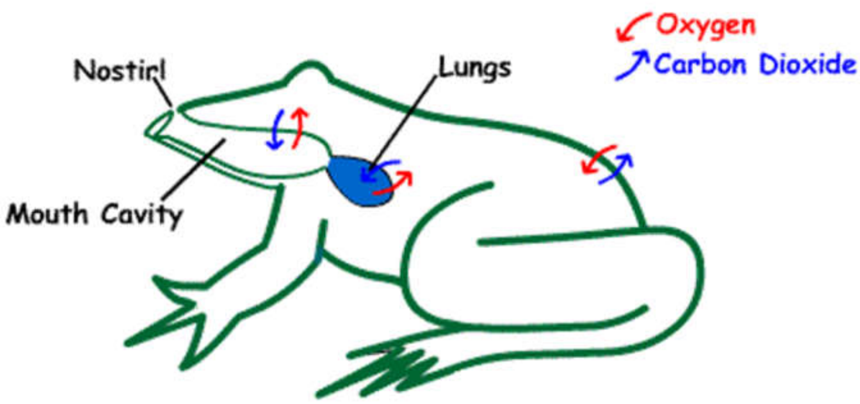
PRESENTS KCSE BIOLOGY NOTES

FORM TWO

TOPIC 7: GASEOUS EXCHANGE IN PLANTS AND ANIMALS



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SPECIFIC OBJECTIVES

By the end of the topic, the learner should be able to:

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a) Explain the need for gaseous exchange in living organisms

b) Explain the mechanism of gaseous exchange in plants

c) Compare the internal structures of aquatic and terrestrial roots, stems and leaves

d) Examine various types of respiratory structures in animals and relate them to their functions

e) State the characteristics of respiratory surfaces

f) Describe the mechanisms of gaseous exchange in protozoa, insects, fish, frog and mammal

g) Describe the factors which control the rate of breathing in humans

h) State the causes, symptoms and prevention of respiratory diseases.

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INTRODUCTION TO GASEOUS EXCHANGE IN PLANTS AND ANIMALS

Necessity for Gaseous Exchange in Living Organisms

- ✓ Living organisms require energy to perform cellular activities.
- ✓ The energy comes from breakdown of food in respiration.
- ✓ Carbon (IV) oxide is a byproduct of respiration and its accumulation in cells is harmful which has to be removed.
- ✓ Most organisms use oxygen for respiration which is obtained from the environment.
- ✓ Photosynthetic cells of green plants use carbon (IV) oxide as a raw material for photosynthesis and produce oxygen as a byproduct.
- ✓ The movement of these gases between the cells of organisms and the environment comprises gaseous exchange.
- ✓ The process of moving oxygen into the body and carbon (Iv) oxide out of the body is called breathing or ventilation.
- ✓ Gaseous exchange involves the passage of oxygen and carbon (IV) oxide through a respiratory surface.
- ✓ Diffusion is the main process involved in gaseous exchange.

Gaseous Exchange in Plants

- ✓ Oxygen is required by plants for the production of energy for cellular activities.
- ✓ Carbon (IV) oxide is required as a raw material for the synthesis of complex organic substances.
- ✓ Oxygen and carbon (IV) oxide are obtained from the atmosphere in the case of terrestrial plants and from the surrounding water in the case of aquatic plants.
- ✓ Gaseous exchange takes place mainly through the stomata.

Structure of Guard Cells

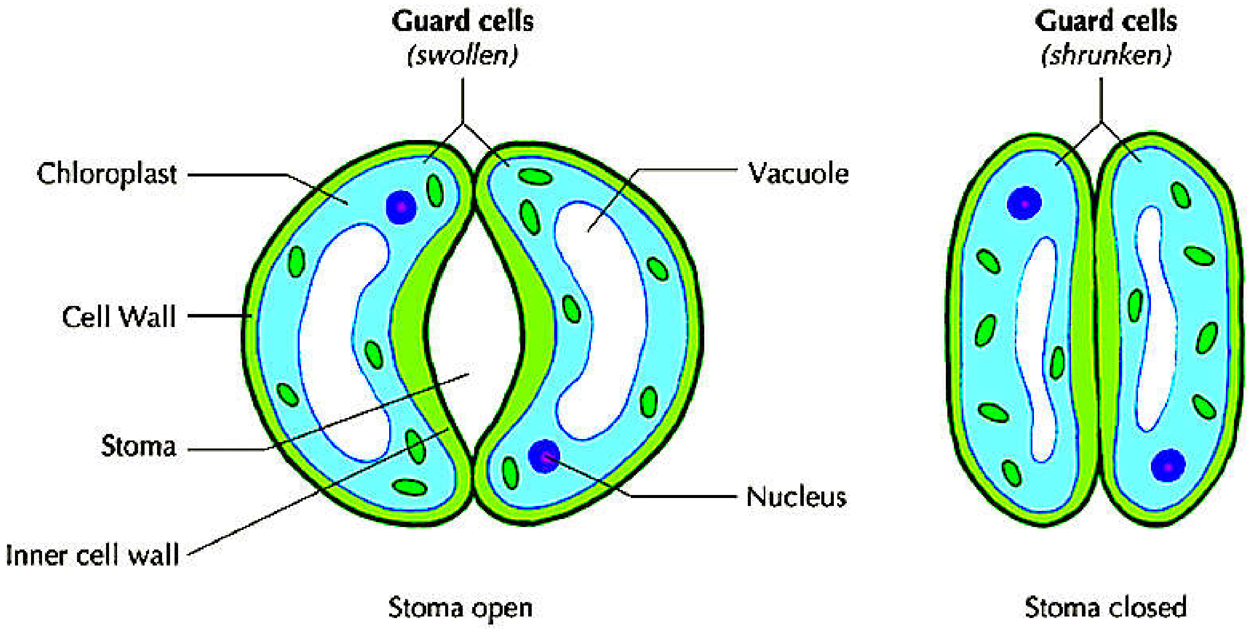

FIGURE 1: STRUCTURE OF GUARD CELL

- ✓ The stoma (stomata - plural) is surrounded by a pair of guard cells.
- ✓ The structure of the guard cells is such that changes in turgor inside the cell cause changes in their shape.
- ✓ They are joined at the ends and the cell walls facing the pore (inner walls) are thicker and less elastic than the cell walls farther from the pore (outer wall).
- ✓ Guard cells control the opening and closing of stomata.

Mechanism of Opening and Closing of Stomata

- ✓ In general stomata open during daytime (in light) and close during the night (darkness).
- ✓ Stomata open when osmotic pressure in guard cells becomes higher than that in surrounding cells due to increase in solute concentration inside guard cells. Water is then drawn into guard cells by osmosis.
- ✓ Guard cells become turgid and extend.
- ✓ The thinner outer walls extend more than the thicker walls.

- ✓ This causes a bulge and stoma opens.
- ✓ Stomata close when the solute concentration inside guard cells become lower than that of surrounding epidermal cells.
- ✓ The water moves out by osmosis, and the guard cells shrink i.e. lose their turgidity and stoma closes.

Proposed causes of turgor changes in guard cells.

Accumulation of sugar.

- ✓ Guard cells have chloroplasts while other epidermal cells do not.
- ✓ Photosynthesis takes place during daytime and sugar produced raises the solute concentration of guard cells.
- ✓ Water is drawn into guard cells by osmosis from surrounding cells.
- ✓ Guard cells become turgid and stoma opens.
- ✓ At night no photosynthesis occurs hence no sugar is produced.
- ✓ The solute concentration of guard cells falls and water moves out of the guard cells by osmosis.
- ✓ Guard cells lose turgidity and the stoma closes.

pH changes in guard cells occur due to photosynthesis.

- ✓ In day time carbon (IV) oxide is used for photosynthesis. This reduces acidity while the oxygen produced increases alkalinity.
- ✓ Alkaline pH favours conversion of starch to sugar.
- ✓ Solute concentration increases inside guard cells, water is drawn into the cells by osmosis. Guard cells become turgid and the stoma opens.
- ✓ At night when no photosynthesis, Respiration produces carbon (IV) oxide which raises acidity. This favours conversion of sugar to starch. Low sugar concentration lead to loss of turgidity in guard cells and stoma closes.

Explanation is based on accumulation of potassium

Ions

- ✓ In day time (light) adenosine triphosphate (ATP) is produced which causes potassium ions to move into guard cells by active transport.
- ✓ These ions cause an increase in solute concentration in guard cells that has been shown to cause movement of water into guard cells by osmosis.
- ✓ Guard cells become turgid and the stoma opens.
- ✓ At night potassium and chloride ions move out of the guard cells by diffusion and level of organic acid also decreases.
- ✓ This causes a drop in solute concentration that leads to movement of water out of guard cells by osmosis.
- ✓ Guard cells lose turgor and the stoma closes.

Process of Gaseous Exchange in Root Stem and Leaves of Aquatic and Terrestrial Plants

Gaseous Exchange in leaves of Terrestrial Plants

Gaseous exchange takes place by diffusion.

The structure of the leaf is adapted for gaseous exchange by having intercellular spaces that are filled.

These are many and large in the spongy mesophyll.

When stomata are open, carbon (IV) oxide from the atmosphere diffuses into the substomatal air chambers.

From here, it moves into the intercellular space in the spongy mesophyll layer.

The CO_2 goes into solution when it comes into contact with the cell surface and diffuses into the cytoplasm.

A concentration gradient is maintained between the cytoplasm of the cells and the intercellular spaces.

CO_2 therefore continues to diffuse into the cells.

The oxygen produced during photosynthesis moves out of the cells and into the intercellular spaces.

From here it moves to the substomatal air chambers and eventually diffuses out of the leaf through the stomata.

At night oxygen enters the cells while CO_2 moves out.

Gaseous exchange in the leaves of aquatic (floating) plants

- ✓ Aquatic plants such as water lily have stomata only on the upper leaf surface.
- ✓ The intercellular spaces in the leaf mesophyll are large.
- ✓ Gaseous exchange occurs by diffusion just as in terrestrial plants.

Observation of internal structure of leaves of aquatic plants

Transverse section of leaves of an aquatic plant such as Nymphaea differs from that of terrestrial plant.

The following are some of the features that can be observed in the leave of an aquatic plant;

- ✓ Absence of cuticle
- ✓ Palisade mesophyll cells are very close to each other i.e. compact.
- ✓ Air spaces (aerenchyma) in spongy mesophyll are very large.
- ✓ Sclereids (stone cells) are scattered in leaf surface and project into air spaces.
- ✓ They strengthen the leaf making it firm and assist it to float.

Gaseous Exchange through Stems

Terrestrial Plants

Stems of woody plants have narrow openings or slits at intervals called lenticels.

They are surrounded by loosely arranged cells where the bark is broken.

They have many large air intercellular spaces through which gaseous exchange occurs.

Oxygen enters the cells by diffusion while carbon (IV) oxide leaves.

Unlike the rest of the bark, lenticels are permeable to gases and water.

Aquatic Plant Stems

The water lily, Salvia and Wolfia whose stems remain in water are permeable to air and water.

Oxygen dissolved in the water diffuses through the stem into the cells and carbon (IV) oxide diffuses out into the water.

Gaseous Exchange in Roots

Terrestrial Plants

Gaseous exchange occurs in the root hair of young terrestrial plants.

Oxygen in the air spaces in the soil dissolves in the film of moisture surrounding soil particles and diffuses into the root hair along a concentration gradient.

It diffuses from root hair cells into the cortex where it is used for respiration.

Carbon (IV) oxide diffuses in the opposite direction.

In older roots of woody plants, gaseous exchange takes place through lenticels.

Aquatic Plants

Roots of aquatic plants e.g. water lily are permeable to water and gases.

Oxygen from the water diffuses into roots along a concentration gradient.

Carbon (IV) oxide diffuses out of the roots and into the water.

The roots have many small lateral branches to increase the surface area for gaseous exchange.

They have air spaces that help the plants to float.

Mangroove plants grow in permanently waterlogged soils, muddy beaches and at estuaries.

They have roots that project above the ground level.

These are known as breathing roots or pneumatophores.

These have pores through which gaseous exchange takes place e.g. in Avicenia the tips of the roots have pores.

Others have respiratory roots with large air spaces.

Gaseous Exchange in Animals

All animals take in oxygen for oxidation of organic compounds to provide energy for cellular activities.

The carbon (IV) oxide produced as a by-product is harmful to cells and has to be constantly removed from the body.

Most animals have structures that are adapted for taking in oxygen and for removal of carbon (IV) oxide from the body.

These are called "respiratory organs".

The process of taking in oxygen into the body and carbon (IV) oxide out of the body is called breathing or ventilation.

Gaseous exchange involves passage of oxygen and carbon (IV) oxide through a respiratory surface by diffusion.

Types and Characteristics of Respiratory surfaces

Different animals have different respiratory surfaces.

The type depends mainly on the habitat of the animal, size, shape and whether body form is complex or simple.

- ✓ **Cell Membrane**: In unicellular organisms the cell membrane serves as a respiratory surface.
- ✓ **Gills:** Some aquatic animals have gills which may be external as in the tadpole or internal as in bony fish e.g. tilapia. They are adapted for gaseous exchange in water.
- ✓ **Skin:** Animals such as earthworm and tapeworm use the skin or body surface for gaseous exchange. The skin of the frog is adapted for gaseous exchange both in water and on land. The frog also uses epithelium lining of the mouth or buccal cavity for gaseous exchange.
- ✓ **Lungs:** Mammals, birds and reptiles have lungs which are adapted for gaseous exchange.

Characteristics of Respiratory Surfaces

- ✓ They are permeable to allow entry of gases.
- ✓ They have a large surface area in order to increase diffusion.
- ✓ They are usually thin in order to reduce the distance of diffusion.
- ✓ They are moist to allow gases to dissolve.
- ✓ They are well-supplied with blood to transport gases and maintain a concentration gradient.

Gaseous Exchange in Amoeba

- ✓ Gaseous exchange occurs across the cell membrane by diffusion.
- ✓ Oxygen diffuses in and carbon (IV) oxide diffuses out.
- ✓ Oxygen is used in the cell for respiration making its concentration lower than that in the surrounding water.
- ✓ Hence oxygen continually enters the cell along a concentration gradient.
- ✓ Carbon (IV) oxide concentration inside the cell is higher than that in the surrounding water thus it continually diffuses out of the cell along a concentration gradient.

Gaseous Exchange in Insects

Gaseous exchange in insects e.g., grasshopper takes place across a system of tubes penetrating into the body known as the tracheal system.

The main trachea communicate with atmosphere through tiny pores called spiracles.

Spiracles are located at the sides of body segments;

Two pairs on the thoracic segments and eight pairs on the sides of abdominal segments.

Each spiracle lies in a cavity from which the trachea arises.

Spiracles are guarded with valves that close and thus prevent excessive loss of water vapour.

A filtering apparatus i.e. hairs also traps dust and parasites which would clog the trachea if they gained entry.

The valves are operated by action of paired muscles.

Mechanism of Gaseous Exchange in Insects

- ✓ The main tracheae in the locust are located laterally along the length of the body on each side and they are interconnected across.
- ✓ Each main trachea divides to form smaller tracheae, each of which branches into tiny tubes called tracheoles.
- ✓ Each tracheole branches further to form a network that penetrates the tissues. Some tracheoles penetrate into cells in active tissue such as flight muscles.
- ✓ These are referred to as intracellular tracheoles.
- ✓ Tracheoles in between the cells are known as intercellular tracheoles.
- ✓ The main tracheae are strengthened with rings of cuticle.
- ✓ This helps them to remain open during expiration when air pressure is low.

Adaptation of Insect Tracheoles for Gaseous Exchange

The fine tracheoles are very thin about one micron in diameter in order to permeate tissue.

They are made up of a single epithelial layer and have no spiral thickening to allow diffusion of gases.

Terminal ends of the fine tracheoles are filled with a fluid in which gases dissolve to allow diffusion of oxygen into the cells.

Amount of fluid at the ends of fine tracheoles varies according to activity i.e. oxygen demand of the insect.

During flight, some of the fluid is withdrawn from the tracheoles such that oxygen reaches muscle cells faster and the rate of respiration is increased.

In some insects, tracheoles widen at certain places to form air sacs.

These are inflated or deflated to facilitate gaseous exchange as need arises.

Atmospheric air that dissolves in the fluid at the end of tracheoles has more oxygen than the surrounding cells of tracheole epithelium'.

Oxygen diffuses into these cells along a concentration gradient. '

Carbon (IV) oxide concentration inside the cells is higher than in the atmospheric.

Air and diffuses out of the cells along a concentration gradient.

It is then removed with expired air.

Ventilation in Insects

Ventilation in insects is brought about by the contraction and relaxation of the abdominal muscles.

In locusts, air is drawn into the body through the thoracic spiracles and expelled through the abdominal spiracles.

Air enters and leaves the tracheae as abdominal muscles contract and relax.

The muscles contract laterally so the abdomen becomes wider and when they relax it becomes narrow.

Relaxation of muscles results in low pressure hence inspiration occurs while contraction of muscles results in higher air pressure and expiration occurs.

In locusts, air enters through spiracles in the thorax during inspiration and leaves through the abdominal spiracles during expiration.

This results in efficient ventilation.

Maximum extraction of oxygen from the air occurs sometimes when all spiracles close and hence contraction of abdominal muscles results in air circulating within the tracheoles.

The valves in the spiracles regulate the opening and closing of spiracles.

Observation of Spiracle in Locust

Some fresh grass is placed in a gas jar.

A locust is introduced into the jar.

A wire mesh is placed on top or muslin cloth tied around the mouth of the beaker with rubber band.

The insect is left to settle.

Students can approach and observe in silence the spiracles and the abdominal movements during breathing.

Alternatively the locust is held by the legs and observation of spiracles is made by the aid of hand lens.

Gaseous Exchange in Bony Fish (e.g., Tilapia)

Gaseous exchange in fish takes place between the gills and the surrounding water.

The gills are located in an opercular cavity covered by a flap of skin called the operculum.

Each _gill consists of a number of thin leaf-like lamellae projecting from a skeletal base bronchial arch (gill bar) situated in the wall of the pharynx.

There are four gills within the opercular cavity on each side of the head.

Each gill is made up of a bony gill arch which has a concave surface facing the mouth cavity (anterior) and a convex posterior surface.

Gill rakers are bony projections on the concave side that trap food and other solid particles which are swallowed instead of going over and damaging the gill filaments.

Two rows of gill filaments subtend from the convex surface.

Adaptation of Gills for Gaseous Exchange

Gill filaments are thin walled.

Gill filaments are very many (about seventy pairs on each gill), to increase surface area.

Each gill filament has very many gill lamellae that further increase surface area.

The gill filaments are served by a dense network of blood vessels that ensure efficient transport of gases.

It also ensures that a favourable diffusion gradient is maintained.

The direction of flow of blood in the gill lamellae is in the opposite direction to that of the water (counter current flow) to ensure maximum diffusion of gases.

Ventilation

As the fish opens the mouth, the floor of the mouth is lowered.

This increases the volume of the buccal cavity.

Pressure inside the mouth is lowered causing water to be drawn into the buccal cavity.

Meanwhile, the operculum is closed, preventing water from entering or leaving through the opening.

As the mouth closes and the floor of the mouth is raised, the volume of buccal cavity decreases while pressure in the opercular cavity increases due to contraction of opercular muscles.

The operculum is forced to open and water escapes.

As water passes over the gills, oxygen is absorbed and carbon dioxide from the gills dissolves in the water.

As the water flows over the gill filaments oxygen in the water is at a higher concentration than that in the blood flowing, in the gill.

Oxygen diffuses through the thin walls of gill filaments/lamellae into the blood.

Carbon (IV) oxide is at a higher concentration in the blood than in the water.

It diffuses out of blood through walls of gill filaments into the water.

Counter Current Flow

In the bony fish direction of flow of water over the gills is opposite that of blood flow through the gill filaments.

This adaptation ensures that maximum amount of oxygen diffuses from the water into the blood in the gill filament.

This ensures efficient uptake of oxygen from the water.

Where the flow is along the same direction (parallel flow) less oxygen is extracted from the water.

Observation of Gills of a Bony Fish (Tilapia)

Gills of a fresh fish are removed and placed in a petri-dish with enough water to cover them.

A hand lens is used to view the gills.

Gill bar, gill rakers and two rows of gill filaments are observed.

Gaseous Exchange in an Amphibian - Frog

An adult frog lives on land but goes back into the water during the breeding season.

A frog uses three different respiratory surfaces.

These are the skin, buccal cavity and lungs.

Skin

The skin is used both in water and on land.

It is quite efficient and accounts for 60% of the oxygen taken in while on land.

Adaptations of a Frog's Skin for Gaseous Exchange

The skin is a thin epithelium to allow fast diffusion.

The skin between the digits in the limbs (i.e. webbed feet) increase the surface area for gaseous exchange.

It is richly supplied with blood vessels for transport of respiratory gases.

The skin is kept moist by secretions from mucus glands.

This allows for respiratory gases to dissolve.

Oxygen dissolved in the film of moisture diffuses across the thin epithelium and into the blood which has a lower concentration of oxygen.

Carbon (IV) oxide diffuses from the blood across the skin to the atmosphere along the concentration gradient.

Buccal (Mouth) Cavity

Gaseous exchange takes place all the time across thin epithelium lining the mouth cavity.

Adaptations of Buccal Cavity for Gaseous Exchange

It has a thin epithelium lining the walls of the mouth cavity allowing fast diffusion of gases.

It is kept moist by secretions from the epithelium for dissolving respiratory gases.

It has a rich supply of blood vessels for efficient transport of respiratory gases.

The concentration of oxygen in the air within the mouth cavity is higher than that of the blood inside the blood vessels.

Oxygen, therefore dissolves in the moisture lining the mouth cavity and then diffuses into the blood through the thin epithelium.

On the other hand, carbon (IV) oxide diffuses in the opposite direction along a concentration gradient.

Lungs

There is a pair of small lungs used for gaseous exchange.

Adaptation of Lungs

The lungs are thin walled for fast diffusion of gases.

Have internal folding to increase surface area for gaseous exchange.

A rich supply of blood capillaries for efficient transport of gases.

Moisture lining for gases to dissolve.

Ventilation

Inspiration

During inspiration, the floor of the mouth is lowered and air is drawn in through the nostrils.

When the nostrils are closed and the floor of the mouth is raised, air is forced into the lungs.

Gaseous exchange occurs in the lungs, oxygen dissolves in the moisture lining of the lung and diffuses into the blood through the thin walls.

Carbon (IV) oxide diffuses from blood into the lung lumen.

Expiration

When the nostrils are closed and the floor of mouth is lowered by contraction of its muscles, volume of mouth cavity increases.

Abdominal organs press against the lungs and force air out of the lungs into buccal cavity.

Nostrils open and floor of the mouth is raised as its muscles relax.

Air is forced out through the nostrils.

Gaseous Exchange in a Mammal -Human

The breathing system of a mammal consists of a pair of lungs which are thin-walled elastic sacs lying in the thoracic cavity.

The thoracic cavity consists of vertebrae, sternum, ribs and intercostal muscles.

The thoracic cavity is separated from the abdominal cavity by the diaphragm.

The lungs lie within the thoracic cavity.

They are enclosed and protected by the ribs which are attached to the sternum and the thoracic vertebrae.

There are twelve pairs of ribs, the last two pairs are called 'floating ribs' because they are only attached to the vertebral column.

The ribs are attached to and covered by internal and external intercostal muscles.

The diaphragm at the floor of thoracic cavity consists of a muscle sheet at the periphery and a central circular fibrous tissue.

The muscles of the diaphragm are attached to the thorax wall.

The lungs communicate with the outside atmosphere through the bronchi, trachea, mouth and nasal cavities.

The trachea opens into the mouth cavity through the larynx.

A flap of muscles, the epiglottis, covers the opening into the trachea during swallowing.

This prevents entry of food into the trachea.

Nasal cavities are connected to the atmosphere through the external nares(or nostrils)which are lined with hairs and mucus that trap dust particles and bacteria, preventing them from entering into the lungs.

Nasal cavities are lined with cilia.

The mucus traps dust particles,

The cilia move the mucus up and out of the nasal cavities.

The mucus moistens air as it enters the nostrils.

Nasal cavities are winding and have many blood capillaries to increase surface area to ensure that the air is warmed as it passes along.

Each lung is surrounded by a space called the pleural cavity.

It allows for the changes in lung volume during breathing.

An internal pleural membrane covers the outside of each lung while an external pleural membrane lines the thoracic wall.

The pleural membranes secrete pleural fluid into the pleural cavity.

This fluid prevents friction between the lungs and the thoracic wall during breathing.

The trachea divides into two bronchi, each of which enters into each lung.

Trachea and bronchi are lined with rings of cartilage that prevent them from collapsing when air pressure is low.

Each bronchus divides into smaller tubes, the bronchioles.

Each bronchiole subdivides repeatedly into smaller tubes ending with fine bronchioles.

The fine bronchioles end in alveolar sacs, each of which gives rise to many alveoli.

Epithelium lining the inside of the trachea, bronchi and bronchioles has cilia and secretes mucus.

Adaptations of Alveolus to Gaseous Exchange

Each alveolus is surrounded by very many blood capillaries for efficient transport of respiratory gases.

There are very many alveoli that greatly increases the surface area for gaseous exchange.

The alveolus is thin walled for faster diffusion of respiratory gases.

The epithelium is moist for gases to dissolve.

Gaseous Exchange between the Alveoli and the Capillaries

The walls of the alveoli and the capillaries are very thin and very close to each other.

Blood from the tissues has a high concentration of carbon (IV) oxide and very little oxygen compared to alveolar air.

The concentration gradient favours diffusion of carbon (IV) oxide into the alveolus and oxygen into the capillaries.

No gaseous exchange takes place in the trachea and bronchi.

These are referred to as dead space.

Ventilation

Exchange of air between the lungs and the outside is made possible by changes in the volumes of the thoracic cavity.

This volume is altered by the movement of the intercostal muscles and the diaphragm.

Inspiration

The ribs are raised upwards and outwards by the contraction of the external intercostal muscles, accompanied by the relaxation of internal intercostal muscles.

The diaphragm muscles contract and diaphragm moves downwards.

The volume of thoracic cavity increases, thus reducing the pressure.

Air rushes into the lungs from outside through the nostrils.

Expiration

The internal intercostal muscles contract while external ones relax and the ribs move downwards and inwards.

The diaphragm muscles relaxes and it is pushed upwards by the abdominal organs. It thus assumes a dome shape.

The volume of the thoracic cavity decreases, thus increasing the pressure.

Air is forced out of the lungs.

As a result of gaseous exchange in the alveolus, expired air has different volumes of atmospheric gases as compared to inspired air.

Component	Inspired %	Expired %
Oxygen	21	16
Carbon dioxide	0.03	4
Nitrogen	79	79
Moisture	Variable	Saturated

TABLE 1: COMPARISON OF INSPIRED AND EXPIRED AIR (% BY VOLUME)

Lung Capacity

The amount of air that human lungs can hold is known as lung capacity.

The lungs of an adult human are capable of holding 5,000 cm3 of air when fully inflated.

However, during normal breathing only about 500 cm3 of air is exchanged.

This is known as the tidal volume.

A small amount of air always remains in the lungs even after a forced expiration.

This is known as the residual volume.

The volume of air inspired or expired during forced breathing is called vital capacity.

Control of Rate of Breathing

The rate of breathing is controlled by the respiratory centre in the medulla of the brain.

This centre sends impulses to the diaphragm through the phrenic nerve.

Impulses are also sent to the intercostal muscles.

The respiratory centre responds to the amount of carbon (IV) oxide in the blood.

If the amount of carbon (IV) oxide rises, the respiratory centre sends impulses to the diaphragm and the intercostal muscles which respond by contracting in order to increase the ventilation rate.

Carbon (IV) oxide is therefore removed at a faster rate.

Factors Affecting Rate of Breathing in Humans

- ✓ Factors that cause a decrease or increase in energy demand directly affect rate of breathing.
- ✓ Exercise, any muscular activity like digging.
- ✓ Sickness
- ✓ Emotions like anger, flight
- ✓ Sleep.

Effects of Exercise on Rate of Breathing

- ✓ Students to work in pairs.
- ✓ One student stands still while the other counts (his/her) the number of breaths per minute.
- ✓ The student whose breath has been taken runs on the sport vigorously for 10 minutes.
- ✓ At the end of 10 minutes the number of breaths per minute is immediately counted and recorded.
- ✓ It is noticed that the rate of breathing is much higher after exercise than at rest.

Dissection of a Small Mammal (Rabbit) to Show Respiratory Organs

The rabbit is placed in a bucket containing cotton wool which has been soaked in chloroform.

The bucket is covered tightly with a lid.

The dead rabbit is placed on the dissecting board ventral side upwards.

Pin the rabbit to the dissecting board by the legs.

Dissect the rabbit to expose the respiratory organs.

Ensure that you note the following features.

Ribs, intercostal muscles, diaphragm, lungs, bronchi, trachea, pleural membranes, thoracic cavity.

Diseases of the Respiratory System

Asthma

Asthma is a chronic disease characterised by narrowing of air passages.

Causes:

1) **Allergy**

Due to pollen, dust, fur, animal hair, spores among others.

If these substances are inhaled, they trigger release of chemical substances and they may cause swelling of the bronchioles and bring about an asthma attack.

2) **Heredity**

Asthma is usually associated with certain disorders which tend to occur in more than one member of a given family, thus suggesting' a hereditary tendency.

3) **Emotional or mental stress**

Strains the body immune system hence predisposes to asthma attack.

Symptoms

Asthma is characterized by wheezing and difficulty in breathing accompanied by feeling of tightness in the chest as a result of contraction of the smooth muscles lining the air passages.

Treatment and Control

- ✓ There is no definite cure for asthma.
- ✓ The best way where applicable is to avoid whatever triggers an attack (allergen).
- ✓ Treatment is usually by administering drugs called bronchodilators.
- ✓ The drugs are inhaled, taken orally or injected intravenously depending on severity of attack to relief bronchial spasms.

Bronchitis

This is an inflammation of bronchial tubes.

Causes

This is due to an infection of bronchi and bronchioles by bacteria and viruses.

Symptoms

- ✓ Difficulty in breathing.
- ✓ Cough that produces mucus.

Treatment

- ✓ Antibiotics are administered.

Pulmonary Tuberculosis

Tuberculosis is a contagious disease that results in destruction of the lung tissue.

Causes

- ✓ Tuberculosis is caused by the bacterium Mycobacterium tuberculosis.
- ✓ Human tuberculosis is spread through droplet infection i.e., in saliva and sputum.
- ✓ Tuberculosis can also spread from cattle to man through contaminated milk.
- ✓ From a mother suffering from the disease to a baby through breast feeding.
- ✓ The disease is currently on the rise due to the lowered immunity in persons with HIV and AIDS (Human Immuno Deficiency Syndrome).
- ✓ Tuberculosis is common in areas where there is dirt, overcrowding and malnourishment.

Symptoms

It is characterised by a dry cough, lack of breath and body wasting.

Prevention

- ✓ Proper nutrition with a diet rich in proteins and vitamins to boost immunity.
- ✓ Isolation of sick persons reduces its spread.
- ✓ Utensils used by the sick should be sterilised by boiling.

- ✓ Avoidance of crowded places and living in well ventilated houses.
- ✓ Immunisation with B.C.G. vaccine gives protection against tuberculosis.
- ✓ This is done a few days after birth with subsequent boosters.

Treatment

Treatment is by use of antibiotics.

Pneumonia

Pneumonia is infection resulting in inflammation of lungs.

The alveoli get filled with fluid and bacterial cells decreasing surface are for gaseous exchange.

Pneumonia is caused by bacteria and virus.

More infections occur during cold weather.

The old and the weak in health are most vulnerable.

Symptoms

Pain in the chest accompanied by a fever, high body temperatures (39-40°C) and general body weakness.

Prevention

- ✓ Maintain good health through proper feeding.
- ✓ Avoid extreme cold.

Treatment

- ✓ If the condition is caused by pneumococcus bacteria, antibiotics are administered.
- ✓ If breathing is difficult, oxygen may be given using an oxygen mask.

Whooping Cough

- ✓ Whooping cough is an acute infection of respiratory tract.

- ✓ The disease is more common in children under the age of five but adults may also be affected.

Causes

It is caused by Bordetella pertusis bacteria and is usually spread by droplets produced when a sick person coughs.

Symptoms:

- ✓ Severe coughing and frequent vomiting.
- ✓ Thick sticky mucus is produced.
- ✓ Severe broncho-pneumonia.
- ✓ Convulsions in some cases.

Prevention

- ✓ Children may be immunised against whooping cough by means of a vaccine which is usually combined with those against diphtheria and tetanus.
- ✓ It is called "Triple Vaccine" or Diphtheria, Pertusis and Tetanus (DPT).

Treatment

- ✓ Antibiotics are administered.
- ✓ To reduce the coughing, the patient should be given drugs.

Practical Activities

Observation of permanent slides of terrestrial and aquatic leaves and stems

Leaves

- ✓ Observation of T.S. of bean and water lily are made under low and 'medium power objectives. Stomata and air space are seen.
- ✓ Labelled drawings of each are made.
- ✓ The number and distribution of stomata on the lower and upper leaf surface is noted.
- ✓ Also the size of air spaces and their distribution.

Stem

- ✓ Prepared slides (TS) of stems of terrestrial and aquatic plants such as croton and reeds are obtained.
- ✓ Observations under low power and medium power of a microscope are made.
- ✓ Labelled drawings are made and the following are noted:
  1) Lenticels on terrestrial stems.
  2) Large air spaces (aerenchyma) in aquatic stems.