterial species is very high, only a few bacteria are associated with human diseases and are called pathogenic bacteria. Such pathogens may emit toxins and affected the body.

- Bacteria spread through air, water or by inhaling the droplets/aerosols or even by sharing utensils, dresses with an infected person. Typhoid fever can be confirmed by Widal test

Viral diseases

- Viruses are the smallest intracellular obligate parasites, which multiply within living cells. Outside the living cells they cannot carry out the characteristics of a living organism. Viruses invade living cells, forcing the cells to create new viruses. The new viruses break out of the cell, killing it and invade other cells in the body, causing diseases in human beings. Rhino viruses cause one of the most infectious human ailment called the “Common cold”.

- Viral diseases are generally grouped into four types on the basis of the symptoms produced in the body organs.

- Pneumotropic diseases (respiratory tract infected by influenza)
- Dermotropic diseases (skin and subcutaneous tissues affected by chicken pox and measles)
- Viscerotropic diseases (blood and visceral organs affected by yellow fever and dengue fever)
- Neurotropic diseases (central nervous system affected by rabies and polio).

Bacterial resistance

If an antibiotic is used too often to fight a specific bacterial infection, the bacteria may become resistant to the specific antibiotic. Hence the specific antibiotic can no longer be used to treat the bacterial infection. Some bacteria have developed resistance to many antibiotics. Therefore, infections caused by these bacteria are difficult to be cured.

Risk of bacterial resistance can be reduced by observing the following steps

- Avoid using antibiotics to treat minor infections that can be taken care by our immune system.
- Do not use an antibiotic to treat viral infections such as common cold or flu.
- Always follow the prescription. Skipping doses or failing to complete the prescription may allow antibiotic resistance to develop.

Bacterial diseases in human beings

S.No	Diseases	Causative agent	Site of infection	Mode of transmission	Symptoms
1	Shigellosis (Bacillary dysentery)	Shigella sp.	Intestine	Food and Water contaminated by faeces/ faecal oral route	Abdominal pain, dehydration, blood and mucus in the stools
2	Bubonic plague (Black death)	Yersinia pestis	Lymph nodes	Rat flea vector – Xenopsyllache opis	Fever, headache, and swollen lymph nodes.
3	Diphtheria	Corynebacterim diphtheriae	Larynx, skin, nasal and genital passage	Droplet infection	Fever, Sore throat, hoarseness and difficulty in breathing
4	Cholera	Vibrio cholerae	Intestine	Contaminated food and water/ faecal oral route	Severe diarrhoea and dehydration.
5	Tetanus (Lock	Clostridium tetani	Spasm of	Through	Rigidity of

	Jaw)		muscles	wound infection	jaw muscle, increased heart beat rate and spasm of the muscles of the jaw and face.
6	Typhoid(Enteric fever)	Salmonella typhi	Intestine	Through contaminated food and water	Headache, abdominal discomfort, fever and diarrhoea.
7	Pneumonia	Streptococcus pneumoniae	Lungs	Droplet infection	Fever, cough, Painful breathing and brown sputum
8	Tuberculosis	Mycobacterium tuberculosis	Lungs	Droplet infection	Thick mucopurulant nasal discharge.

Viral diseases in human beings

S.No	Diseases	Causative Agent	Site of infection	Mode of transmission	Symptoms
1	Common Cold	Rhino Viruses	Respiratory tract	Droplet infection	Nasal congestion and discharge, sore throat, cough and headache.
2	Mumps	Mumps virus (RNA virus) Paramyxo virus	Salivary glands	Saliva and droplet infection	Enlargement of the parotid glands.
3	Measles	Rubella virus (RNA virus), Paramyxo virus	Skin and respiratory	Droplet infection	Sore throat, running nose, cough and fever. Reddish rashes on the skin, neck and ears.
4	Viral hepatitis	Hepatitis – B Virus	Liver	Parenterak route, blood transfusion	Liver damage, jaundice, nausea, Yellowish eyes,

					fever and pain in the abdomen
5	Chicken pox	Varicella Zoster virus (DNA Virus)	Respiratory tract, skin and nervous system	Droplet infection and direct contact	Mild fever with itchy skin, rash and blisters
6	Poliomyelitis	Polio virus (RNA virus)	Intestine, brain, spinal cord	Droplet infection through faecal oral route	Fever, muscular stiffness and weakness, paralysis and respiratory failure
7	Dengue fever (Break bone fever)	Dengue virus or flavi virus (DENV 1-4 virus)	Skin and blood	Mosquito vector Aedesaegypti	Severe flu like illness with a sudden onset of fever and painful headache, muscle and joint pain.
8	Chikungunya	Alpha virus (Toga virus)	Nervous system	Mosquito vector Aedesaegypti	Fever and joint pain, headache and joint swelling

Nipah virus is a zoonotic virus (transmitted from animals to humans) and also transmitted through contaminated food. In infected people, it causes a range of illness from asymptomatic infection to acute respiratory illness and fatal encephalitis.

Swine flu was first recognised in the 1919 pandemic and still circulates as a seasonal flu virus. Swine flu is caused by the H1N1 virus strain. Symptoms include fever, cough, sore throat, chills, weakness and body aches. Children, pregnant women and the elderly are at risk from severe infection

Protozoan diseases

- About 15 genera of protozoans live as parasites within the human body and cause diseases. Amoebiasis also called amoebic dysentery or amoebic colitis is caused by Entamoebahistolytica, which lives in the human large intestine and feeds on food particles and bacteria. Infective stage of this parasite is the trophozoite, which penetrates the walls of the host intestine (colon) and secretes histolytic enzymes causing ulceration, bleeding, abdominal pain and stools with excess mucus. Symptoms of amoebiasis can range from diarrhoea to dysentery with blood and mucus in the stool. House flies (Muscadomestica) acts as a carrier for transmitting the parasite from contaminated faeces and water.

- African sleeping sickness is caused by Trypanosoma species. Trypanosoma is generally transmitted by the blood sucking Tsetse flies. Three species of Trypanosoma cause sleeping sickness in man.

  - T. gambiense is transmitted by Glossinapalpalis (Tsetse fly) and causes Gambian or Central African sleeping sickness.

  - T. rhodesiense is transmitted by Glossinamorsitans causing Rhodesian or East African sleeping sickness.

  - T. cruzi is transmitted by a bug called Triatomamegista and causes Chagas disease or American trypanosomiasis.

- Kala – azar or visceral leishmaniasis is caused by Leishmaniadonovani, which is transmitted by the vector Phlebotomus (sand fly). Infection may occur in the endothelial cells, bone marrow, liver, lymph glands and blood vessels of the spleen. Symptoms of Kala azar are weight loss, anaemia, fever, enlargement of spleen and liver.

- Malaria is caused by different types of Plasmodium species such as P. vivax, P. ovale, P. malariae and P. falciparum . Plasmodium lives in the RBC of human in its mature condition it is called as trophozoite. It is transmited from one person to another by the bite of the infected female Anopheles mosquito.

Life cycle of Plasmodium

- Plasmodium vivax is a digenic parasite, involving two hosts, man as the secondary host and female Anopheles mosquito as the primary host. The life cycle of Plasmodium involves three phases namely schizogony, gamogony and sporogony

- The parasite first enters the human blood stream through the bite of an infected female Anopheles mosquito. As it feeds, the mosquito injects the saliva containing the sporozoites. The sporozoite within the blood stream immediately enters the hepatic cells of the liver. Further in the liver they undergo multiple asexual fission (schizogony) and produce merozoites. Afterbeing released from liver cells, the merozoites penetrate the RBC's.

- Inside the RBC, the merozoite begins to develop as unicellular trophozoites. The trophozoite grows in size and a central vacuole develops pushing them to one side of cytoplasm and becomes the signet ring stage. The trophozoite nucleus then divides asexually to produce the schizont. The large schizont shows yellowish - brown pigmented granules called Schuffners granules. The schizont divides and produces mononucleatedmerozoites. Eventually the erythrocyte lyses, releasing the merozoites and haemozoin toxin into the blood stream to infect other erythrocytes. Lysis of red blood cells results in cycles of fever and other symptoms. This erythrocytic stage is cyclic and repeats itself approximately every 48 to 72 hours or longer depending on the species of Plasmodium involved. The sudden release of merozoites triggers an attack on the

RBCs. Occasionally,merozoites differentiate into macrogametocytes and microgametocytes. When these are ingested by a mosquito, they develop into male and female gametes respectively.

- In the mosquito's gut, the infected erythrocytes lyse and male and female gametes fertilize to form a diploid zygote called ookinete. The ookinete migrates to the mosquito's gut wall and develop into an oocyte. The oocyte undergoes meiosis by a process called sporogony to form sporozoites. These sporozoites migrate to the salivary glands of the mosquito. The cycle is now completed and when the mosquito bites another human host, the sporozoites are injected and the cycle begins a new.

- The pathological changes caused by malaria, affects not only the erythrocytes but also the spleen and other visceral organs. Incubation period of malaria is about 12 days. The early symptoms of malaria are headache, nausea and muscular pain. The classic symptoms first develop with the synchronized release of merozoites, haemozoin toxin and erythrocyte debris into the blood stream resulting in malarial paroxysms – shivering chills, high fever followed by sweating. Fever and chills are caused partly by malarial toxins that induce macrophages to release tumour necrosis factor (TNF-α) and interleukin.

Types of malaria

S.No	Types of Malaria	Causative agent	Duration of Erythrocytic Cycle.
1	Tertian, benign tertian or vivax malaria	P. Vivax	48 hours
2	Quartan malaria	P. malariae	72 hours
3	Mild tertian malaria	P. ovale	48 hours
4	Malignant tertian or quotidian malaria	P. falciparum	36-48 hours

- Ponds, drainage ditches and other permanent bodies of water can be stocked with fishes such as Gambusia which feed on mosquito larvae. Preparations containing Bacillus thuringiensis can be sprayed to kill the mosquito larvae since it is not toxic to other forms of life. The best protection against malaria is to avoid being bitten by mosquito. People are advised to use mosquito nets, wire gauging of windows and doors to prevent mosquito bites.

- In the 1950's the World Health Organisation (WHO) introduced the Malaria eradication programme. This programme was not successful due to the resistance of Plasmodium to the drugs used to treat it and resistance of mosquito's to DDT and other insecticides.

Malaria vaccine is used to prevent malaria. The only approved vaccine as of 2015 is RTS,S(Mosquirix). It requires four injections and has relatively low efficacy (26–50%). Due to this low efficacy, WHO does not recommend the use of RTS,S vaccine in babies between 6 and 12 weeks of age.

Fungal diseases

- Fungi was recognized as a causative agent of human diseases much earlier than bacteria. Dermatomycosis is a cutaneous infection caused by fungi belonging to the genera Trichophyton, Microsporum and Epidermophyton.

- Ringworm is one of the most common fungal disease in humans. Appearance of dry, scaly lesions on the skin, nails and scalp are the main symptoms of the disease. Heat and moisture help these fungito grow and makes them to thrive in skin folds such as those in the groin or between the toes. Ringworms of the feet is known as Athlete's foot caused by Tineapedis. Ringworms are generally acquired from soil or by using clothes, towels and comb used by infected persons.

Helminthic diseases

- Helminthes are mostly endoparasitic in the gut and blood of human beings and cause diseases called helminthiasis. The two most prevalent helminthic diseases are Ascariasis and Filariasis.

- Ascaris is a monogenic parasite and exhibits sexual dimorphism. Ascariasis is a disease caused by the intestinal endoparasiteAscarislumbricoides commonly called the round worms. It is transmitted through ingestion of embryonated eggs through contaminated food and water. Children playing in contaminated soils are also prone to have a chance of transfer of eggs from hand to mouth. The symptoms of the disease are abdominal pain, vomiting, headache, anaemia, irritability and diarrhoea. A heavy infection can cause nutritional deficiency and severe abdominal pain and causes stunted growth in children. It may also cause enteritis, hepatitis and bronchitis.

- Filariasis is caused by Wuchereriabancrofti, commonly called filarial worm. It is found in the lymph vessels and lymph nodes of man. Wuchereriabancrofti is sexually dimorphic, viviparous and digenic. The life cycle is completed in two hosts, man and the female Culexmosquito The female filarial worm gives rise to juveniles called microfilariae larvae. In the lymph glands, the juveniles develop into adults. The accumulation of the worms block the lymphatic system resulting in inflammation of the lymph nodes.

- In some cases, the obstruction of lymph vessels causes elephantiasis or fi lariasis of the limbs, scrotum and mammary glands

Maintenance of personal and public hygiene

- Hygiene is a set of practices performed to conserve good health. According to the World Health Organization (WHO), hygiene refers to "conditions and practices that help to maintain health and prevent the spread of diseases." Personal hygiene refers to maintaining one's body clean by bathing, washing hands, trimming fingernails, wearing

clean clothes and also includes attention to keeping surfaces in the home and workplace, including toilets, bathroom facilities, clean and pathogen-free.

- Our public places teem with infection, contamination and germs. It seems that every surface we touch and the air we breathe are with pollutants and microbes. It's not just the public places that are unclean, but we might be amazed at the number of people who do not wash their hands before taking food, after visiting the restroom, or who sneeze without covering their faces. Many infectious diseases such as typhoid, amoebiasis and ascariasis are transmitted through contaminated food and water.

- Advancement in science and technology provide effective controlling measures for many infectious and non-infectious diseases. The use of vaccines and adopted immunization programmes have helped to eradicate small pox in India. Moreover a large number of infectious diseases like polio, diphtheria, pneumonia and tetanus have been controlled by the use of vaccines and by creating awareness among the people.

Adolescence – drug and alcohol abuse

- Adolescence begins with a period of rapid physical and sexual development called puberty to maturity at 12 to 19 years of age. Adolescence is also a highly dynamic period of psychologicaland social changes in individuals. Adolescents are vulnerable to group (peer) pressure and many youngsters are pushed into experimenting with drugs and alcohol. Proper education and guidance would enable youth to say no to drugs and alcohol and to follow a healthy life style.

- Alcohol is a psychoactive drug, which acts on the brain, affecting a person's mind and behaviour. It is a depressant, which slows down the activity of the nervous system. The intake of certain drugs for a purpose other than their normal clinical use in an amount and frequency that impair one's physical, physiological and psychological functions is called drug abuse.

- The drugs which are commonly abused include opioids, cannabinoids, coca-alkaloids, barbiturates, amphetamines and LSD.

- Opioids are drugs which bind to specific opioid receptors present in the central nervous system and intestinal tract. Heroin (smack) is chemically diacetyl morphine, which is white, odourless and bitter crystallinecompound. It is obtained by acetylation of morphine, which is extracted from flowers of the poppy plant. Morphine is one of the strongest pain killer and is used during surgery. It is the most widely abused narcotic drug which acts as a depressant and slows down body functions.

- Cannobinoids are a group of chemicals obtained from Cannabis sativa, the Indian hemp plant. Natural cannabinoids are the main source of marijuana, ganja, hashish and charas. It interferes in the transport of the neurotransmitter, dopamine and has a potent stimulating action on the CNS, producing increased energy and a sense of euphoria.

- Cocaine is a white powder that is obtained from the leaves of the coca plant, Erythroxylum coca. It is commonly called coke or crack. Cocaine causes serious physical and psychological problems including hallucinations and paranoia. The other plants with hallucinogenic properties are Atropa belladonna and Datura.

Classification of drugs

Group	Drugs	Effects
Stimulants	Amphetamines, cocaine, nicotine and tobacco	Accelerates the activity of the brain
Depressants	Alcohol, Barbiturates, Tranquilizers	Slows down the activity of the brain
Narcotic/ Analgesics	Opium, Morphine	Act as depressants on the Central Nervous System
Cannabis	Bhang (Marijuana), Ganja, Charas	Affects the cardiovascular system
Hallucinogens	Lysergic acid diethylamide (LSD), Phencyclidine	Distorts the way one sees, hears and feels.

- Drugs like methamphetamine, amphetamines, barbiturates, tranquilizers, Lysergic acid diethylamide (LSD) are normally used as medicine to treat patients with mental illness like depression and insomnia and are often abused.

- Tobacco is smoked, chewed and used as snuff. It increases the carbon monoxide content of blood and reduces the concentration of haem bound oxygen, thus causing oxygen deficiency in the body. Tobacco contains nicotine, carbon monoxide and tars, which cause problems in the heart, lung and nervous system. Adrenal glands are stimulated by nicotine to release adrenaline and nor adrenaline which increases blood pressure and heart beat.

Addiction and dependence

- Addiction is a physical or psychological need to do or take or use certain substance such as alcohol, to the point where it could be harmful to the individual. This addictive behaviour can be personally destructive to a person. Overtime addicts start to lose not only their jobs, homes and money, but also friendship, family relationships and contact with the normal world. Addiction to drugs and alcohol can lead to a psychological attachment to certain effects such as euphoria and temporary feeling of well being.

- Repeated use of drugs and alcohol may affect the tolerance level of the receptors present in the body. These receptors then respond only to highest doses of drugs and alcohol leading to greater intake and addiction. Excessive use of drug and alcohol leads to physical and psychological dependence. When psychological dependence develops, the drug user gets mentally 'hooked on' to the drug. The drug user constantly thinks only about the drug and has continuous uncontrollable craving for it. This state called "euphoria" is characterized by mental and emotional preoccupation with the drug.

- Physical dependence is a state in which the user's body requires a continuous presence of the drug. If the intake of the drug or alcohol is abruptly stopped, he or she would develop withdrawal symptoms. In a sense, the body becomes confused and protests against the absence of the drug. The withdrawal symptoms may range from mild tremors to convulsions, severe agitation and fits, depressed mood, anxiety, nervousness, restlessness, irritability, insomnia, dryness of throat, etc, depending on the type of drug abuse.

Effects of drugs and alcohol

- Short-term effect appears only for a few minutes after the intake of drugs and alcohol. The abuser feels a false sense of well being and a pleasant drowsiness. Some short term effects are euphoria, pain, dullness of senses, alteration in behaviour, blood pressure, narcosis (deep sleep), nausea and vomiting.

- Drugs and alcohol have long-term effect that lead to serious damages, because of the constant and excessive use. The physical and mental disturbance makes the life of the user unbearable and torturous. For example heavy drinking permanently damages the liver and brain.

- The use of alcohol during adolescence may have long-term effects. Alcohol interferes with the ability of the liver to break down fat. Over time fat accumulation and high levels of alcohol destroy the liver cells and a scar tissue grows in the place of dead cells. This scarring of the liver is called "Liver cirrhosis". Alcohol irritates the stomach lining due to the production of excess acid leading to ulcers. Excessive alcohol use weakens the heart muscle, causing scar tissue to build up in the cardiac muscle fibers. As a result, heavy drinkers have an increased risk of high blood pressure, stroke, coronary artery disease and heart attack. Korsakoff syndrome, a chronic memory disorder is most commonly caused by alcohol misuse.

Alcoholism is the inability to control drinking due to physical and emotional dependence on alcohol. Treatment involves counseling by a healthcare professional. Detoxification programme in a hospital or medical facility is an option for those who need additional assistance. Medications are available to reduce the desire to drink and smoke.

Prevention and control

- It is practically possible to prevent some one from using drugs and alcohol. Here are some ways that help to prevent drug and alcohol abuse.

➢ **Effectively dealing with peer pressure**

The biggest reason for teens to start on drugs is due to their friends / peer groups imposing pressure on them. Hence, it is important to have a better group of friends to avoid such harmful drugs and alcohol.

➢ **Seeking help from parents and peers**

Help from parents and peer group should be sought immediately so that they can be guided appropriately. Help may even be sought from close and trusted friends. Getting proper advice to sort out their problems would help the young to vent their feelings of anxiety and guilt.

➢ **Education and counselling**

Education and counselling create positive attitude to deal with many problems and to accept disappointments in life.

➢ **Looking for danger signs**

Teachers and parents need to look for sign that indicate tendency to go in for addiction.

➢ **Seeking professional and medical assistance**

Assistance is available in the form of highly qualified psychologists, psychiatrists and de-addiction and rehabilitation programmes to help individuals to overcome their problems.

Mental health – Depression

- Mental health is a state of well being of the mind, with self esteem. Self esteem means liking yourself and being able to stand up for what you believe is right. Positive mental health is an important part of wellness. A mentally healthy person reflects a good personality. Activities of mentally healthy people are always appreciated and rewarded by the society as these persons are creative as well as cooperative with others. Mental health improves the quality of life.

- Depression is a common mental disorder that causes people to experience depressed mood, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep poor appetite, low energy and poor concentration.

Alcoholic Anonymous

Alcoholic anonymous was started in 1935 by a businessman and a doctor who had been a "hopeless drunk" for many years. After the men helped each other to stop drinking and to stay sober, they then founded the alcoholic anonymous to help other alcoholics. Since that

time alcoholic anonymous has spread throughout the world.

Signs and symptoms of mental depression

- Loss of self confidence and self esteem
- Anxiety
- Not being able to enjoy things that are usually pleasurable or interesting.

- Lifestyle changes like exercise, meditation, yoga and healthy food habits can help to be relieved from depression. Exercise stimulates the body to produce serotonin and endorphins, which are neurotransmitters that suppress depression. Practicing exercise in daily life creates a positive attitude .

Participating in an exercise programme can:

- Increase self-esteem
- Boost self-confidence
- Create a sense of empowerment
- Enhance social connections and relationships

- Brain is one of the most metabolically active part of the body and needs a steady stream of nutrients to function. A poor diet may not provide the nutrients for a healthy body and may provoke symptoms of anxiety and depression.

Lifestyle disorders in human beings

- The old saying that "health is wealth" is truly applicable to human beings. With the changes in life style, there are many emerging medical conditions and diseases that are reducing human longevity. Life style disorder result due to activities involving smoking, alcohol and drug abuse, consuming high fat diet, lack of exercise or living a latent life.

- The World Health Organization (WHO) in its report cautions a slow moving public health disaster due to life style disorders in the form of non-communicable diseases like diabetes, cardiovascular and lung diseases. WHO believes that not thousands but millions of people die every year within the age groupof thirty to sixty due to life style related disorders.

- The following facts will help in better understanding of life style disorders.

- Life style disorder causes cardiovascular diseases resulting in 31 percent of global deaths.

- The sedentary life style also causes deficiency of vitamins such as vitamin D resulting in fatigue, tiredness, back pain, depression, bone loss, muscle pain, etc,

- Life style disorder also includes social isolation resulting in age related problems.

- Eating junk foods that have high caloric values, rich in carbohydrates and fat can lead to obesity and early health issues.

- Consumption of processed and packaged food, which lacks in fiber may result in constipation.

- Several people today complain of irritable bowel syndrome with stomach discomfort or pain and trouble with bowel movements, causing diarrhoea. The main cause of irritable bowel syndrome is stress and other illnesses.

Life style modifications

- Avoid eating junk food and foods that have preservatives and colouring agents.

- Physical exercises such as brisk walking and yoga can be done regularly.

- Following medical advice, if any health problems in addition to life style disorders.

- To avoid smoking drugs and drinking alcohol.

- To follow a healthy balanced diet rich in vitamins and proteins.

- 7 – 8 hours of sleep every day is required.

Chapter 8 – Immunology

8. Immunology

- In the previous chapter, we have studied in detail the various infections which cause diseases in human beings. In this chapter, we shall discuss how our body protects us from these infections by the effective mechanism of the immune system.

Basic concepts of immunology

- Immunology is the study of immune system. This system protects an individual from various infective agents. It refers to all the mechanisms used by the body for protection from environmental agents that are foreign to the body.

- When the immune system does not function efficiently in an individual, it leads to infection causing disease. The overall ability of body to fight against the disease causing pathogen is called immunity. It is also called disease resistance and the lack of immunity is known as susceptibility. Immunity is highly specific.

- Normally many of the responses of the immune system initiate the destruction and elimination of invading organisms and any toxic molecules produced by them. These immune reactions are destructive in nature and are made in response only to moleculesthat are foreign to the host and not to those of host itself. This ability to distinguish foreign molecules from self is another fundamental feature of the immune system. However, occasionally, it fails to make its distinction and reacts destructively against the host's own molecules; such autoimmune diseases can be fatal to the organism.

- Almost all the macromolecules e.g. proteins, polysaccharides, nucleic acids, etc., as long as they are foreign to recipient organism can induce immune response. Any substance capable of eliciting immune response is called an ANTIGEN (Antibody Generator). There are two broad classes of immunity responses namely, innate immunity and acquired immunity (Fig. 8.1).

Type of innate Immunity	Mechanism
1. Anatomical barriers • **Skin** • **Mucus Membrane**	• Prevents the entry of microbes. Its acidic environment (pH 3-5) retards the growth of microbes. • Mucus entraps foreign microorganisms and competes with microbes for attachment.
2. Physiological barriers • **Temperature** • **Low pH**	• Normal body temperature inhibits the growth of pathogens. Fever also inhibits the growth of pathogens. • Acidity of gastric secretions (HCl) kills most ingested

• **Chemical mediators**	microbes. • Lysozyme acts as antibacterial agent and cleaves the bacterial cell wall. Interferon's induce antiviral state in the uninfected cells. Complementary substances produced from leucocytes lyse the pathogenic microbes or facilitate phagocytosis.
3. Phagocytic bazrriers	Specialized cells (Monocytes, neutrophils, tissue macrophages) phagocytose, and digest whole micro -organisms.
4. Inflammatory barriers	Tissue damage and infection induce leakage of vascular fluid, containing chemotactic signals like serotonin, histamine and prostaglandins. They influx the phagocytic cells into the affected area. This phenomenon is called diapedesis.

8.2 Innate immunity

- Innate immunity is the natural phenomenon of resistance to infection which an individual possesses right from the birth. The innate defense mechanisms are non-specific in the sense that they are effective against a wide range of potentially infectious agents. It is otherwise known as non-specific immunity or natural immunity. A number of innate defense mechanisms are operative non-specifically against a large number of microorganisms as shown in the Table 8.1 and Fig. 8.2.

Acquired immunity

- The immunity that an individual acquires after birth is known as acquired immunity. It is the body's resistance to a specific pathogen.

- The unique features of acquired immunity are antigenic specificity, diversity, recognition of self and non-self and immunological memory.

Components of acquired immunity

- Acquired immunity has two components – cell mediated immunity (CMI) and antibody mediated immunity or humeral immunity.

1. Cell mediated immunity

- When pathogens are destroyed by cells without producing antibodies, then it is knownas cell mediated immune response or cell mediated immunity. This is brought about by T cells, macrophages and natural killer cells.

2. Antibody mediated immunity or humoral immunity

- When pathogens are destroyed by the production of antibodies, then it is known as antibody mediated or humoral immunity. This is brought about by B cells with the help

of antigen presenting cells and T helper cells. Antibody production is the characteristic feature of vertebrates only.

Types of acquired immunity

- Acquired immunity may be active immunity or passive immunity (Table 8.2). The immunological resistance developed by the organisms through the production of antibodies in their body is called active immunity. Active immunity is acquired through the use of a person's immune responses, which lead to the development of memory cells. Active immunity results from an infection or an immunization. Passive immunity does not require the body to produce antibodies to antigens. The antibodies are introduced from outside into the organism. Thus, passive immunity is acquired without the activation of a person's immune response, and therefore there is no memory.

The process of production of blood cells in the bone marrow is called haematopoiesis.

S. No	Active Immunity	Passive immunity
1.	Active immunity is produced actively by host's immune system.	Passive Immunity is received passively and there is no active host participation.
2.	It is produced due to contact with pathogen or bu its antigen.	It is produced due to antibodies obtained from outside.
3.	It is durable and effective in protection	It is transient and les effective.
4.	Immunological memory is present.	No memory.
5.	Booster effect on subsequent does is possible.	Subsequent dose is less effective.
6.	Immunity is effective only after a short period.	Immunity develops immediately

Immune responses

- The immune responses may be primary or secondary (Table 8.3).

Primary immune response

- The primary immune response occurs when a pathogen comes in contact with the immune system for the first time. During this, the immune system has to learn to recognize the antigen, produce antibody against it and eventually produce memory lymphocytes. The primary immune response is slow and short – lived.

S. No	Primary Immune Response	Secondary Immune Response
1.	It occurs as a result of primary contact with an antigen.	It occurs as a result of second and subsequent contacts with the same antigen.
2.	Antibody level reaches peak in 7 to 10	Antibody level reaches peak in 3 to 5

	days.	days.
3.	Prolonged periods is required	It establishes immunity in a short time.
4.	There is rapid decline in antibody level.	Antibody level remains high for longer period.
5.	It appears mainly in the lymph nodes and spleen.	It appears mainly in the bone marrow, followed by the spleen and lymph nodes.

Secondary immune response

- The secondary immune response occurs when a person is exposed to the same antigen again. During this, time immunological memory has been established and the immune system can start producing antibodies immediately. Within hours after recognition of the antigen, a new army of plasma cells are generated. Within 2 to 3 days, the antibody concentration in the blood rises steeply to reach much higher level than primary response. This is also called as "booster response".

Lymphoid organs

- Immune system of an organism consists of several structurally and functionally different organs and tissues that are widely dispersed in the body. The organs involved in the organ, maturation and proliferation of lymphocytes are called lymphoid organs (Fig.8.3). Based on their functions, they are classified into primary or central lymphoid organs and secondary or peripheral lymphoid organs trap antigens and make it available for mature lymphocytes, which can effectively fight against these antigens.

Primary lymphoid organs

- Bursa of Fabricius of birds, bone marrow and thymus gland of mammals constitute the primary lymphoid organs involved in the production and early selection of lymphocytes. These lymphocytes become dedicated to a particular antigenic specificity. Only when the lymphocytes mature in the primary lymphoidal organs, they become immunocompetent cells. In mammals, B cell maturation occurs in the bone marrow and T cells maturation occurs in the thymus.

Thymus

- The thymus is a flat and bilobed organ located behind the sternun, above the heart. Each lobe of the thymus contains numerous lobules, separated from each other by connective tissue called septa. Each lobule is differentiated into two compartments, the outer compartment or outer cortex, is densely packed with immature T cells called thymocytes, whereas the inner compartment or medulla is sparsely populated with thymocytes. One of its main secretions is the hormone thymosin. It stimulates the T cell to become mature and immune competent. By the early teens, the thymus begins to atrophy and is replaced by adipose tissue (Fig. 8.4). Thus thymus is most active during the neonatal and pre-adolescent periods.

Bone marrow

- Bone marrow is a lymphoid tissue found within the spongy portion of the bone. Bone marrow contains stem cells known as haematopoietic cells. These cells have the potential to multiply through cell division and either remain as stem cells or differentiate and mature into different kinds of blood cells.

Secondary or peripheral lymphoid organs

- In secondary or peripheral lymphoid organs, antigen is localized so that it can be effectively exposed to mature lymphocytes. The best examples are lymph nodes, appendix, Peyer's patches of gastrointestinal tract, tonsils, adenoids, spleen, MALT (Mucosal-Associated Lymphoid Tissue), GALT (Gut-Associated Lymphoid Tissue), BALT (Bronchial/Tracheal-Associated Lymphoid Tissue).

Peyer's patches are oval-shaped areas of thickened tissue that are embedded in the mucus-secreting lining of the small intestine of humans and other vertebrate animals. Peyer's patches contain a variety of immune cells, including macrophages, dendritic cells, T cells, and B cells.

The tonsils (palatine tonsils) are a pair of soft tissue masses located at the back of the throat (pharynx). The tonsils are part of the lymphatic system, which help to fight infections. They stop invading germs including bacteria and viruses.
Spleen is a secondary lymphoid organ located in the upper part of the abdominal cavity close to the diaphragm. Spleen contains B and T cells. It brings humoral and cell mediated immunity.

- The adenoids are glands located in the roof of the mouth, behind the soft palate where the nose connects to the throat. The adenoids produce antibodies that help to fight infections. Typically, the adenoids shrink during adolescence and may disappear by adulthood.

Lymph node

- Lymph node is a small bean-shaped structure and is part of the body's immune system. It is the first one to encounter the antigen that enters the tissue spaces. Lymph nodes filter and trap substances that travel through the lymphatic fluid. They are packed tightly with white blood cells, namely lymphocytes and macrophages. There are hundreds of lymph nodes found throughout the body. They are connected to one another by lymph vessels. Lymph is a clear, transparent, colourless, mobile and extracellular fluid connective tissue. As the lymph percolates through the lymph node, the particulate antigen brought in by the lymph will be trapped by the phagocytic cells, follicular and interdigitating dendritic cells.

- Lymph node has three zones (Fig. 8.5). They are the cortex, paracortex and medulla. The outer most layer of the lymph node is called cortex, which consists of B-lymphocytes, macrophages, and follicular dendritic cells. The paracortex zone is beneath the cortex, which is richly populated by T lymphocytes and interdigitating dendritic cells. The inner most zone is called the medulla which is sparsely populated by lymphocytes, but many of them are plasma cells, which actively secrete antibody molecules. As the lymph enters, it slowly percolates through the cortex, paracortex and medulla, giving sufficient chance for the phagocytic cells and dendritic cells to trap the antigen brought by the lymph. The lymph leaving a node carries enriched antibodies secreted by the medullary plasma cells against the antigens that enter the lymph node. Sometimes visible swelling of lymph nodes occurs due to active immune response and increased concentration of lymphocytes. Thus swollen lymph nodes may signal an infection. There are several groups of lymph nodes are found in the neck, under the chin, in the armpits and in the groin.

The mucosa – associated lymphoid tissue (MALT) is a diffuse system of small concentrations of lymphoid tissue in the alimentary, respiratory and urino-genital tracts. MALT is populated by lymphocytes such as T and B cells, as well as plasma cells and macrophages, each of which is well situated to encounter antigens passing through the mucosal epithelium.

Gut-associated lymphoid tissue (GALT) is a component of the mucosa-associated lymphoid tissue (MALT) which worked in the immune system to protect the body from invasion in the gut.

Bronchus Associated Lymphoid Tissues **(BALT)** also a component of MALT is made of lymphoid tissue (tonsils, lymph nodes, lymph follicles) is found in the respiratory mucosae from the nasal cavities to the lungs.

Cells of the immune system

- The immune system is composed of many interdependent cells that protect the body from microbial infections and the growth of tumour cells. The cellular composition of adult human blood is given in Table8. 4.

Cell type	Number of cells per μl	Approximate percentage
Red blood	4200,000- 6500,000	-
White blood cells		
i **Agranulocytes**		
• Lymphocytes	1500 - 4000	20 – 30
• Monocytes	200 - 950	2 – 7

ii **Granulocytes**		
• Neutrophils	2000 – 7000	50- 70
• Basophils	50 - 100	<1
• Eosinophils	40 - 500	2 – 5
• Platelets	150,000 – 500,000	

- All these cells are derived from pluripotent haematopoetic stem cells. Each stem cell had the capacity to produce RBC, WBC and platelets. The only cells capable of specifically recognising and producing an immune response are the lymphocytes. The other types of white blood cells play an important role in non-specific immune response, antigen presentation and cytokine production.

Lymphocytes

- About 20-30% of the white blood cells are lymphocytes. They have a large nucleus filling most of the cell, surrounded by a little cytoplasm. The two main types of lymphocytes are B and T lymphocytes. Both these are produced in the bone marrow. B lymphocytes (B cells) stay in the bone marrow until they are mature. Then they circulate around the body. Some remain in the blood, while others accumulate in the lymph nodes and spleen. T lymphocytes leave the bone marrow and mature in the thymus gland. Once mature, T cells also accumulate in the same areas of the body as B cells. Lymphocytes have receptor proteins on their surface. When receptors on a B cell bind with an antigen, the B cell becomes activated and divides rapidly to produce plasma cells. The plasma cells produce antibodies. SomeB cells do not produce antibodies but become memory cells. These cells are responsible for secondary immune response. T lymphocytes do not produce antibodies. They recognize antigen-presenting cells and destroy them. The two important types of T cells are Helper T cells and Killer T cells. Helper T cells release a chemical called cytokine which activates B cells. Killer cells move around the body and destroy cells which are damaged or infected (Fig. 8.6).

- Apart from these cells neutrophils and monocytes destroy foreign cells by phagocytosis. Monocytes when they mature into large cells, they are called macrophages which perform phagocytosis on any foreign organism.

Dendritic cells are called so because it's covered with long, thin membrane extensions that resemble dendrites of nerve cells. These cells present the antigen to T-helper cells. Four types of dendritic cells are known. They are Langerhans, interstitial cells, myeloid and lymphoid cells.

Antigens

- The term antigen (Ag) is used in two senses, the first to describe a molecule which generates an immune response and the second, a molecule which reacts with antibodies. In general antigens are large, complex molecular substances that can induce a detectable immune response. Thus an antigen is a substance that is specific to an antibody or a T-cell receptor and is often used as a synonym for immunogen.

The histocompatibility antigens are cell surface antigens that induce an immune response leading to rejection of allografts.

- An immunogen is a substance capable of initiating an immune response. Haptens are substance that are non-immunogenic but can react with the products of a specific immune response. Substances that can enhance the immune response to an antigen are called adjuvants. Epitope is an antigenic determinant and is the active part of an antigen. A paratope is the antigen – binding site and is a part of an antibody which recognizes and binds to an antigen.

Antigenicity is the property of a substance (antigen) that allows it to react with the products of the specific immune response.

Types of antigens

- On the basis of origin, antigens are classified into exogenous antigens and endogenous antigens. The antigens which enter the host from the outside in the form of microorganisms, pollens, drugs, or pollutants are called exogenous antigens. The antigens which are formed within the individual are endogenous antigens. The best examples are blood group antigens.

Antibodies

- Antibodies are immunoglobulin (Ig) protein molecules synthesized on exposure to antigen that can combine specifically with the antigen. Whenever pathogens enter our body, the B-lymphocytes produce an army of proteins called antibodies to fight with them. Thus, they are secreted in response to an antigen (Ag) by the effect of B cells called plasma cells. The antibodies are classified into five major categories, based on their physiological and biochemical properties. They are IgG (gamma), IgM (mu), IgA (alpha), IgD (delta) and IgE (epsilon).

- In the 1950s, experiments by Porter and Edelman revealed the basic structure of the immunoglobulin. An antibody molecule is Y shaped structure that comprises of four polypeptide chains, two identical light chains (L) of molecular weight 25,000 Da (approximately 214 amino acids) and two identical heavy chains (H) of molecular weight 50,000 Da (approximately 450 amino acids). The polypeptide chains are linked together by di-sulphide (S-S) bonds. One light chain is attached to each heavy chain and two heavy chains are attached to each other to form a Y shaped (Fig. 8.7) structure. Hence, an antibody is represented by H2 L2. The heavy chains have a flexible hinge region at their approximate middles.

- Each chain (L and H) has two terminals. They are C - terminal (Carboxyl) and amino or N-terminal. Each chain (L and H) has two regions. They have variable (V) region at one end and a much larger constant (C) region at the other end. Antibodies responding to different antigens have very different (V) regions but their (C) regions are the same in all

antibodies. In each arm of the monomer antibody, the (V) regions of the heavy and light chains combines to form an antigen – binding site shaped to 'fit' a specific antigenic determinant. Consequently each antibody monomer has two such antigen – binding regions. The (C) regions that forms the stem of the antibody monomer determine the antibody class and serve common functions in all antibodies. The functions of immunoglobulin are agglutination, precipitation, opsonisation, neutralization etc.,

Antigen and antibody interaction

- The reaction between an antigen and antibody is the basis for humoral immunity or antibody mediated immunity. The reaction between antigen and antibody occurs in three stages. During the first stage, the reaction involves the formation of antigen - antibody complex. The next stage leads to visible events like precipitation, agglutination, etc,.The final stage includes destruction of antigen or its neutralization (Fig. 8.8).

Binding force of antigen - antibody reaction

- The binding force between antigen and antibody is due to three factors. They are closeness between antigen and antibody, non-covalent bonds or intermolecular forces and affinity of antibody.When antigen and antibody are closely fitted, the strength of binding is great. When they are apart binding strength is low.The bonds that hold the antigen to the antibody combining site are all non-covalent in nature. These include hydrogen bonds, electrostatic bonds, Van der Waals forces and hydrophobic bonds. Antibody affinity is the strength of the reaction between a single antigenic determinant and a single combining site on the antibody.

- The chief application of antigen - antibody reactions are to determine blood groups for transfusion, to study serological ascertainment of exposure to infectious agents, to develop immunoassays for the quantification of various substances, to detect the presence or absence of protein in serum and to determine the characteristics of certain immunodeficiency diseases.

Different types of antigen and antibody reactions

- The reaction between soluble antigen and antibody leads to visible precipitate formation, which is called precipitin reaction. Antibodies that bring about precipitate formation on reacting with antigens are called as precipitins.
- Whenever a particulate antigen interacts with its antibody, it would result in clumping or agglutination of the particulate antigen, which is called agglutination reaction. The antibody involved in bringing about agglutination reaction is called agglutinin.

- Opsonisation or enhanced attachment is the process by which a pathogen is marked of ingestion and destruction by a phagocyte. Opsonisation involves the binding of an opsonin i.e., antibody, to a receptor on the pathogen's cell membrane. After opsonin binds to the membrane, phagocytes are attracted to the pathogen. So, opsonisation is a process in which pathogens are coated witha substance called an opsonin, marking the

pathogen out for destruction by the immune system. This results in a much more efficient phagocytosis.

- The neutralization reactions are the reactions of antigen-antibody that involve the elimination of harmful effects of bacterial exotoxins or a virus by specific antibodies. These neutralizing substances i.e., antibodiesare known as antitoxins. This specific antibody is produced by a host cell in response to a bacterial exotoxin or corresponding toxoid (inactivated toxin).

Vaccines

- A vaccine is a biological preparation that provides active acquired immunity to a particular disease and resembles a microorganism and is often made from weakened of attenuated or killed forms of the microbes, their toxins, or one of its surface proteins. Vaccines "teach "our body how to defend itself when viruses or bacteria, invade it/ Vaccines deliver only very little amounts of inactivated or weakened viruses or bacteria, or parts of them. This allows the immune system to recognize the organism without actually experiencing the diseases. Some vaccines need to be given more than once (i.e., a 'booster' vaccination) to make sure the immune system can overcome a real infection in the future.

- First generation vaccine is further subdivided into live attenuated vaccine, killed vaccine and toxoids (Fig. 8.9). Live attenuated vaccines use the weakened (attenuated), aged, less virulent form of the virus. E.g. Measles, mumps and rubella (MMR) vaccine and the Varicella (chickenpox) vaccine, Killed (inactivated) vaccines are killed or inactivated by heat and other methods. E.g. Salk's polio vaccine. Toxoid vaccines contain a toxin or chemical secreted by the bacteria or virus. They make us immune to the harmful effects of the infection, instead of to the infection itself. E.g. DPT vaccine (Diphtheria, Pertussis and Tetanus).

- Second generation vaccine contains the pure surface antigen of the pathogen. E.g.Hepatitis-B vaccine. Third generation vaccine contains the purest and the highest potency vaccines which are synthetic in generation. The latest revolution in vaccine is DNA vaccine or recombinant vaccine (Refer Chapter- 10 for details).

Vaccino therapy is the method of use of vaccine from treatment of disease. Dr. Edward Jenner prepared first vaccine for small pox in 1796. Polio vaccine was developed by Dr. Jonas Salk (vaccine consists of inactivated microorganism) and Dr. Albert Sabin (live attenuated oral poliacaccine). Louis Pasteur (1885) discovered vaccine against rabies, anthrax and cholera. BCG vaccine was developed by Calmette and Guerin against tuberculosis in France in the Year 1908.

Vaccination and immunization

- "Vaccination is the process of administrating a vaccine into the body or the act of introducing a vaccine into the body to produce immunity to a specific disease."

Immunization is the process of the body building up immunity to a particular disease. Immunization describes the actual changes in the body after receiving a vaccine. Vaccines work by fighting the pathogen and then recording it in their memory system to ensure that the next time this pathogen enters the body, it is eliminated far quickly. Once, the body is able to fight against the disease, it is believed to have built the immunity for it, also known as the body being immunized against the disease.

Hypersentivity – Overactive Immune Response

- Some of the individuals are very sensitive to some particles present in the environment. The exaggerated response of the immune system to certain antigens present in the environment is called allergy (allo-altered, erg-reaction). The substances to which such an immune response is produced are called allergens. Anallergen is an antigen that causes an allergic reaction. Allergic reactions begin within few seconds after the contact with the allergen and last about half an hour. The common examples of allergens are mites in dust, pollens and some proteins in insect venom. Hay fever and asthma are some common examples of allergy. Symptoms of allergic reactions include sneezing, watery eyes, running nose and difficulty in breathing. Allergy is a form of over active immune response mediated by IgE and mast cells. It can also be due to the release of chemicals like histamine and serotonin from the mast cells. Anaphylaxis is the classical immediate hypersensitivity reaction. It is a sudden, systematic, severe and immediate hypersensitivity reaction occurring as a result of rapid generalized mast-cell degranulation.

Immunodeficiency disease –Ineffective immune response – AIDS

- Immunodeficiency results from the failure of one or more components of the immune system. Primary immune deficiencies are caused by genetic developmental defects. Secondary immune deficiencies arise due to various reasons like radiation, use of cytolytic and immunosuppressive drugs and infections. AIDS is an acronym for Acquired Immuno Deficiency Syndrome. It is the deficiency of immune system, acquired during the life time of an individual indicating that it is not a congenital disease. AIDS is caused by Human Immuno Deficiency Virus (HIV). It selectively infects helper T cells. The infected helper T cells will not stimulate antibody production by B-cells resulting in loss of natural defence against viral infection. On the basis of genetic characteristics and differences in the viral antigens, HIV is classified into the types 1 and 2 (HIV-1, HIV-2).

Structure of HIV

- The human immunodeficiency virus belongs to the genus Lentivirus. When observed under the electron microscope, HIV is seen as a spherical virus, 100-120 nm in diameter, containing a dense core surrounded by a lipoprotein envelope. The envelope has glycoprotein (gp) spikes termed gp 41 and gp 120. At the core, there are two large single stranded RNA. Attached to the RNA are molecules of reverse transcriptase. It also contains enzymes like protease and ribonuclease. The core is covered by a capsid made of proteins. This is followed by another layer of matrix proteins as shown in the Fig 8.10.

HIV Transmission

- The HIV is often located within the cells especially in macrophages. HIV can survive for 1.5 days inside a cell but only about 6 hours outside a cell. Routes of HIV transmission include unsafe sexual contact, blood-contaminated needles, organ transplants, blood transfusion and vertical transmission from HIV infected mother to child. HIV is not transmitted by insects or by casual contact.

- After getting into the body of the person, the virus enters into macrophages where RNA genome of the virus replicates to form viral DNA with the help of the enzyme reverse transcriptase. This viral DNA gets incorporated into the DNA of host cells and directs the infected cells to produce viral particles. The macrophages continue to produce virus and in this way acts like a HIV factory. Simultaneously, HIV enters into helper T-lymphocytes, replicates and produces progeny viruses. The progeny viruses released in the blood attack other helper T-lymphocytes. This is repeated, leading to a progressive decrease in the number of helper T lymphocytes in the body of the infected person. During this period, the person suffers from bouts of fever, diarrhoea and weight loss. Due to decrease in the number of helper T lymphocytes, the person starts suffering from infections and becomes immune deficient and unable to protect against any infection.

- A simple blood test is available that can determine whether the person has been infected with HIV. The ELISA test (Enzyme Linked ImmuneSorbent Assay) detects the presence of HIV antibodies. It is a preliminary test. Western blot test is more reliable and a confirmatory test. It detects the viral core proteins. If both tests detect the presence of the antibodies, the person is considered to be HIV positive.

- AIDS has no cure. Prevention of AIDS is the best option. Advocating safe sex and promoting regular check-up, safe blood for transfusion, use of disposable needles, use of condoms during sexual contact, prevention of drug abuse, AIDS awareness programme by NACO (National AIDS Control Organisation), NGOs (Non-Governmental Organisations) and WHO are to prevent the spreading of AIDS.

Autoimmune diseases

- Autoimmunity is due to an abnormal immune response in which the immune system fails to properly distinguish between self andnon-self and attacks its own body. Our body produces antibodies (auto antibodies) and cytotoxic T cells that destroy our own tissues. If a disease-state results, it is referred to as auto-immune disease. Thus, autoimmunity is a misdirected immune response. Autoimmunity is evidenced by the presence of auto antibodies and T cells that are reactive with host antigens. When the cells act as antigens in the same body, they are called auto antigens.

- Autoimmune diseases in human can be divided into two broad categories, namely organ-specific and non-organ-specific (systemic) autoimmune diseases. In organ-specific disease, the autoimmune process is directed mostly against one organ. The

autoantibodies may block the functions performed by the organs. Examples include Hashimoto's thyroiditis, Graves' disease (thyroid gland) and Addison's disease (adrenal glands). In non-organ specific (systemic) disorders, autoimmune activity is widely spread throughout the body. Rheumatoid arthritis and multiple sclerosis are example for systemic disorder.

Tumour immunology

- A tumour or neoplasm is a group of cells whose growth has gone unchecked. When a tumour continues to grow and invades healthy tissue, it is called cancer. They spread to other parts of the body from the tumour and give rise to secondary tumour. This is known as metastasis. Tumour may be benign or malignant depending on its characteristics. Benign or non-cancerous tissues are capable of indefinite growth and do not invade other body parts. In the malignant tumour, the cells grow indefinitely, detach and migrate into healthy surrounding tissues.

- In normal cells, cell growth and differentiation is highly controlled and regulated. But in cancer cells, there is breakdown of this regulatorymechanism. Normal cells show a property called contact inhibition, which inhibits uncontrolled growth. Cancer cells do not have this property. As a result, cancerous cells divide continuously giving rise to mass of tissues called tumours (Table 8.5).

- When a cell undergoes malignant transformation, it acquires new surface antigen and may also lose some normal antigens. These antigens are present on the membranes of malignant cells and they induce an immune response. Both humoral and cellular responses can be observed in malignancy. Cancer cells can avoid immune detection as they are not foreign bodies but are abnormally functioning body cells. This makes them difficult to treat.

- The concept of immunological surveillance postulates that the primary function of the immune system is to "seek and destroy" malignant cells that arise by somatic mutation. The efficiency of the surveillance mechanism reduces either as a result of ageing or due to congenital or acquired immune deficiencies, leads to increased incidence of cancer. Thus, if immunological surveillance is effective, cancer should not occur. The development of tumour represents a lapse in surveillance.

Immunotherapy of cancer

- Immunotherapy also called biological therapy uses substances made by the body or in a laboratory (monoclonal antibodies) to improve or to resist the immune system function. Different approaches have been attempted in the immunotherapy of cancer. Immunotherapy appears to be important in getting rid of the residual malignant cells after the gross tumour has been removed. The best results in the treatment of cancer is to follow an integrated approach to therapy, combining surgery, radiotherapy, chemotherapy and immunotherapy.

Scope of Immunology

The younger graduates in this field can find number of employment opportunities in Government as well as private hospitals. The scope of the immunology is immunotherapy, microbial immunology, clinical immunology, cellularimmunology, allergy and immunology, translational immunology, transplantation immunology, neuro-inflammatory disorders, tumour immunology, vaccine immunology, inflammatory disorders, ocular immunology and inflammation.

Summary

- Immunology deals with a study of the immune system. The immune system recognises and eliminates the invaders, and the ability of the body to overcome the pathogen is called immunity. Immunity is classified into innate immunity and acquired immunity. Acquired immunity is further classified into cell mediated immunity and antibody mediated immunity as its components. Acquired immunity may be active or passive immunity. Immune response is the body's response to pathogens and it may be primary or secondary. The organs involved in the origin, maturation and proliferation of lymphocytes are called lymphoid organs. Thymus, bone marrow are primary lymphoid organs. The secondary lymphoid organs are lymph node, MALT, GALT and BALT.

- An antigen is a substance that is specific to an antibody. An immunogen is a substance capable of initiating an immune response. Haptens are substance that are non-immunogenic but can react with the product of a specific immune response. Substances that can enhance the immune response to an antigen are called adjuvants. An epitope is also known as antigenic determinant and is the active part of the antigen. A paratope is the part of antibody. Precipitation, agglutination, neutralization, opsonisation etc. are the different types of antigen and antibody reaction. A vaccine is biological preparation that provides active acquired immunity. The malfunctioning of immune system leads to hypersensitivity, immunodeficiency or autoimmune diseases. A tumour or neoplasm is a group of cells whose growth has gone unchecked. The best results in the treatment of cancer is achieved by an integrated approach to therapy, surgery, radiotherapy, chemotherapy and immunotherapy.

12th zoology
Unit - 9. Microbes in Human Welfare

- Microbes such as bacteria, fungi, protozoa, certain algae, viruses, viroids and prions are some of the major components of the biological system on Earth. Several microorganisms are beneficial and contribute to human welfare. Microbes are

presenteverywhere – in soil, water, air and within bodies of animals and plants. Microbes like bacteria and fungi can be grown on nutritive media to form colonies which can be visibly seen. Some of the microbes useful to human welfare are discussed here.

Microbes in household products

- In every-day life, microbes and their products are used in the preparation of idli, dosa, cheese, curd, yogurt, dough, bread, vinegar, etc., Bacteria like Lactobacillus acidophilus, L. lactis and Streptococcus lactis commonly called lactic acid bacteria (LAB) are probiotics which check the growth of pathogenic microbes in the stomach and other parts of the digestive tract.The LAB bacteria grows in milk and convert it into curd, thereby digesting the milk protein casein. A small amount of curd added to fresh milk as a starter or inoculum contains millions of Lactobacilli, which under suitabletemperature (≤40oC) multiply and convert milk into curd. Curd is more nutritious than milk as it contains a number of organic acids and vitamins.

❖ **Prebiotics** are compounds in food (fibers) that induce the growth or activity of beneficial microorganisms. ❖ **Probiotics** are live microorganisms intended to provide health benefits when consumed, generally by improving or restoring the gut flora.

- Yogurt is produced by bacterial fermentation of milk, and lactic acid is produced as a by-product. Microorganisms such as *Streptococcus thermophilus* and Lactobacillus bulgaricus coagulate the milk protein and convert the lactose in the milk to lactic acid. The flavour in yogurt is due to acetaldehyde.Cheese is a dairy product produced in a wide range of flavours, textures and is formed by coagulation of the milk protein, casein. During cheese production, milk is usually acidified and the enzyme rennet is added to cause coagulation. The solids are separated and pressed to form cheese. Most cheese are made with a starter bacteria, Lactococcus, Lactobacillus or Streptococcus.

- Paneer (cottage cheese) is fresh cheese common in South Asia, especially in India. It is made by curdling milk with lemon juice, vinegar and other edible acids. Large holes in Swiss cheese is due to the production of large amount of carbon-di-oxide by the bacterium Propionibacteriumshermanii.

- The dough used in the preparation of idlis and dosas are fermented by the bacteria Leuconostocmesenteroides whereas the dough used in bread making is fermented by Saccharomyces cerevisiae (Baker's Yeast). Fermentation of glucose mainly forms ethyl alcohol and carbon-di-oxide, which is responsible for leavening of dough. When leavened dough is baked, both carbon-di-oxide and ethyl alcohol evaporate making the bread porous and soft.

Single cell protein (SCP)

- Single cell protein refers to edible unicellular microorganisms like Spirulina. Protein extracts from pure or mixed cultures of algae, yeasts, fungi or bacteria may be used as

ingredient or as a substitute for protein rich foods and is suitable for human consumption or as animal feed.

Microbes in industrial products

- Microbes are used to synthesize a number of products valuable to human beings. Products like beverages, antibiotics, organic acids, amino acids, vitamins, biofuels, single cell protein, enzymes, steroids, vaccines, pharmaceutical drugs, etc., are produced in industries. Production on a large scale requires growing microbes in very large vessels called fermentors. A fermentor (bioreactor) is a closed vessel with adequate arrangement for aeration, agitation, temperature, pH control and drain or overflow vent to remove the waste biomass of cultured microorganisms along-with their products.

Antibiotic production

- Antibiotics are chemical substances produced by microorganisms which can kill or retard the growth of other disease causing microbes even in low concentration. Antibiotic means "against life". Antibiotics are used to treat diseases such as plague, meningitis, diphtheria, syphilis, leprosy, tuberculosis etc., Selman Waksman discovered Streptomycin and was the first to use the term "antibiotic" in 1943.

- While working on Staphylococci bacteria, Alexander Fleming observed a green mould growing in one of his unwashed culture plates around which Staphylococci could not grow. He found that it was due to a chemical produced by the mould and he named it as penicillin, which was the first antibiotic discovered by Alexander Fleming in 1926 (Fig. 9.1). Penicillin is produced by the fungi Penicilliumnotatum and Penicilliumchrysogenum. It is bactericidal (antibiotics that kill bacteria) in action and inhibits the synthesis of the bacterial cell wall. Penicillin is also referred as the "queen of drugs" and its full potential as an effective antibiotic was established much later by Earnest Chain and Howard Florey when they treated the wounded soldiers in World War II with penicillin. Fleming, Chain and Florey were awarded the Nobel prize in 1945 for the discovery of penicillin.

- Antibiosis is the property of antibiotics to kill microorganisms.
- Broad-spectrum antibiotics act against a wide range of disease-causing bacteria.
- Narrow-spectrum antibiotics are active against a selected group of bacterial types.

Hypersensitivity reaction is a major problem with the use of penicillin, resulting in nausea, vomiting, wheezing and ultimately cardiovascular collapse. To check the sensitivity reaction, doctors use a needle to prick the forearm of the patients to give a weak dose of penicillin. An itchy red region in the forearm is an indication that the patient is allergic to penicillin. This test is important before administration of penicillin to a patient.

- Tetracycline is a broad spectrum bacteriostatic antibiotic (antibiotics that limit the growth of bacteria) that inhibits microbial protein synthesis. Chlortetracycline is the first antibiotic of this group, isolated from the cultures of Streptomyces aureofaciens.

Streptomycin is a broad spectrum antibiotic isolated from the actinomycetes, Streptomyces griseus. It is bactericidal against both gram positive and gram negative bacteria, especially against Mycobacterium tuberculosis. Antibiotics, such as erythromycin, chloromycetin, griseofulvin, neomycin, kenamycin, bacitracin, etc., are also isolated as microbial products.

Antibiotic resistance

- Antibiotic resistance occurs when bacteria develop the ability to defeat the drug designed to kill or inhibit their growth. It is one of the most acute threat to public health. Antibiotic resistance is accelerated by the misuse and over use of antibiotics, as well as poor infection prevention control. Antibiotics should be used only when prescribed by a certified health professional. When the bacteria become resistant, antibiotics cannot fight against them and the bacteria multiply. Narrow spectrum antibiotics are preferred over broad spectrum antibiotics. They effectively and accurately target specific pathogenic organisms and are less likely to cause resistance. "Superbug" is a term used todescribe strains of bacteria that are resistant to the majority of antibiotics commonly used today.

Fermented beverages

- Microbes especially yeast is being used from time immemorial for the production of beverages like wine, beer, whisky, brandy and rum. Wine is among the oldest alcoholic beverages known and is produced by fermentation of fruit juice by yeast. Zymology is an applied science which deals with the biochemical process of fermentation and its practical uses. Saccharomyces cerevisiae commonly called brewer's yeast is used for fermenting malted cereals and fruit juices to produce various alcoholic beverages. Wine and beer are produced without distillation, whereas whisky, brandy and rum are obtained by fermentation and distillation.
- Oenology is the science and study of wine and wine making. Wine is made from the fermentation of grape juice. Grape juice is fermented by various strains of Saccharomyces cerevisiae into alcohol. Grape wine is of two types, red wine and white wine. For red wine, black grapes are used including skins and sometimes the stems also are used. In contrast white wine is produced only from the juice of either white or red grapes without their skin and stems. Beer is produced from germinated barley malt grain by Saccharomyces carlsbergensis or Saccharomyces cerevisiae. Rum is made from fermented sugarcane or molasses or directly from sugarcane juice by Saccharomyces cerevisiae. Whisky is a type of distilled alcoholic beverage made from fermented grain mash by Saccharomyces cerevisiae.

Alcohol content in various beverages

- Beer contains 3 to 5 percent of alcohol.
- Wine contains 9 to 14 percent alcohol. Wine coolers are made of wine mixed with carbonated water and flavourings. Wine coolers have about 4 to 6 percent alcohol.
- Distilled spirits such as whiskey, gin, scotch and vodka usually contain 35 to 50 percent alcohol.

- In some parts of South India, a traditional drink called pathaneer is obtained from fermenting sap of palms and coconut trees. A common source is tapping of unopened spadices of coconut. It is a refreshing drink, which on boiling produces jaggery or palm sugar. When pathaneer is left undisturbed for few hours it gets fermented to form toddy with the help of naturally occurring yeast, to form a beverage that contains 4 percent alcohol. After 24 hours toddy becomes unpalatable and is used for the production of vinegar.

- Saccharomyces cerevisiae is the major producer of ethanol (C2H5OH). It is used for industrial, laboratory and fuel purposes. So ethanol is referred to as industrial alcohol. Bacteria such as Zymomonasmobilis and Sarcinaventriculi are also involved in ethanol production. The principal substrates for the commercial production of industrial alcohol include molasses or corn, potatoes and wood wastes. The process of ethanol production starts by milling a feed stock followed by the addition of dilute or fungal amylase (enzyme) from Aspergillus to break down the starch into fermentable sugars.

- Yeast is then added to convert the sugars to ethanol which is then distilled off to obtain ethanol which is upto 96 percent in concentration. The two most common type of biofuels in use today are ethanol and biodiesel, both of them represent the first generation of biofuel technology. Ethanol is often used as a fuel, mainly as a biofuel additive for gasoline.

Biodiesel is a fuel made from vegetable oils, fats or greases. Biodiesel fuel can be used in diesel engines without altering the engine. Pure biodiesel is non-toxic, biodegradable and produces lower level of air pollutants than petroleum-based diesel fuel. The Government of India approved the National Policy on Biofuels in December 2009 and identified Jatrophacurcas as the most suitable oilseed for biodiesel production. Pongamia species is also a suitable choice for production of biodiesel.

Chemicals, enzymes and other bioactive molecules

- Microbes are not only used for commercial and industrial production of alcohol, but also used for production of chemicals like organic acids and enzymes. Examples of organic acid producers are Aspergillusniger for citric acid, Acetobacteraceti for acetic acid, Rhizopusoryzae for fumaric acid, Clostridium butyricum for butyric acid and Lactobacillus for lactic acid.

- Yeast (Saccharomyces cerevisiae) and bacteria are used for commercial production of enzymes. Lipases are used in detergent formulations and are used for removing oily stains from the laundry. Bottled juices are clarified by the use of pectinase, protease and cellulase. Rennet can also be used to separate milk into solid curds for cheese making. Streptokinase produced by the bacterium Streptococcus and genetically engineered Streptococci are used as "clot buster" forremoving clots from the blood vessels of patients who have undergone myocardial infarction.

- Cyclosporin A, an immunosuppressant used in organ transplantation is produced from the fungus Trichodermapolysporum. It is also used for its anti-inflammatory, anti-fungal and anti-parasitic properties. Statins produced by the yeast Monascuspurpureus have been used to lower blood cholesterol levels. It acts by competitively inhibiting the enzyme responsible for the synthesis of cholesterol. Recombinant human insulin has been produced predominantly using E. coli and Saccharomyces cerevisiae for therapeutic use in human.

Microbes in sewage treatment and energy generation

- Sewage is the waste generated every day in cities and towns containing human excreta. It contains large amounts of organic matter and microbes, which are pathogenic to humans and are bio-degradable pollutants. Domestic waste consists of approximately 99 percent water, suspended solids and other soluble organic and inorganic substances. Sewage should not be discharged directly into natural water bodies like rivers and streams. Before disposal, sewage should be treated in sewage treatment plants to make it less polluting.

Wastewater treatment

- The main objective of a wastewater treatment process is to reduce organic and inorganic components in wastewater to a level that it nolonger supports microbial growth and to eliminate other potentially toxic materials. Microorganisms mainly bacteria and some protozoa play an essential part in the treatment of sewage to make it harmless. Sewage contains pathogenic bacteria. These bacteria must be destroyed in order to prevent the spread of diseases. Sewage treatment is usually performed in the following three stages.

Primary treatment

- Primary treatment involves the physical removal of solid and particulate organic and inorganic materials from the sewage through filtration and sedimentation. Floating debris is removed by sequential filtration. Then the grit (soil and small pebbles) are removed by sedimentation. All solids that settle form the primary sludge and the supernatant forms the effluent. The effluent from the primary settling tank is taken for secondary treatment.

Secondary treatment or biological treatment

- The primary effluent is passed into large aeration tanks where it is constantly agitated mechanically and air is pumped into it. This allows vigorous growth of useful aerobic microbes into floc (masses of bacteria associated with fungal filaments to form mesh like structures). While growing, these microbes consume themajor part of the organic matter in the effluent. This significantly reduces the BOD (Biochemical oxygen demand or Biological oxygen demand). BOD refers to the amount of the oxygen that would be consumed, if all the organic matter in one litre of water were oxidized by bacteria. The

sewage water is treated till the BOD is reduced. The greater the BOD of the waste water more is its polluting potential.

- Once the BOD of sewage water is reduced significantly, the effluent is then passed into a settling tank where the bacterial "**flocs**" are allowed to sediment. This sediment is called **activated sludge**. A small part of activated sludge is pumped back into the **aeration tank** to serve as the inoculum. The remaining major part of the sludge is pumped into large tanks called **anaerobic sludge digesters**. Here, the bacteria which grow anaerobically, digest the bacteria and the fungi in the sludge. During this digestion, bacteria produce a mixture of gases such as methane, hydrogen sulphide and CO2. These gases form biogas and can be used as a source of energy.

Tertiary treatment

- Tertiary treatment is the final process that improves the quality of the waste water before it is reused, recycled or released into natural water bodies. This treatment removes the remaining inorganic compounds andsubstances, such as nitrogen and phosphorus. UV is an ideal disinfectant for wastewater since it does not alter the water quality – except for inactivating microorganisms. UV is a chemical-free process that can completely replace the existing chlorination system and also inactivates chlorine-resistant microorganisms like Cryptosporidium and Giardia.

Act enforced by Government to conserve water bodies

- National river conservation plan (NRCP) was enacted in 1995 to improve the water quality of the rivers, which are the major fresh water resources in our country. This important assignment taken up under the NRCP includes,

  - ✓ To capture the raw sewage flowing into the river through open drains and divert them for treatment.
  - ✓ Setting up sewage treatment plants for treating the diverted sewage.
  - ✓ Construction of low cost sanitation toilets to prevent open defecation on river banks.

- The ministry for environment, forest and climate change has initiated the Ganga action plan and the Yamuna action plan to save the major rivers of the country. The Ganga action plan was launched on 14th January 1986. The main objective of the programme is to improve the water quality of River Ganges by interception, diversion and treatment of domestic sewage and to identify grossly polluting units to prevent pollution. The Yamuna Action Plan is a bilateral project between the Government of India and Japan. It was formally launched in April 1993. It was proposed to build large number of sewage treatment plants to discharge treated wastewater into the rivers.

Microbial fuel cell(MFC)

- A microbial fuel cell is a bio-electrochemical system that drives an electric current by usingbacteria and mimicking bacterial interaction found in nature (Fig. 9.3). Microbial

fuel cells work by allowing bacteria to oxidize and reduce organic molecules. Bacterial respiration is basically one big redox reaction in which electrons are being moved around. A MFC consists of an anode and a cathode separated by a proton exchange membrane. Microbes at the anode oxidize the organic fuel generating protons which pass through the membrane to the cathode and the electrons pass through the anode to the external circuit to generate current.

Microbes in the production of biogas (Gobar gas)

- Biogas is a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural wastes, manure, municipal wastes, plant material, sewage, food waste, etc., Biogas is produced under anaerobic condition, when the organic materials are converted through microbiological reactions into gas and organic fertilizer. Biogas primarily consists of methane (63 percent), along with CO2 and hydrogen. Methane producing bacteria are called methanogens and one such common bacterium is Methanobacterium. Biogas is devoid of smell and burns with a blue flame without smoke. The Methanogens are also present in anaerobic sludge and rumen of cattle.

- In rumen, these bacteria help in the breakdown of cellulose. The excreta of cattle called dung is commonly called "Gobar". Gobar gas is generated by the anaerobic decomposition of cattle dung. It consists of methane, CO2 with some hydrogen, nitrogen and other gases in trace amounts.

- In a biogas plant, anaerobic digestion is carried out in an air tight cylindrical tank known as digester (Fig. 9.4). It is made up of concrete bricks and cement or steel. Bio-wastes are collected and slurry of dung is fed into this digester. It has a side opening into which organic materials for digestion are incorporated for microbial activity. Anaerobic digestion is accomplished in three stages: solubilisation, acidogenesis and methanogenisis. The outlet is connected to a pipe to supply biogas. The slurry is drained through another outlet and is used as fertilizer. Biogas is used for cooking and lighting. The technology of biogas production was developed in India mainly due to the efforts of Indian Agricultural Research Institute (IARI) and Khadi and Village Industries Commission (KVIC).

Microbes as bio control agents and bio fertilisers

- Large scale application of chemical insecticides and pesticides have a deleterious effect on the health of human beings and pollute our environment. Biocontrol is a method of controlling pest by use of microbessuch as fungi, bacteria, viruses or by naturally occurring substances derived from plants and animals. The use of a microbes or other biological agents to control a specific pest is called a biopesticide. Biopesticides are used to control insect pests. The lady bird beetle and dragonflies are useful to control aphids and mosquito larvae respectively. Bacillus thuringiensis is a soil dwelling bacterium which is commonly used as a biopesticide and contains a toxin called cry toxin (Fig. 9.5).

Scientists have introduced this toxin producing genes into plants and have raisedgenetically engineered insect resistant plants. E.g.Bt-cotton.

- During sporulation Bacillus thuringiensis produces crystal proteins called Delta-endotoxin which is encoded by cry genes. Delta-endotoxins have specific activities against the insects of the orders Lepidoptera, Diptera, Coleoptera and Hymenoptera. When the insects ingest the toxin crystals their alkaline digestive tract denatures the insoluble crystals making them soluble. The cry toxin then gets inserted into the gut cell membrance and paralyzes the digestive tract. The insect then stops eating and starves to death.

- Weedicides are substances, which destroy weeds without harming the useful plants. Bioweedicides are compounds and secondary metabolites derived from microbes such as fungi, bacteria or protozoa. The first bio herbicide developed in 1981 was a Mycoheribicide derived from the fungus Phytophthorapalmivora. It controls the growth of strangler vine in citrus crops. Trichoderma species are free living fungi that are very common in the root ecosystem. They are effective biocontrol agents for several plant pathogens. Buculoviruses are pathogens thatattack insects and other arthropods. The genus Nucleopolyhedrovirus is used as a biocontrol agent. These viruses are species specific and have narrow spectrum insecticidal applications.

Biofertilisers

- Biofertilisers are formulation of living microorganisms that enrich the nutrient quality of the soil. They increase physico – chemical properties of soils such as soil structure, texture, water holding capacity, cation exchange capacity and pH by providing several nutrients and sufficient organic matter. The main sources of biofertilisers are bacteria, fungi and cyanobacteria. Rhizobium is a classical example for symbiotic nitrogen fixing bacteria. This bacterium infects the root nodules of leguminous plants and fixes atmospheric nitrogen into organic forms. Azospirillum and Azotobacter are free living bacteria that fix atmospheric nitrogen and enrich the nitrogen content of soil.

- A symbiotic association between a fungus and the roots of the plants is called mycorrhiza. The fungal symbiont in these associations absorbs the phosphorus from soil and transfers to the plant. Plants having such association show other benefits such as resistance to root-borne pathogens, tolerance to salinity, drought, enhances plant growth and developments. For example, many members of the genus Glomusform mycorrhiza. Cyanobacteria (or) blue green algae (BGA) are prokaryotic free-living organisms which can fix nitrogen. Oscillatoria, Nostoc, Anabaena, Tolypothrix are well known nitrogen fixing cyanobacteria. Their importance is realized in the water logged paddy fields where Cyanobacteria multiply and fix molecular nitrogen. Cyanobacteria secrete growth promoting substances like indole-3-acetic acid, indole-3- butyric acid, naphthalene acetic acid, amino acids, proteins, vitamins which promotes plant growth and production.

- Biofertilisers are commonly used in organic farming methods. Organic farming is a technique, which involves cultivation of plants and rearing of animals in natural ways.

This process involves the use of biological materials, avoiding synthetic substances to maintain soil fertility and ecological balance thereby minimizing pollution and wastage.

Key features of organic farming

- ❖ Protecting soil quality using organic materials and encouraging biological activity.
- ❖ Indirect provision of crop nutrients using soil microorganisms.
- ❖ Nitrogen fixation in soils using legumes.
- ❖ Weed and pest control based on methods like crop rotation, biological diversity, natural predators, organic manures and suitable chemical, thermal and biological interventions.

Bioremediation

- The use of naturally occurring or genetically engineered microorganisms to reduce or degrade pollutants is called bioremediation. Bioremediation is less expensive and more sustainable than other remediation's available. It is grouped into in situ bioremediation(treatment of contaminated soil or water in the site) and ex situ bioremediation (treatment of contaminated soil or water that is removed from the site and treated).

Microorganisms involved in bioremediation

- Aerobic microbes degrade the pollutants in the presence of oxygen. They mainly degrade pesticides and hydrocarbons. Pseudomonas putida is a genetically engineered microorganism (GEM). Ananda Mohan Chakrabarty obtained patent for this recombinant bacterial strain. It is multi-plasmid hydrocarbon-degrading bacterium which can digest the hydrocarbons in the oil spills (Fig. 9.6).

- Nitrosomonaseuropaea is also capable of degrading benzene and a variety of halogenated organic compounds including trichloroethylene and vinyl chloride. Ideonellasakaiensis is currently tried for recycling of PET plastics (Fig. 9.7). These bacteria use PETase and MHETase enzymes to breakdown PET plastic into terephthalic acid and ethylene glycol.

- Anaerobic microbes degrade the pollutants in the absence of oxygen. Dechloromonasaromatica has the ability to degrade benzene anaerobically and to oxidize toluene and xylene. Phanerochaetechrysosporium an anaerobic fungus exhibits strong potential for bioremediation of pesticides, polyaromatic hydrocarbons, dyes, trinitrotoluene, cyanides, carbon tetrachloride, etc., Dehalococcoides species are responsible for anaerobic bioremediation of toxic trichloroethene to non-toxic ethane. Pestalotiopsismicrospora is a species of endophytic fungus capable of breaking down

and digesting polyurethane. This makes the fungus a potential candidate for bioremediation projects involving large quantities of plastics.

- Ideonellasakaiensis adhere to PET film PET Bottle Eats the terephthalic acid & ethylene glycol Breaks down PET into terephthalic acid & ethylene glycol Fig. 9.7 Actions of Ideonellasakaiensis

Summary

- All microbes are not pathogenic, many of them are beneficial to human beings. We use microbes and their derived products almost every day. Lactic acid bacteria convert milk into curd. Saccharomyces cerevisiae (yeast) is used in bread making. Idly and dosa are made from dough fermented by microbes. Bacteria and fungi are used in cheese making. Industrial products like lactic acid, acetic acid and alcohol are produced by microbes. Antibiotics are produced from useful microbes to kill the disease causing harmful microbes. For more than a hundred years, microbes are beingused to treat sewage by the process of activated sludge formation. Bio-gas produced by microbes is used as a source of energy in rural areas. Microbes are also used as bio-control agents to avoid the use of toxic pesticides. Now a days chemical fertilisers are gradually replaced by bio-fertilisers. In bio-remediation naturally occurring or genetically engineered microorganisms are used to reduce or degrade pollutants.