

# Gaseous Exchange

## Long Answer Questions

**Q.1** What do you know about cellular respiration?

**Ans.** Cellular respiration is the process in which the C-H bonds in food are broken by oxidation reduction reactions and energy is transformed into ATP.

**Q.2** What is aerobic respiration?

**Ans.** In aerobic respiration, oxygen is used and there is complete oxidation of the food material. Carbon dioxide and water are also produced in this process.

**Q.3** Define gaseous exchange. Why oxygen is needed?

**Ans.** Definition

Taking in oxygen and giving out of carbon dioxide is termed as gaseous exchange.

**Need of Oxygen**

Organisms get the oxygen needed for cellular respiration from their environment and provide it to their cells. The carbon dioxide which produces during cellular respiration is taken out of the cells and ultimately from the body.

**Q.4** What is breathing? How is it different from respiration?

**Ans.** Breathing

The process through which animals take air in their bodies to get oxygen from it and then give out the air for getting rid of carbon dioxide.

**Difference between respiration and breathing**

| RESPIRATION   | BREATHING  |
|---|--|
| (i) It involves the mechanical and the biochemical processes. | (i) It is only the mechanical or physical process of exchanging the gases. |
| (ii) It is of two types and takes place in cells.             | (ii) It occurs in two phases and takes place in respiratory system.        |

**Q.5** Describe the process of gaseous exchange in plants.

**Ans.** Introduction

Plants have no organs or systems for the exchange of gases with the environment. Every cell of a plant exchanges gases with the environment by its own.

**Explanation**

**i) Gaseous exchange in leaves and young stems**

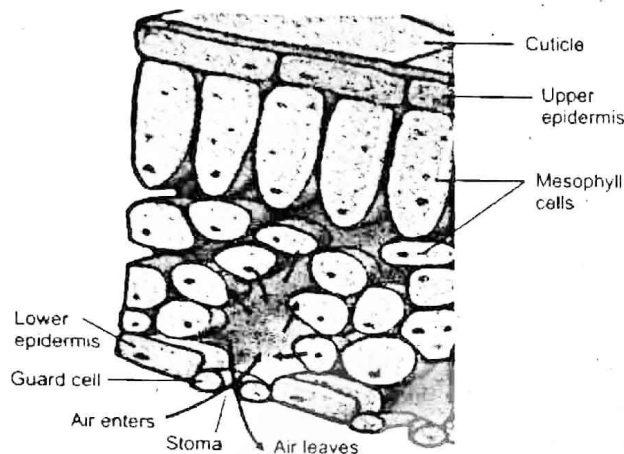
The leaves and young stems have stomata in their epidermis for gaseous exchange.

The inner cells of leaves (mesophyll) and stems also have air spaces among them which help in the exchange of gases. In young stems and leaves, some gaseous exchange also occurs through cuticle.

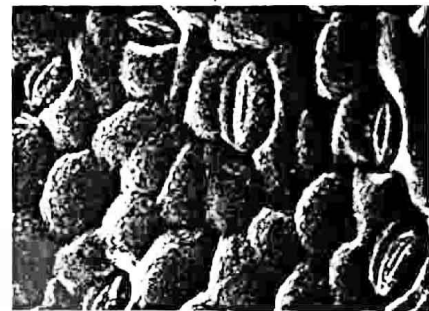
## Explanation

During the daytime mesophyll cells of leaves carry out photosynthesis and respiration side by side, the oxygen produces in photosynthesis is utilized in cellular respiration. Similarly the carbon dioxide produces during cellular respiration is utilized in photosynthesis.

However, during night when there is no photosynthesis occurring, the leaf cells get oxygen from the environment and release carbon dioxide through stomata.



Opening and Closing of a Stomata



## ii. Gaseous exchange in woody stems and mature roots

In woody stems and mature roots, the entire surface is covered by bark which is impervious to gases or water. However, there are certain pores in the layer of bark. These are called the lenticels. The lenticels allow air to pass through them.

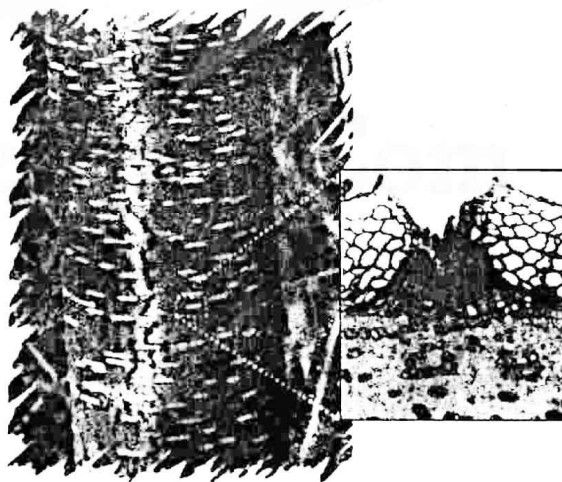


Figure 10.2: Lenticels on a stem and the internal view of a lenticel

## iii. Gaseous exchange in young roots

Gases are found in the soil surrounding the roots. These gases diffuse in and out of the general surface of the young roots.

## iv. Gaseous exchange in aquatic plants

The aquatic plants get the oxygen dissolved in water and release carbon dioxide in the water.

## Q.6 Describe the structure and functions of human respiratory system.

### Ans. Introduction

In humans and other higher animals, the exchange of gases is carried out by the respiratory system.

## Parts of respiratory system

We can divide respiratory system in two parts i.e.

- (1) The air passageway
- (2) The lungs

### 1. Air passageway

#### Definition

It consists of the parts through which the outside air comes in the lungs and after the exchange of gases it goes out.

#### Parts of air passageway

This passage of air consists of the following parts:

##### a) Nasal cavity and nostrils

The nose encloses the nasal cavity. It opens to the outside through the openings called the nostrils.

#### Structure

The nasal cavity is divided into two portions by a wall. Each portion is lined by fine hairs and mucous.

#### Function

Fine hairs and mucous filter the dust particles from the air. The mucous also moistens and warms the incoming air and keeps its temperature nearly equal to that of the body.

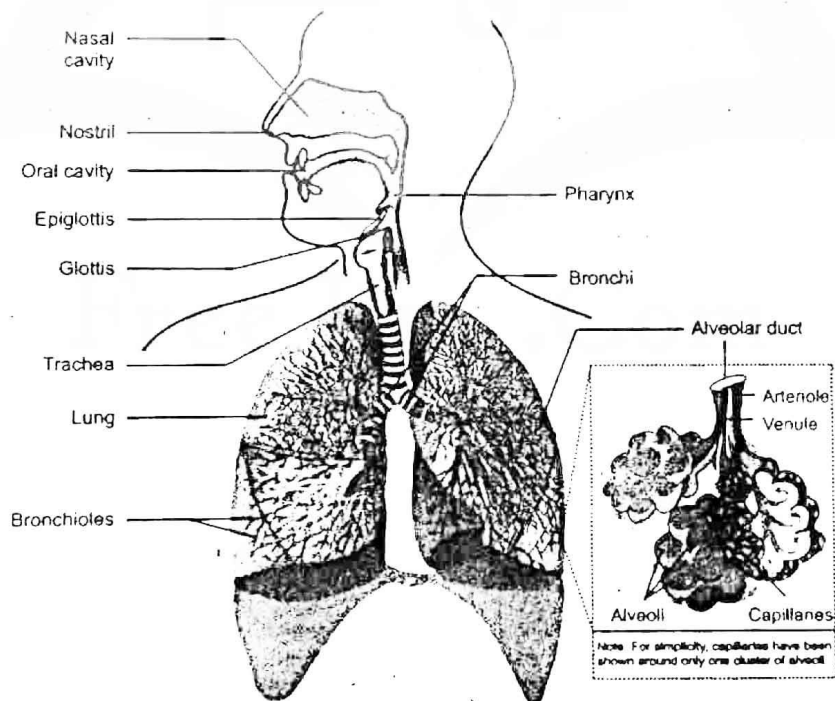


Figure 10.3: The air passageway and the lungs

##### b) Pharynx

The nasal cavity opens into the pharynx by means of two small openings called internal nostrils. It is a muscular passage and is common to both food and air. It extends to the opening of the oesophagus and the larynx.

##### c) Glottis and epiglottis

It is a narrow opening at the floor of pharynx which leads into larynx. The air goes from the pharynx into the larynx. The glottis is guarded by a flap of tissue called the epiglottis.

#### **d) Larynx or voice box**

The larynx is a box made of cartilage. It is also called the voice box.

#### **Location**

It is present between pharynx and trachea.

#### **Vocal cords and sound production**

Two pairs of fibrous bands called vocal cords are stretched across the larynx. When the air passes through them, the vocal cords vibrate. This vibration produces sounds. Movements of lips, cheeks, tongue and jaws produce specific sounds which results in speech. Speech is an ability of only humans.

#### **e) Trachea**

Larynx continues to the trachea, which is also called the windpipe.

#### **Length and location**

It is about 12 cm long tube which lies in front of the oesophagus.

#### **Structure**

There are C-shaped cartilagenous rings in the wall of trachea.

#### **Function of cartilage**

The cartilages keep the trachea from collapsing even when there is no air in it.

#### **f) Bronchi**

On entering the chest cavity, the trachea divides into two smaller tubes called bronchi (singular: bronchus).

#### **Structure**

The bronchi also have cartilagenous plates in their walls.

#### **Division of Bronchi**

Each bronchus enters into the lung of its side and then divides into smaller branches.

#### **Other functions of trachea and bronchi**

Both trachea and the bronchi are also lined with ciliated and glandular cells.

#### **Function of glandular cells**

These cells secrete mucous which moistens the air and also traps any fine particles of dust or bacteria that have escaped from the nasal cavity.

#### **Function of cilia**

The cilia beat with an upward motion so that the foreign particles along the mucous are sent to the oral cavity from where it may be either swallowed or coughed out.

#### **g) Bronchioles**

The bronchi continue dividing in the lungs until they make several fine tubes called bronchioles. The bronchioles progressively lose the cartilages as they become narrower.

#### **h) Alveolar Ducts**

The bronchioles end as fine tubules called the alveolar ducts.

#### **i) Alveoli**

Each alveolar duct opens into a cluster of pouches called alveoli.

Each alveolus is a sac-like structure lined by a single layer of epithelial cells. It is bound on the outside by a network of capillaries.

#### j) Pulmonary artery

The pulmonary artery from the heart containing deoxygenated blood enters the lungs and branches into arterioles and then into capillaries which surround the alveoli.

#### k) Pulmonary vein

Capillaries join together to form the venules which form pulmonary vein. The pulmonary vein carries the oxygenated blood back to the heart.

### 2) Lungs

All the alveoli on one side constitute a lung. There is a pair of lungs in the thoracic cavity.

#### Chest wall formation

It is made up of 12 pairs of ribs and the rib muscles called intercostal muscles.

#### Diaphragm

A thick muscular structure present below the lungs is called diaphragm.

#### Lobes of lungs

The left lung is slightly smaller and has two lobes and the right lung is bigger with three lobes. They are spongy and elastic organs.

#### Blood vessels of lungs

The lungs also have blood vessels that are the branches of the pulmonary arteries and veins.

#### Pleural membranes

Each lung is enclosed by two membranes called the outer pleural membrane and the inner pleural membrane.

The membranes enclose a fluid which provides lubrication for the free expanding and contracting of the lungs.

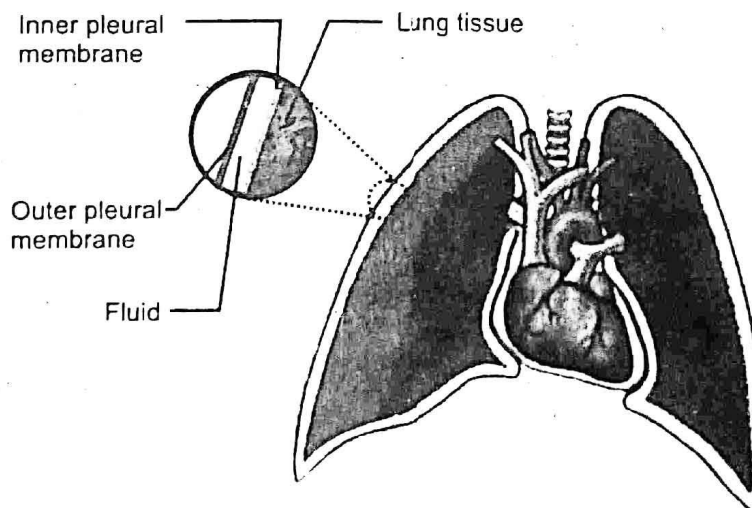


Figure 10.4: Lungs and pleural membranes

**Q.7 Describe the mechanism of breathing.** (Board 2014)

**Ans. Introduction**

The physical movements associated with the gaseous exchange are called breathing.

## Phases of Breathing

There are two phases of breathing i.e.

1. Inhalation
2. Exhalation

### 1. Inhalation or inspiration

#### a) Contraction of rib muscles and diaphragm

During inspiration the rib muscles contract and ribs are raised. At the same time the dome shaped diaphragm contracts and is lowered.

#### b) Effect of contraction

These movements increase the area of the thoracic cavity which reduces the pressure on lungs. As a result, the lungs expand and the air pressure within them also decreases. The air from outside rushes into the lungs to equalize the pressure on both sides.

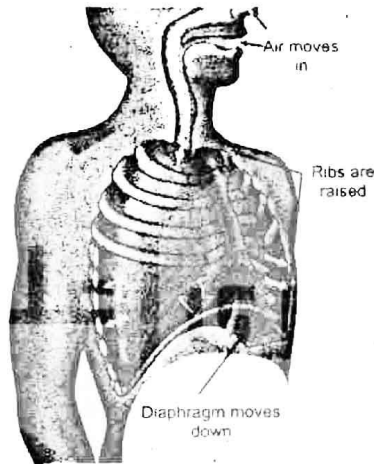


Figure 10.5: Steps of Inhalation

### 2. Exhalation or expiration

#### a) Relaxation of rib muscles and diaphragm

After the gaseous exchange in the lungs, the impure air is expelled out in exhalation. The rib muscles relax bringing the ribs back to the original position. The diaphragm muscles also relax and it gets its raised dome shape.

#### b) Effect of relaxation

This reduces the space in the chest cavity and increases the pressure on lungs. The lungs contract and the air is expelled out of them.

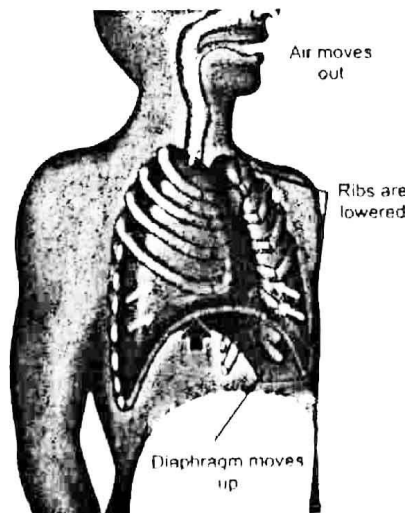


Figure 10.6: Steps of Exhalation

## Breathing rate of humans

Humans breathe 16 – 20 times per minute in normal circumstances i.e. at rest.

## Control of Breathing rate

The rate of breathing is controlled by the respiratory centre in the brain. The respiratory centre is sensitive to the concentration of carbon dioxide in the blood. When we do exercise or some hard job, our muscle cells carry out cellular respiration at greater rate. It results in the production of more carbon dioxide which is released in the blood. This greater than normal concentration of carbon dioxide stimulates the respiratory centre of brain. The respiratory centre sends messages to the rib muscles and diaphragm to increase the rate of breathing so that the excess carbon dioxide present in blood can be removed out of body.

## Breathing rate during exercise

During exercise or other hard physical works the breathing rate may increase up to 30–40 times per minute.

**Q.8 Describe the comparison between the inspired and the expired air.**

**Ans.**

| Feature                  | Inspired air | Expired air                      |
|--------------------------|--------------|----------------------------------|
| Amount of oxygen         | 21%          | 16%                              |
| Amount of carbon dioxide | 0.04%        | 4%                               |
| Amount of nitrogen       | 79%          | 79%                              |
| Amount of water vapours  | Variable     | Saturated                        |
| Amount of dust particles | Variable     | Almost none                      |
| Temperature              | Variable     | Almost equal to body temperature |

**Q.9 Describe different types of respiratory disorders in man.**

**Ans.** There are a number of respiratory disorders which affect people. The high percentage of respiratory disorders in Pakistan is due to more concentration of air pollutants both in urban and rural atmosphere.

**Some of the important respiratory disorders are:**

### i. Bronchitis

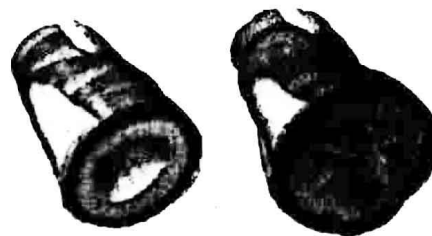
#### a) Introduction

It is the inflammation of the bronchi or bronchioles.

#### b) Causes

i) It results in excessive secretion of mucous into the tubes, leading to the swelling of tubular walls and narrowing of tubes.

ii) It is caused by viruses, bacteria or exposure to chemical irritants (e.g. tobacco smoke).



**Figure 10.7: Bronchi normal (left) and inflamed (right)**



### c) Types

There are two major types of bronchitis i.e. acute and chronic.

#### i) Acute Bronchitis

It usually lasts about two weeks and patient recovers with no permanent damage to bronchi or bronchioles.

#### ii) Chronic bronchitis

In chronic bronchitis, the bronchi develop chronic inflammation. It usually lasts for three months to two years.

### d) Symptoms

Symptoms of bronchitis include:

- Cough
- Mild wheezing
- Fever
- Chills
- Shortness of breath (especially when doing hard job)

### e) Age limit

The majority of people diagnosed with chronic bronchitis are 45 years of age or older.

## ii. Emphysema

### Introduction

It is the destruction of the walls of the alveoli.

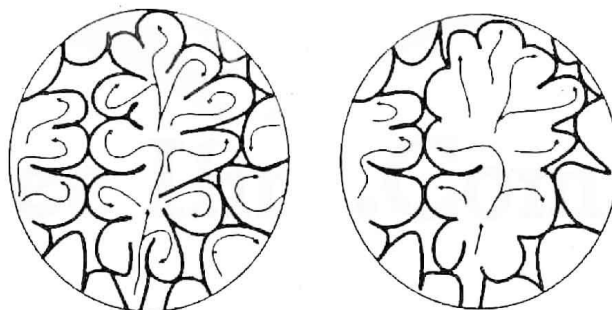


Figure 10.8: The Alveoli, normal (left) and emphysema (right)

### Explanation

It results in larger sacs but with less surface area for gaseous exchange. As lung tissue breaks down, the lungs do not come back to their original shape after exhalation so air cannot be pushed out and is trapped in the lungs.

### Symptoms

It includes:

- i. Shortness of breath
- ii. Fatigue
- iii. Recurrent respiratory infections.
- iv. Weight loss

By the time the symptoms of emphysema appear, the patient has usually lost 50% to 70% of his/her lung tissue.



## Effects

The level of oxygen in blood may get so low that it causes serious complications.

### iii. Pneumonia

#### Introduction

It is an infection of lungs.

#### Double pneumonia

If this infection affects both lungs, it is called double pneumonia.

#### Causes

The most common cause of pneumonia is a bacterium, *Streptococcus pneumoniae*. Some viral (influenza virus) and fungal infections may also lead to pneumonia.

#### Explanation

When the causative organisms enter the alveoli, they break the lung tissues and the area is filled with fluid and pus.

#### Symptoms

It includes a cold that is followed by a high fever, shivering, and a cough with sputum production. Patient may become short of breath.

#### Effects

The patient's skin colour may change and become dusky or purplish. It is due to poor oxygenation of blood.

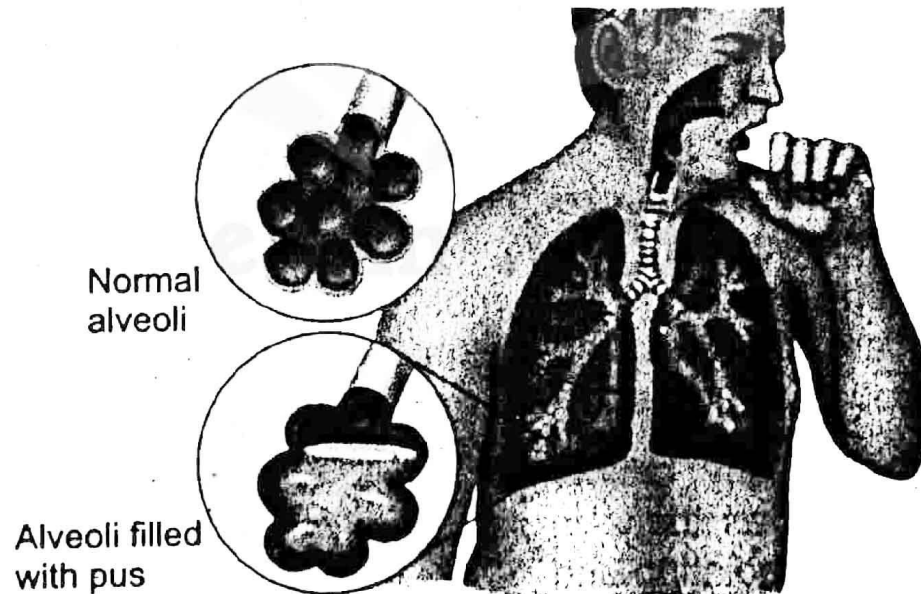


Figure 10.9: Pneumonia

#### Treatment

- i. Vaccines are available to prevent pneumonia caused by *S. pneumoniae*.
- ii. Antibiotics are used in the treatment of this disease.

### iv. Asthma

#### Introduction

It is a form of allergy, in which there is inflammation of the bronchi, more mucous production and narrowing of the airways.

## Explanation

In asthma patients, the bronchi and bronchioles become sensitive to different allergens (allergy causing factors) e.g. dust, smoke, perfumes, pollens etc. When exposed to any of such allergens, the sensitive airways show immediate and excessive response of constriction. In this condition, the patient feels difficulty in breathing.

## Symptoms

It varies from person to person. It includes:

- Shortness of breath (especially with exertion or at night)
- Wheezing (whistling sound when breathing out)
- Cough
- Chest tightness

## Treatment

The medicine in the form of inhalers with ability to dilate the bronchi and bronchioles are used in the treatment of asthma.

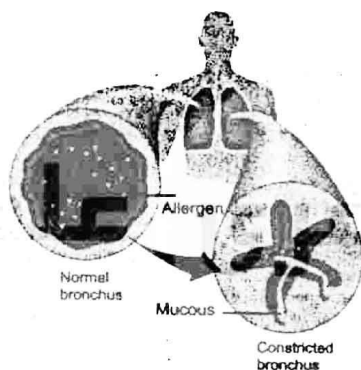


Figure 10.10: Asthma

## (v) Lung Cancer / Explain lung cancer and Passive smoking (Board 2014)

### Introduction

It is a disease of uncontrolled cell divisions in the tissues of the lung.

### Explanation

In lung cancer, cells continue to divide without any control and form tumours. The cellular growth may also invade adjacent tissues beyond the lungs.

### Symptoms

The most common symptoms are:

- Shortness of breath
- Coughing (including coughing up blood)
- Weight loss

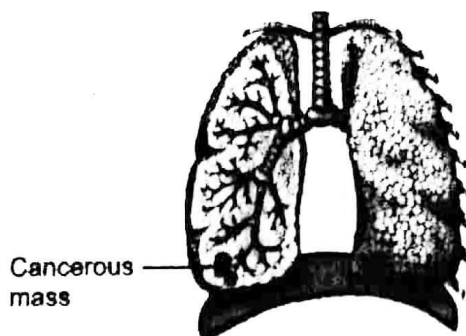


Figure 10.11: Lung Cancer

## **Causes**

### **(1) Main cause:**

Smoking is the main cause of lung cancer.

### **(2) Other Causes are:**

- (i) Carcinogens (such as those in cigarette smoke)
- (ii) Ionizing radiation
- (iii) Viral infection

### **Known number of carcinogens**

Cigarette smoke contains over 50 known carcinogens.

### **Lung cancer in non- smokers**

The risk of lung cancer is significantly lower in non-smokers.

Passive smoking (the inhalation of smoke from another's smoking) is also a cause of lung cancer. The smoke from the burning end of a cigarette is more dangerous than the smoke from the filter end.

### **Prevention**

- (i) Eliminating tobacco smoking is a primary goal in the prevention of lung cancer.
- (ii) The World Health Organization has called for governments to stop tobacco advertising to prevent young people from taking up smoking.
- (iii) If a person stops smoking the chance to develop cancer decreases as damage to the lungs is repaired and contaminant particles are gradually removed.

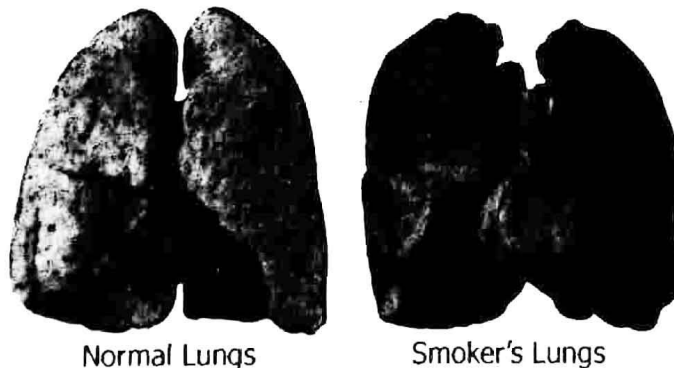
### **Effects**

Lung cancer is the most common cause of cancer-related deaths and is responsible for more than 1.3 million deaths worldwide annually.

**Q.10 Describe bad effects of smoking. Or Write two bad effects of smoking (Board 2014)**

### **Ans. Introduction**

Smoking is harmful due to the chemicals in cigarettes and smoke.



### **Number of chemicals in cigarette smoke**

Tobacco smoke contains over 4000 different chemicals, out of which at least 50 are carcinogens and many are poisonous.

### **Diseases due to smoking**

Smoking not only produces lung cancer but also produces a number of life threatening diseases like:

**(a) Cancers in**

- (i) Kidneys
- (ii) Oral cavity
- (iii) Larynx
- (iv) Breast
- (v) Bladder
- (vi) Pancreas etc.

**(b) Emphysema and other respiratory disorders**

Many chemicals in tobacco smoke damage the air passageway, which leads to emphysema and other respiratory disorders.

**Other effects of smoking**

**(a) Reduction in the oxygen carrying capacity**

It has effects on the circulatory system. The carbon monoxide present in tobacco smoke lessens the oxygen carrying capacity of haemoglobin.

**(b) Increase in the production of platelets**

Many other chemicals in smoke increase the production of blood platelets. When platelets are more than the normal numbers, they make the blood viscous and it can lead to arteriosclerosis.

**(c) Risk of tuberculosis and pneumonia**

Smokers are at greater risk of developing infections, particularly in the lungs like risk of tuberculosis increases by two to four times, and of pneumonia by four times.

**(d) Weakening and staining the teeth**

Smoking is responsible for weakening and staining the teeth. Tooth loss is 2 to 3 times higher in smokers than in non-smokers.

**(e) Effect on social life**

Smoking also affects the social life of a person. Smokers may face social unacceptance because other people may not want to be exposed to other's smoke.

**(f) Increase in the rate of heart diseases and cancer in non- smokers**

Non-smokers who are exposed to second-hand smoke at home or work increase their heart disease risk by 25-30 and their lung cancer risk by 20-30%.

**Q11. What do you know about Nicotine?**

**Ans.** Nicotine is a powerful poison and was widely used as an insecticide in the past. When inhaled through tobacco smoking, it reaches our circulatory system and not only hardens the walls of the arteries but also damages the brain tissues.

**Q12. When the "World No Tobacco Day" is celebrated?**

**Ans.** It is celebrated on the 31<sup>st</sup> of May every year.