
EXTREME HEAT
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CARRY WATER
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altholme

20% of premature deaths in Bangladesh caused by air pollution: WB

We will discuss today

➢ Defense Responses to Toxicants

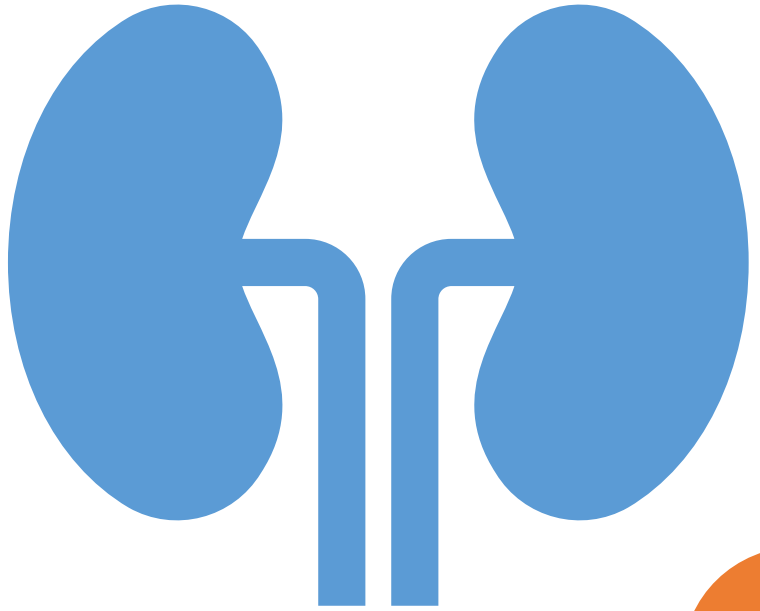
- Several major defense mechanisms available to help the animal or human body to cope with environmental toxicants
- Mechanisms found in respiratory tract, gastrointestinal tract, liver, kidneys, and membranes
- A brief discussion of defense mechanisms manifested by some plant species.

Defense Responses to toxicants

- Living organisms are subjected to the influence of a large number of environmental toxicants in addition to the essential nutrients that are absorbed
- Different defense mechanisms help to protect from environmental toxicants
- The consequences that may result when such defense mechanisms fail
- Today will discuss how organisms may be able to respond to the impact of many of those toxicants.
- The consequences that may result when such defense mechanisms fail will also be discussed

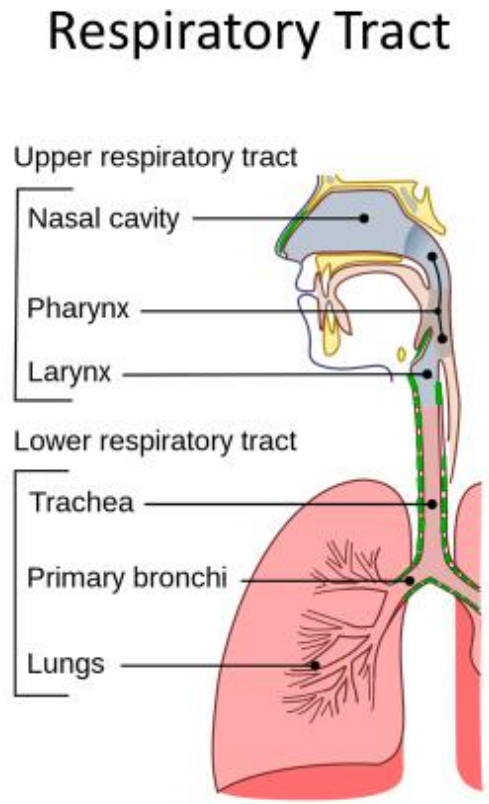
Responses of humans and animals

- Five body systems, mainly in humans and in some cases, in animals:
  - Respiratory tract
  - Gastrointestinal tract
  - Membranes
  - Liver
  - Kidneys



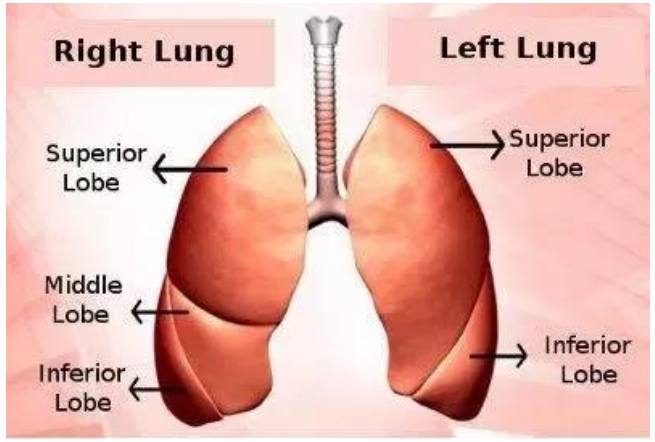
Respiratory Tract

- An adult breathes more than 13,000 liters of air a day, Very important to life
- The respiratory tract is one of the principal ports of entry for air pollutants and is remarkably well equipped to cope with harmful invaders.
- The respiratory tract is divided into 3 segments:
- *Upper respiratory tract*: nose and nasal passages, paranasal sinuses, and throat or pharynx
- *Respiratory airways*: voice box or larynx, trachea, bronchi, and bronchioles
- *Lungs*: respiratory bronchioles, alveolar ducts, alveolar sacs, and alveoli



Respiratory Tract

- Air is inhaled through the nasal cavity, nasopharynx, and trachea
- The trachea divides into the main bronchi, which go to the right and left lungs
- Right lung consists of three lobes, and the left lung, two
- The bronchi divide into finer and finer tubes, called bronchioles



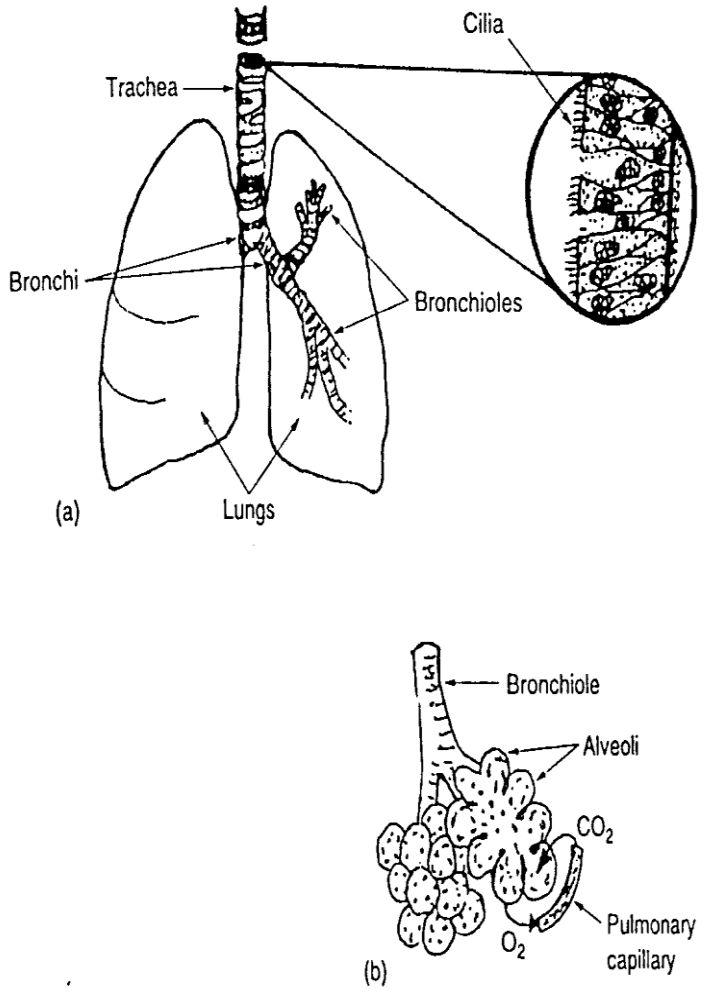
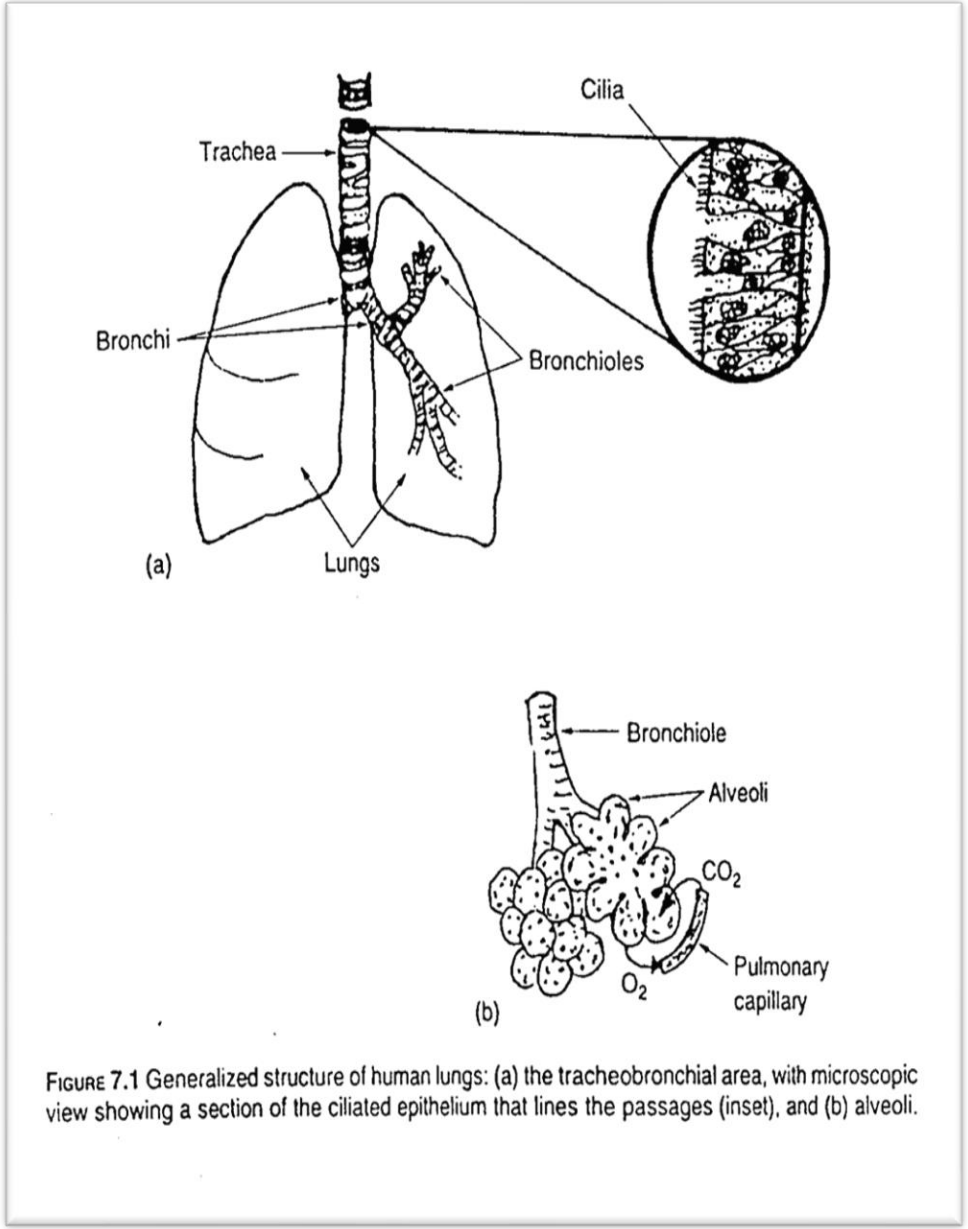


FIGURE 7.1 Generalized structure of human lungs: (a) the tracheobronchial area, with microscopic view showing a section of the ciliated epithelium that lines the passages (inset), and (b) alveoli.

Respiratory Tract

- Many tiny air sacs called alveoli located at the ends of the bronchioles, where the exchange of gases takes place
- At the alveoli, a thin sheet of moving blood picks up molecular oxygen from the inhaled air and unloads carbon dioxide for exhalation
- Cilia (hair like structure) beat rhythmically back and forth in the air passage with a speed of 1300 beats per minute. One of the respiratory system's defense mechanisms. Cilia propel a liquid layer of mucus that covers the airways.
- The mucus layer traps pathogens (potentially infectious microorganisms) and other particles, preventing them from reaching the lungs.
- With a speed of 1300 beats per minute, billions of cilia function like a broom to sweep noxious foreign agents out of the system.
- Pathogens and particles that are trapped on the mucus layer are coughed out or moved to the mouth and swallowed.



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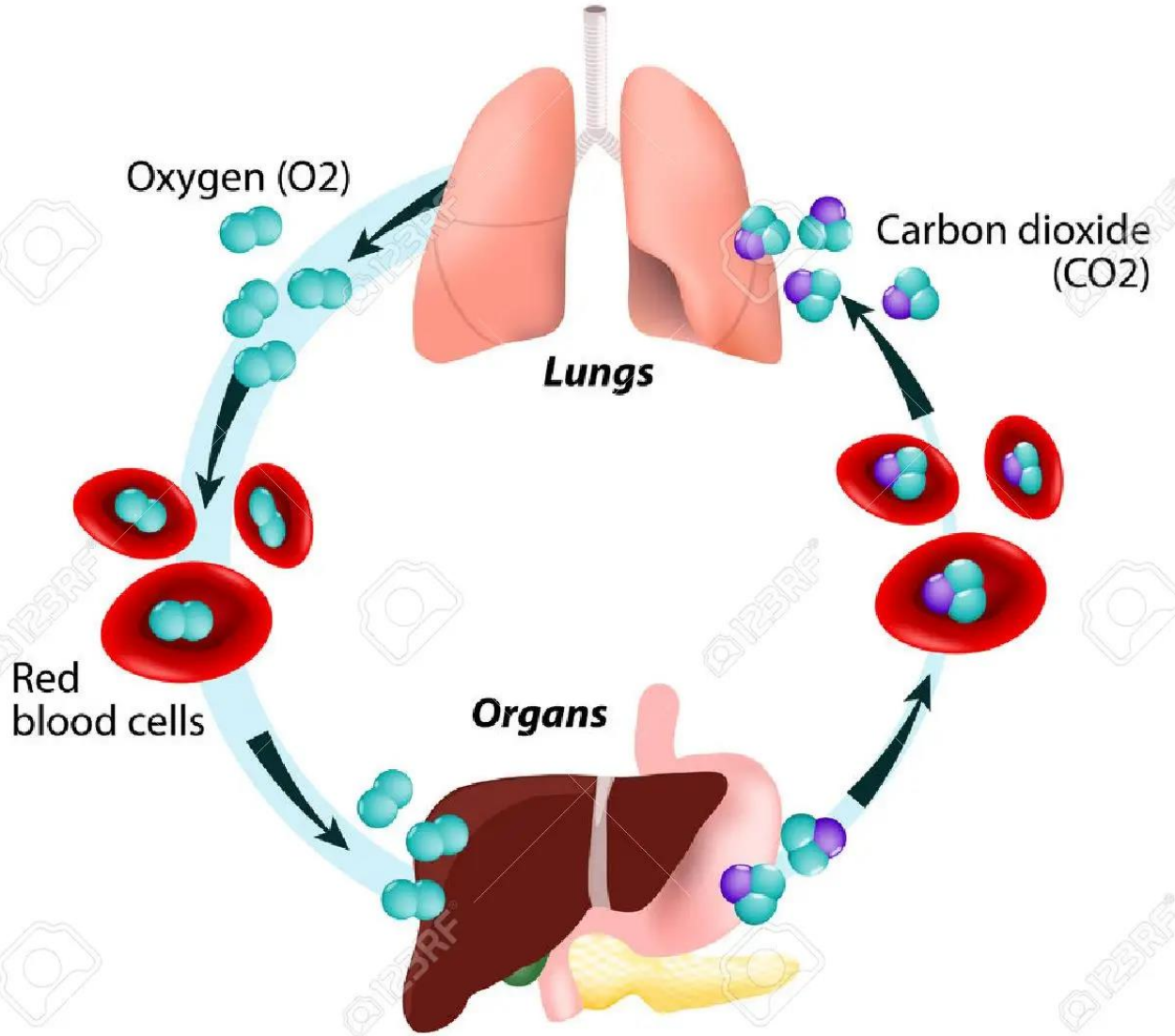
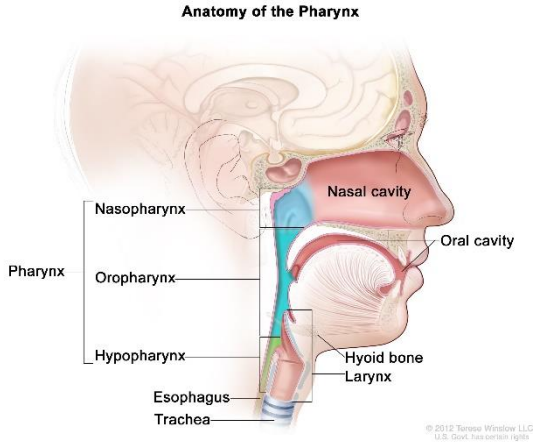
GAS EXCHANGE IN HUMANS



Defense: Respiratory Tract

- Three main processes defense against the invasion of foreign agents: Filtration, Inactivation, and Removal.

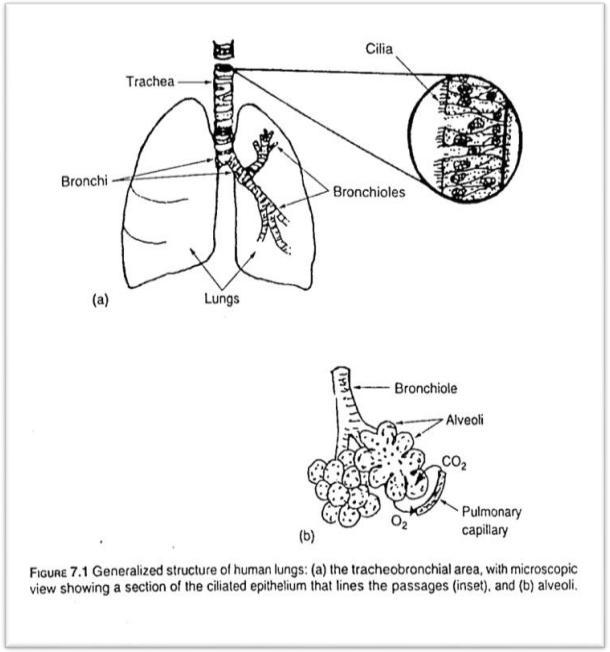
➢Nesopharynx:



- Air that drawn in through the nose and upper throat is warmed and moistened as it moves to the lungs.
- Particulate matter is likewise moistened as it enters the nose.
- Large particles are filtered and removed by the hairs at the entrance of the nose, while smaller particulates, such as, dust, carbon, and pollen spores, are washed out with the aid of mucus.

Respiratory Tract: Tracheobronchial areas

- The response of the tracheobronchial area to large particulates is contraction of the muscles, causing the lumena of bronchi to be narrowed.
- The size of particles is directly linked to their potential for causing health problems. Small particles less than 10 micrometers in diameter pose the greatest problems, because they can get deep into lungs, and some may even get into bloodstream (EPA).
- The mucus that is secreted moistens the particulates as they accumulate, which are then removed through the cough reflex.



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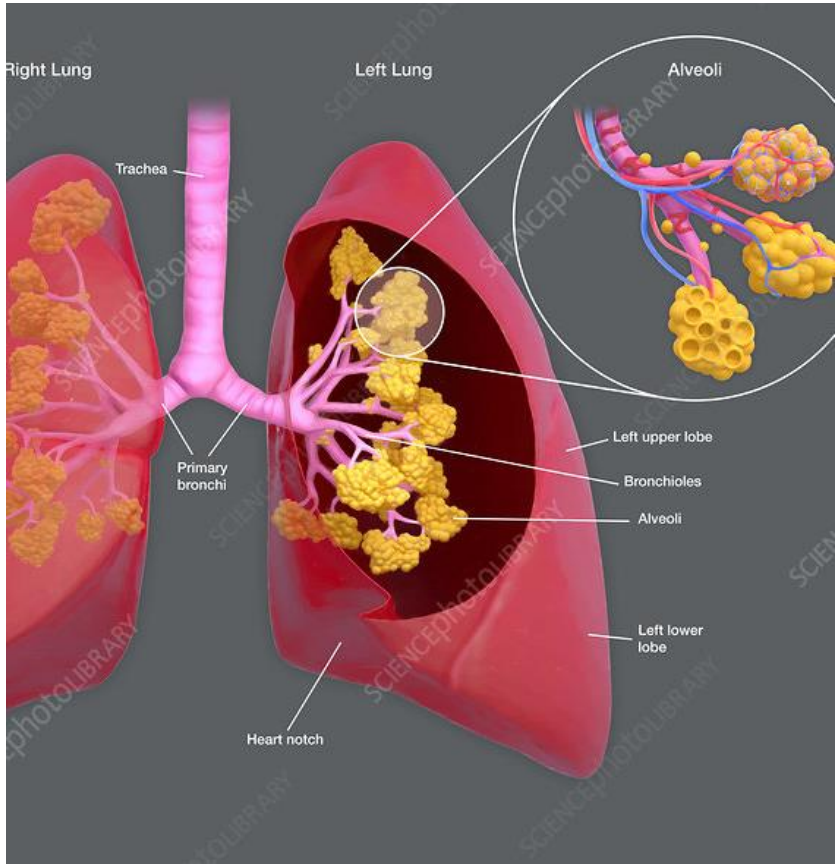
Respiratory Tract: Tracheobronchial areas

- Cilia (hair like structure) beat rhythmically back and forth in the air passage with a speed of 1300 beats per minute, billions of cilia function like a broom to sweep noxious foreign agents out of the system
- The condition commonly called bronchitis is caused by infection of the air passages, starting at the nose and extending through the bronchioles
- Acute bronchitis may result from inhaled irritants, such as smoke, dust, and chemicals. It can also be due to allergy.
- Chronic bronchitis develops slowly and appears in people past the midway point of their lives. Men>>>>Women and more often among city dwellers than rural residents.

Respiratory Tract: Alveoli

- About 400 million alveoli in the lungs of a healthy adult > size of a tennis court
- This is essential to allow absorption of O2 from air and dispersal of CO2 waste gases to take place
- Particulate matter that reaches the alveoli and is deposited is usually 1micron or less in diameter
- There are four types of cells in the alveoli: alveolar epithelial cells, endothelial cells, large alveolar cells, and alveolar macrophages
- alveolar epithelial cells: responsible : the exchange of CO_2 and O_2
- Endothelial cells: are endowed with various protective properties
- Large alveolar cells, and alveolar macrophages: carry out oxidative and synthetic processes that defend the lungs against invading organic and inorganic materials



Respiratory Tract: Alveoli_Emphysema

- Emphysema: the overinflated structures being alveoli
- Tiny bronchioles through which air flows to and from the air sacs have muscle fibers in their walls

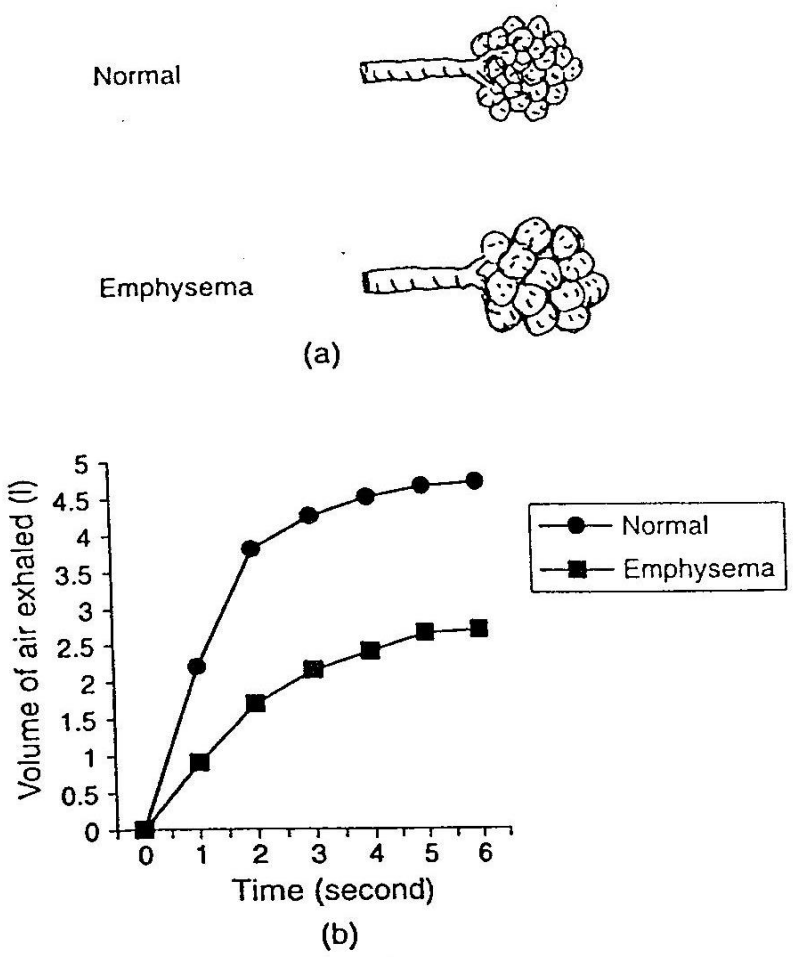
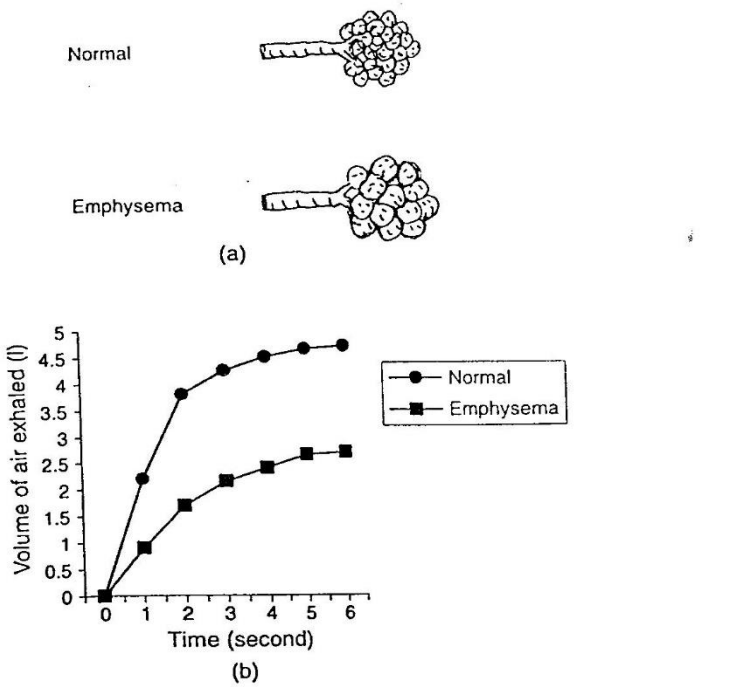


FIGURE 7.2 The effects of emphysema on lungs: (a) decrease in lung surface area due to overexpansion of alveoli, and (b) reduction in ability to exhale.

Respiratory Tract: Alveoli_Emphysema

- Emphysematous patient: the structures of bronchioles and air sacs may become hypertrophied and lose elasticity
- Air will flow into the air sacs easily but cannot flow out easily because of the narrowed diameter of bronchioles.
- The patient can breathe in but cannot breathe out efficiently, resulting in too much stale air in the lungs.



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The cause of emphysema is usually **long-term exposure to irritants that damage your lungs and the airways**. In the United States, cigarette smoke is the main cause. Pipe, cigar, and other types of tobacco smoke can also cause emphysema, especially if you inhale them.

Gastrointestinal (GI) Tract

- Gastrointestinal tract, also called digestive tract or alimentary canal, pathway by which food enters the body and solid wastes are expelled
- The GI tract is the pathway food takes from mouth, through the esophagus, stomach, small and large intestine. In the GI tract, nutrients and water from foods are absorbed to help keeps body healthy. Whatever isn't absorbed keeps moving through GI tract until get rid of it by using the bathroom.
- The small intestine, which comprises the duodenum, jejunum and ileum, is the main part of the gastrointestinal tract where nutrients from the diet are absorbed into the bloodstream
- A toxic agent may be absorbed into the bloodstream through the same route

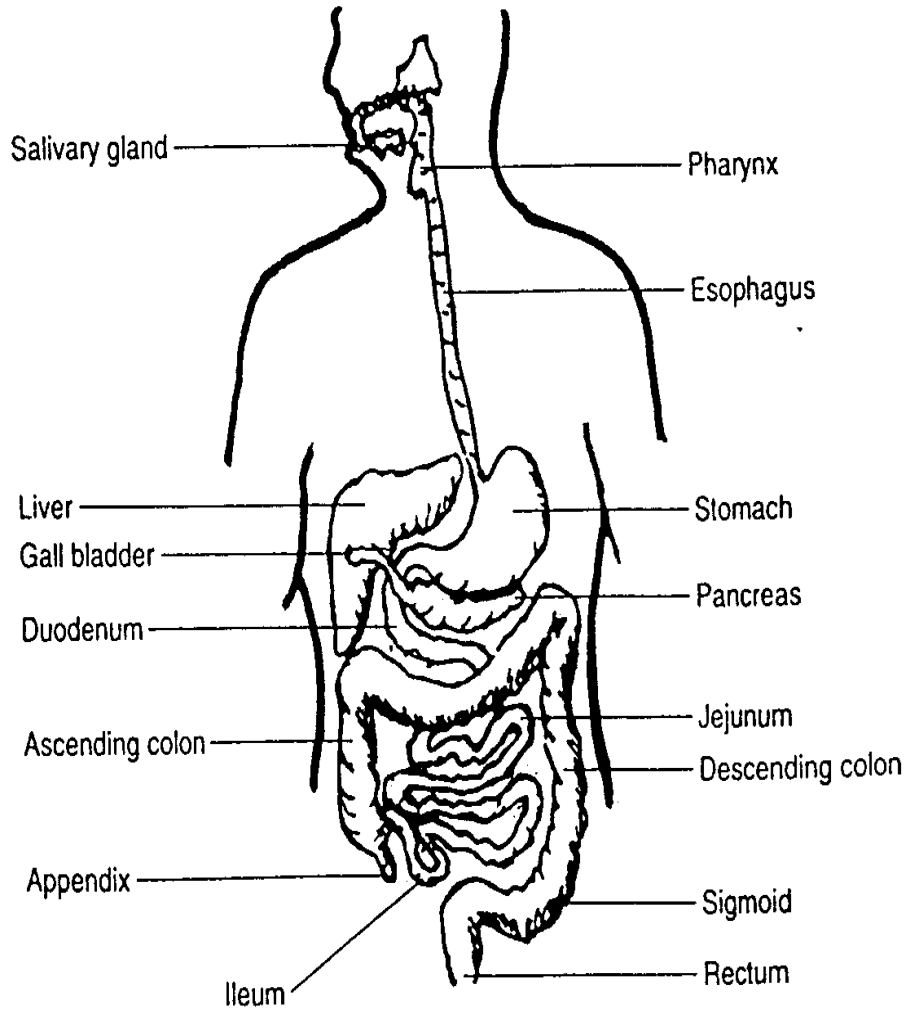


FIGURE 7.3 The human digestive system.

Gastrointestinal tract

- Mechanisms involved in the removal of noxious agents from the gastrointestinal tract include spastic movements in the stomach and bowels
- Spastic movements in the stomach, and bowels, leading to vomiting and speedy propulsion of fecal matter through the entire intestinal tract
- Readily soluble toxicants may be promptly absorbed into the bloodstream, whereas less soluble chemical agents are carried into the lower portion of the bowels and eliminated with feces
- Small particles, up to 50 µm in size, can penetrate the intestinal wall between epithelial cells and be transported through lymphatic system and blood vessels to the liver and other organs

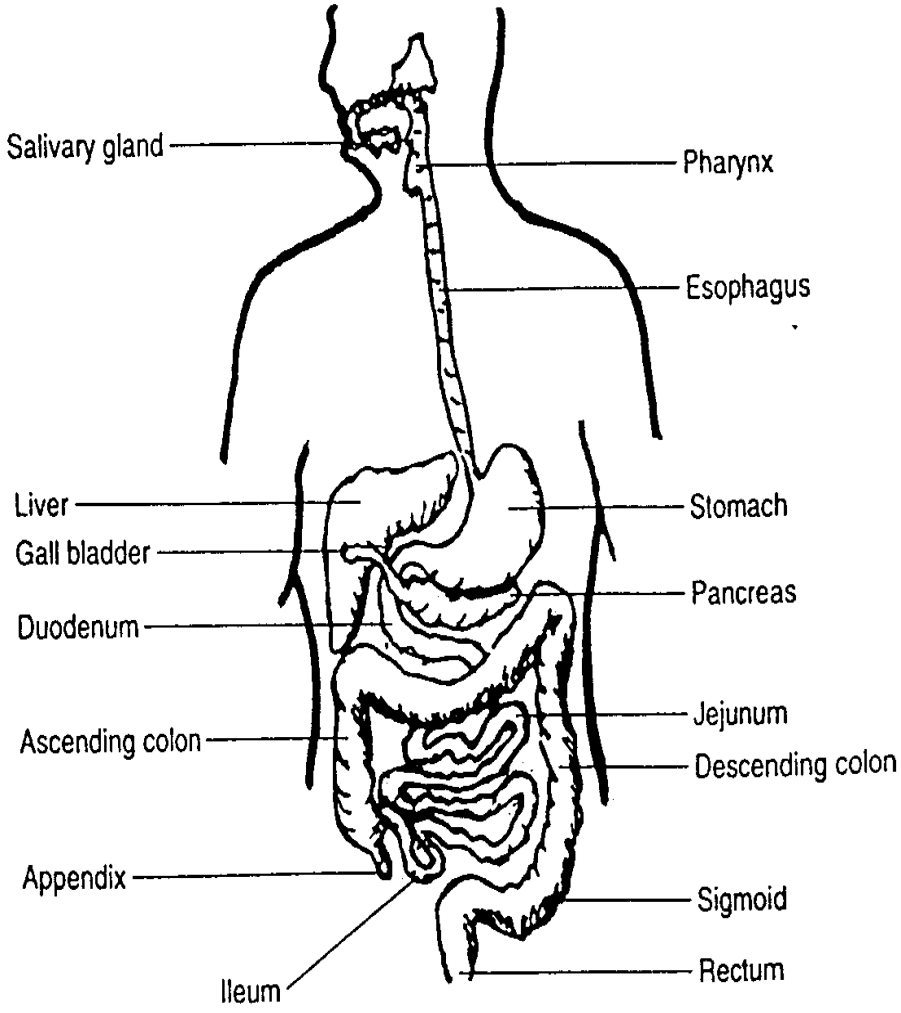


FIGURE 7.3 The human digestive system.

Membranes

- The plasma and intracellular membranes composed of 60% protein and 40% lipid
- The cell membrane serves as the major barrier to the absorption of toxic foreign compounds
- Certain chemicals react with membrane materials and alter the membrane structure
- E.g., Pd, Cd, Hg may react with membrane protein molecules.
- Free radicals formed in the reaction may attack not only lipids but also proteins, leading to disruption of the membrane

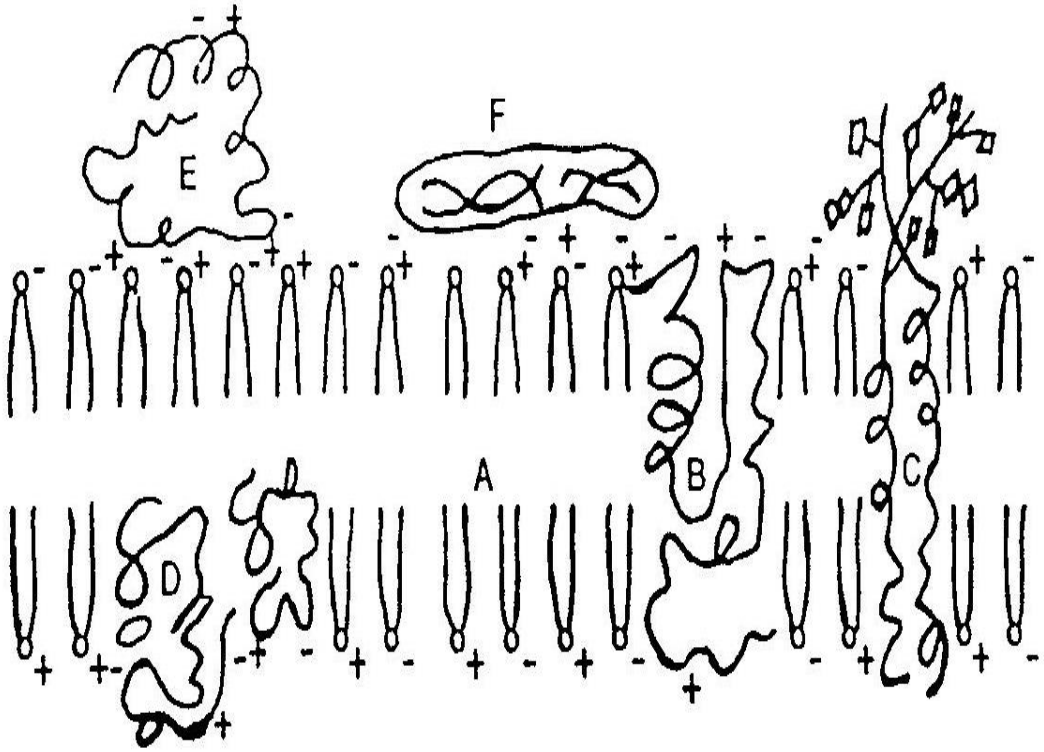
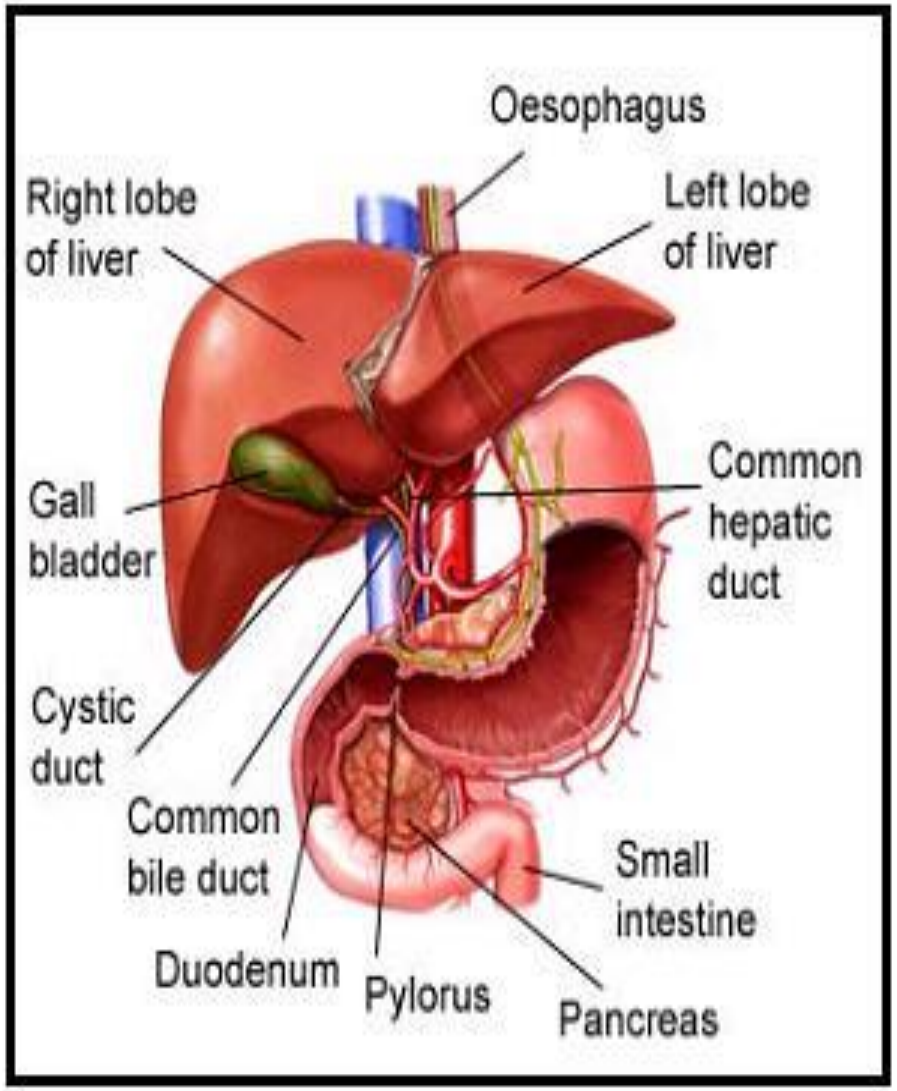


FIGURE 7.4 Arrangement of protein, lipid, and carbohydrate components in biological membranes. A = lipid bilayer region; B–D = intrinsic proteins, e.g., cytochrome oxidase (B), glycophorin with sugar residues indicated (C), cytochrome b (D); E, F = extrinsic proteins, e.g., cytochrome c.

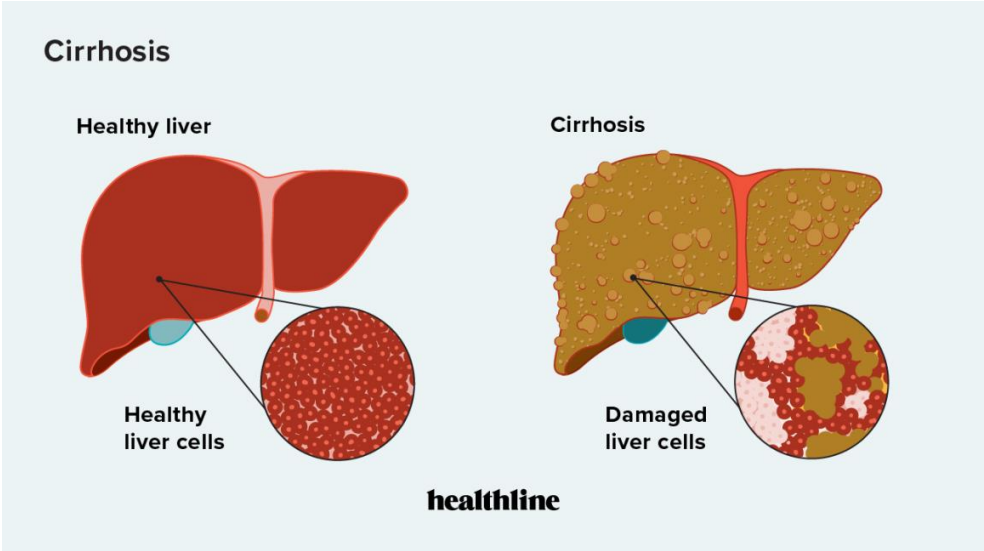
Liver

- The largest solid organ of the body, plays the foremost role in detoxifying xenobiotics
- It is a blood reservoir and a storage organ for some vitamins, and for digested carbohydrate, which is broken down releasing glucose to sustain blood sugar levels
- Manufacturing site for enzymes, cholesterol, proteins, vitamin A, blood coagulation factors, and other molecules
- Although the liver is noted for its ability to regenerate (under certain conditions), it can nevertheless be severely damaged. For example…….



Liver

- ***Cirrhosis:*** (a chronic progressive disease of the liver that is characterized by an excessive formation of connective tissue, followed by hardening and contraction), which is related to alcoholism and poor nutrition, may be caused by chronic exposure to chemicals such as carbon tetrachloride (CCl4).



- ***Fibrosis***: Liver fibrosis occurs when the healthy tissue of your liver becomes scarred and therefore cannot work as well. Fibrosis is the first stage of liver scarring. Later, if more of the liver becomes scarred, it's known as liver cirrhosis.

Kidneys

- Principal organs for excretion of both endogenous and exogenous toxins
- The kidneys remove metabolic waste products and foreign particles from the body, as well as maintain the water volume and the concentration of various ions within the body
- It continuously filter various substances from the blood, reabsorb some of them, and concentrate wastes created by metabolic processes in urine
- Metabolism of chemicals within the kidney may produce substances that are either more or less toxic than the parent chemical

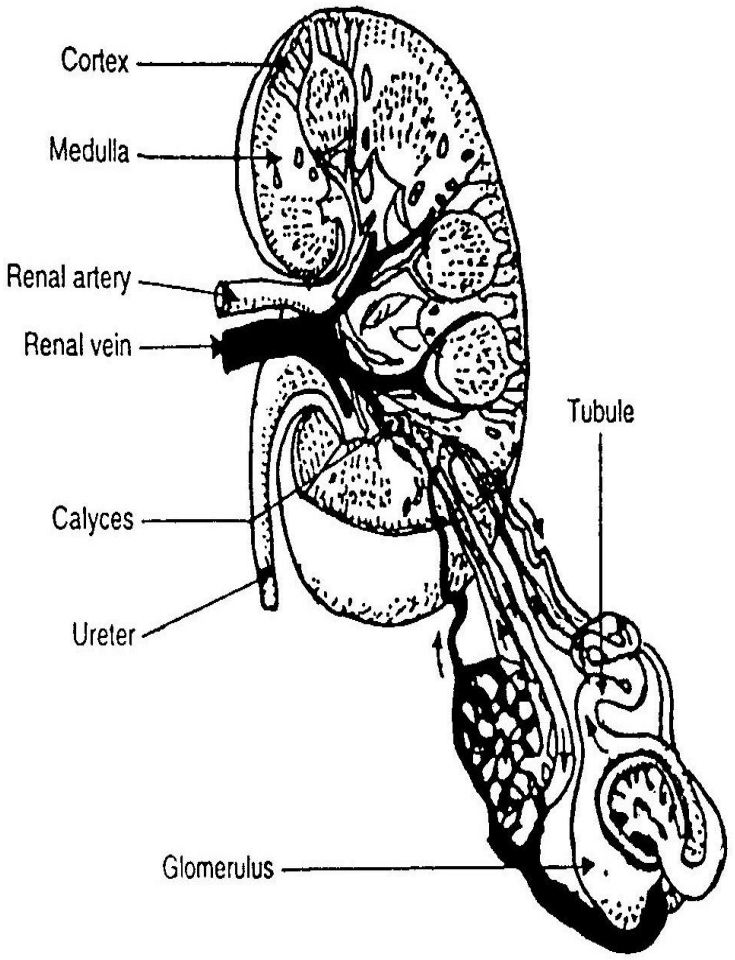


FIGURE 7.5 The structure of the human kidney.

Kidneys

- Heavy metals, such as Pb, Cd, and Hg may cause renal disease.
  - Pb- the adverse effects may be both acute and chronic
  - Cd- the effect is largely chronic
  - Hg- acute (tubular necrosis) and chronic (low dose exposure to mercuric salts)
  - Se- is known to antagonize Hg, reducing its toxicity