Gastrointestinal tract (GIT): Extends from stomach to anus.

Functions of the digestive tract:

1. Ingestion of food.
2. Digestion of food.
3. Movement of food.
4. Secretion of various digestive juices.
5. Absorption of end products of digestion and H_2O, vitamins and salt.
6. Excretion of heavy metals, toxins, bile pigments etc.
7. Regulation of acid base balance.
8. Regulation of water balance.
9. Regulation of blood glucose level.
10. Helps in erythropoiesis.

Gastrointestinal regulation:

The various functions of the GIT, including secretion, digestion and absorption and motility must be regulated in an integrated way to ensure efficient assimilation of nutrients after a meal. There are three main modalities for gastrointestinal regulation that operate in a complementary fashion to ensure that the function is appropriate.

1. **Endocrine regulation:** Endocrine regulation is mediated by the release of hormones by triggers associated with the meal. These hormones travel through the bloodstream to change the activity of a distant segment of the GIT, an organ draining into it (e.g. the pancreas) or both.
2. **Paracrine regulation:** Some mediators alter the function of cells in the local area where they are released, in a paracrine fashion.
3. **Neural regulation of GIT:** It occurs by –
    a. Central nervous system (extrinsic innervation)
    b. Largely autonomous enteric nervous system that comprises both and secreto-motor neurons.

The enteric nervous system integrates central input to the gut but can also regulate gut function independently in response to changes in the luminal environment. In some cases, the same substance can mediate regulation by endocrine, paracrine and neurocrine pathways (e.g. cholecystokinin).

Histology

Stomach

1. **Serosa:** The serosa or visceral peritoneum is the outermost tunic of the stomach. It consists of an outer layer of simple squamous epithelium and an inner layer of connective tissue.
2. **Muscularis:** The muscularis of the stomach consists of three layers:
    - An outer longitudinal layer
    - A middle circular layer and
    - An inner oblique layer

    Deep to the muscular layer are the submucosa and the mucosa, which are thrown into large folds called rugae when the stomach is empty. These folds allow the mucosa and submucosa to stretch, and the folds disappear as the stomach volume increases as it is filled.

3. **Epithelial cells:** There are five types of epithelial cells of the stomach:
    a. Surface mucous cells
    b. Mucous neck cells
    c. Parietal cells
    d. Chief cells
    e. Endocrine cells

They are discussed below:

a. **Surface mucous cells:** Surface mucous cells are found on the surface around the gastric pit. These cells protect the stomach wall from being damaged from acid and digestive enzymes. The cells produce an alkaline mucous on their surface that neutralizes the acid and is a barrier to the digestive enzymes. The surface mucous cells

are connected by tight junctions, which provide an additional barrier that prevents acids and enzymes from reaching deeper tissues. In addition, when surface mucous cells are damaged, they are rapidly replaced.

b. **Mucous neck cells:** The mucous neck cells are located near the openings of the glands and produce mucus.
c. **Parietal cells:** Parietal cells produce HCl and intrinsic factor.
d. **Chief cells:** Chief cells produce the enzyme pepsinogen.
e. **Endocrine cells:** Endocrine cells produce regulatory hormones and paracrine factors. There are several types of endocrine cells such as –
    - **Enterochromaffin-like cells** produce histamine, which stimulates acid secretion by parietal cells.
    - **Gastrin containing cells** secrete gastrin.
    - **Somatostatin containing cells** secrete somatostatin, which inhibits gastric and insulin secretion.

Identifying characters of the histology of the stomach:

1. There are five layers in the wall of the stomach.
2. Numerous microfolds in the name of rugae are seen.
3. Gastric glands are there in the mucosa layer.
4. Areolar tissue is there in the submucosa layer.

Small intestine

The wall of small intestine is made up of six layers:

1. **Serosa layer:** This is the outermost layer of small intestine and is made up of squamous epithelial tissue and loose connective tissue like blood vessels, lymph vessel and adipose tissue.
2. **Longitudinal muscle layer:** Beneath the serosa layer there is layer of longitudinally placed muscle fibers.
3. **Circular muscle layer:** It is the layer of circular muscles and placed under the longitudinal muscle.
4. **Submucosa layer:** This layer is composed of loose connective tissue like blood vessel, lymph vessel and also nerves.
5. **Muscularis layer:** It is a very thin layer of smooth muscle.
6. **Mucosa layer:** This is the innermost layer of the wall of the small intestine and is made up of four major cell types:
    a. **Absorptive cells:** Absorptive cells are cells with microvilli that produce digestive enzymes and absorb digestive food.
    b. **Goblet cells:** Goblet cells produce a protective mucus.
    c. **Granular cells or Paneth cells:** Granular cells or Paneth cells may help protect the intestinal epithelium from bacteria.
    d. **Endocrine cells:** Endocrine cells produce regulatory hormones.

Liver

1. **Hepatic lobules:** The liver is divided into hexagon-shaped hepatic lobules by connective tissue septa with a portal triad at each corner. The triads are so named because three structures – the haptic portal vein, hepatic artery and hepatic duct – are located in them.
2. **Hepatic cords:** Hepatic cords are strings of cells that radiate out from the central vein of each lobule like the spokes of a wheel. The hepatic cords are composed of hepatocytes, the functional cells of the liver.
3. **Hepatic sinusoids:** The spaces between the hepatic cords and blood channels are called hepatic sinusoids. The sinusoids are lined with a very thin, irregular squamous epithelium consisting of two cell populations:
    - **Endothelial cells:** They are extremely thin sparse cells.
    - **Hepatic phagocytic cells or Kupffer cells**

Hepatocytes have six major functions:

1. Bile production
2. Storage
3. Interconversion of nutrients
4. Detoxification
5. Phagocytosis and
6. Synthesis of blood components

Lung

1. **Wall:** The wall of lung is a two-layered membrane. The outer one is made up of squamous epithelium, connective tissue and muscle fibers and the inner one is made up of ciliated epithelium, mucus gland and blood capillaries.
2. **Alveoli:** Large number of empty spaces named alveoli are found. The lining of each alveolus is made up of moist epithelium, collagen and elastic fibers.
3. **Trabecula:** Alveoli are separated from each other by trabecula. The wall of trabecula is very rich in muscle fibers and blood capillaries.
4. **Bronchioles:** Large sized empty spaces bounded by ciliated epithelium are found. These are called bronchioles.

Q. Define saliva. What are the functions of saliva?

Saliva: Saliva is a viscous, colorless, opalescent fluid which is secreted by three pairs of salivary glands – the parotid, submandibular and sublingual glands. There are also many small buccal glands from which salivation occurs.

Functions of saliva:

1. **Mechanical function:**
    a. Keeps the mouth moist and helps in speech.
    b. Facilitates swallowing.
    c. Helps in preparing food staffs into a bolus, suitable for deglutination.
    d. Dilutes hot and irritant food, thus prevents injury to the mucosa.
    e. Acts as a lubricant.
    f. Washes down the food debris, thereby prevents bacterial growth.
2. **Role in taste:** Helps in taste by dissolving food staffs.
3. **Digestive function:** It breaks down starch into maltose, maltotriose, α-limit dextrin by ptyalin (salivary α amylase)

$$\text{Starch} \xrightarrow{Salivary\ amylase} \text{maltose, maltotriose, } \alpha\text{-limit dextrin.}$$

4. **Excretory function:** It excretes urea, heavy metals (Pb, Bi, As), thiocyanates, iodine, morphine, penicillin, organism (e.g. virus of rabies in hydrophobia) etc.
5. **Role in water balance:** By evoking the sensation of thirst it reflects the need of water intake. If body water is lost (e.g. in diarrhea, vomiting, burn), the salivation is depressed. So drying up of the mucus membrane of pharynx and mouth occurs; this sends afferent impulse to hypothalamic center, to be reasoned as thirst.
6. **Buffering function:** Due to the presence of HCO_3^-, PO_4^{3-} in saliva, it acts as buffer; $NaHCO_3/H_2CO_3$ and Na_2HPO_4/NaH_2PO_4.
7. **Bacteriolytic function:** Saliva dissolves the cell wall of many bacteria by the enzyme lysozyme and kills them.

Q. Name the protective constituents of saliva.

Protective constituents of saliva:

1. **Secretory IgA:** Kills pathogens.
2. **Lysozyme:** Kills bacteria.
3. **Mucin:** Lubricates food, provides mechanical protection.
4. **Bicarbonate:** Neutralizes acid.

Q. Discuss the regulation of saliva secretion.

Regulation or control of saliva secretion:

1. **Neural control:** Salivary secretion is almost entirely controlled by neural influences.
    - **Sympathetic stimulation:** It causes small amount of saliva rich in organic constituents from submandibular gland. It has little influence on volume.
    - **Parasympathetic stimulation:** It causes the most prominent role and causes increased secretion of watery saliva poor in organic content.
2. **Reflex:**

Q. Enumerate the functions of gastric HCl.

Functions of gastric HCl:

1. Converts inactive pepsinogen into active pepsin.
2. Provides suitable environment for pepsin to start protein digestion.
3. Kills many ingested bacteria.
4. Stimulates the flow of bile and pancreatic juice.
5. Keeps the iron in ferrous state for absorption.
6. Hydrolyzes sucrose into glucose and fructose.

Q. Write short note on: Parietal cell of stomach.

Parietal cell of stomach

Synonym: Oxyntic cell.

Location: Predominantly the upper half of gastric glands in the fundus and body.

Receptors present on the parietal cells:

1. M_3 muscarinic receptor
2. Gastrin receptor
3. H_2 receptor

Secretion:

1. HCl
2. Intrinsic factor of Castle

Functions of the secretion:

1. **HCl:** Activates pepsinogen and kills microorganisms in the food.
2. **Intrinsic factor of Castle:** It is essential for the absorption of vitamin B_{12}.

Q. Write short on Intrinsic factor of Castle.

Intrinsic factor or Intrinsic factor of Castle: It is a 49 kDa glycoprotein. It is secreted from the gastric parietal cells, binds with vitamin B_{12} and is necessary for its absorption from the small intestine.

Mechanism of action: It binds to vitamin B_{12} in the stomach and protects it from being digested and destroyed as it passes into the small intestine. Then, when the intrinsic factor – vitamin B_{12} complex reaches the terminal ileum, the intrinsic factor binds with receptors on the surface of the enterocytes. This in turn makes it possible for the vitamin B_{12} to be absorbed.

Deficiency of intrinsic factor: In the absence of intrinsic factor, only about $\frac{1}{50}$ of the vitamin B_{12} is absorbed. This leads to vitamin B_{12} deficiency and pernicious anemia.

Q. Why is stomach not digested itself?

Protection of stomach against acid-pepsin digestion: Autodigestion of gastric mucosa by the acid-pepsin mixture is prevented by some factors e.g.

1. **Mucosal barrier:**
   - Mucus secreted from the neck and surface mucus cells forms a flexible gel that coats the mucosa. This mucosal barrier prevents the contact of pepsin and HCl with gastric mucosa.
   - The surface membrane of mucosal cells and the tight junctions between the cells are also part of the mucosal barrier that protects the gastric epithelium from damage.
2. Mucosal blood flow is very high. High blood flow provides O_2, HCO_3^- and glucose to the epithelial cells.
3. Peptidoglycan: Prostaglandin provides cytoprotective action. It stimulates secretion of mucus and HCO_3^- but inhibits secretion of HCl. It also causes vigorous protein synthesis and this assist the cell renewal.

4. Cell renewal of gastric mucosa normally occurs in heavy amount. This aids the resistance against autodigestion.
5. Surface mucus cells also secrete HCO_3^-, that counteracts the effect of HCl.
6. Some of the resistance of the gastric mucosa to autodigestion is also provided by the presence of trefoil peptides in the mucosa. They are acid-resistant.

Q. For peptic digestion, HCl is a must – Explain.

This is because –

1. HCl converts inactive pepsinogen to active pepsin.
2. Pepsin cannot act in neutral or alkaline media. HCl makes the medium acidic in which pepsin is highly proteolytic.

Q. Write down the functions of gall bladder.

Functions of gall bladder:

1. It acts as a store house of bile. The storage function of the gall bladder is very important, as bile, because of its continuous secretion would have been wasted, except during meal time.
2. It protects the liver by acting as a reservoir.
3. Gall bladder absorbs water and concentrates bile about 10 – 20 times.
4. It helps in the intermittent flow of bile.
5. It absorbs inorganic salts from the bile to some extent and reduces the alkalinity of liver bile.
6. It excretes the cholesterol to some extent.
7. It secretes mucus which is the main source of mucin of bile.
8. It equalizes the pressure in the biliary system due to its concentrating power.

Q. How bile secretion is regulated or controlled?

Regulation of bile secretion:

1. When food enters the mouth, the resistance of the sphincter of Oddi decreases under both neural and hormonal influences.
2. Fatty acids and amino acids in the duodenum releases CCK which causes gall bladder contraction.
3. The production of bile is increased by stimulation of the vagus nerves and by the hormone secretin, which increases the water and HCO_3^- content of bile.
4. Substances that increase the secretion of bile are known as choleretics. Bile acids themselves are among the most important physiologic choleretics.

Q. What is bile? Justify bile as a digestive juice.

Bile: Bile is the secretory product of liver made up of bile salts, bile pigments and other substances dissolved in an alkaline solution that resembles the pancreatic juice.

Criteria:

1. Yellowish green fluid.
2. **Consistency:** Viscid mucus liquid.
3. **Reaction:** Alkaline.
4. **Taste:** Bitter.
5. Produced by hepatocytes.
6. Stored in gall bladder.
7. Secreted into the 2nd part of the duodenum along with the pancreatic juice through the hepato-pancreatic duct.

Justification of bile as a digestive juice: Though bile has no enzymes, bile is a digestive juice because:

1. It helps in the digestion and absorption of fat by –
    - Emulsifying fat
    - Activating pancreatic lipase
    - Forming micelles.
2. It also helps in the absorption of fat soluble vitamins like A, D, E and K.

— Chronic disease
— Thalassemia
— Pb poisoning

Generally, a low MCV and a MCHC will be found together. Anemias in which both MCV and MCHC are low are called microcytic hypochromic anemia.

Classification:

A. Morphological classification

1. **Normocytic normochromic anemia:** MCV (mean corpuscular volume), MCH (mean corpuscular hemoglobin) and MCHC (mean corpuscular hemoglobin concentration) is normal; RBC count is decreased. **Example:**
   - Hemorrhagic anemia
   - Hemolytic anemia
   - Aplastic anemia
2. **Macrocytic hypochromic anemia:** MCV > 96 fL (famto Liter); MCHC is less (cells are of pale colour). **Example:**
   - Megaloblastic anemia
   - Pernicious anemia
   - Folate deficiency anemia
3. **Microcytic hypochromic anemia:** MCV < 80 fL; MCH < 27 pg; MCHC < 30 g/dL. **Example:**
   - Iron deficiency anemia
   - Thalassemia

B. Etiological classification:

1. **Hemorrhagic anemia or Blood loss anemia:** It occurs due to chronic blood loss; characterized by small red blood cells with too little Hb in RBCs (microcytic hypochromic anemia).

Acute	Chronic
• Accidental blood loss • Surgical blood loss	• Hook worm infection • Menorrhagia • Peptic ulcer • Hemorrhoids • Carcinoma of stomach, colon.

2. **Hemolytic anemia:**
   a. **Intrinsic**
      - Defect in RBC membrane: Hereditary spherocytosis.
      - Defect in Hb: Thalassemia, sickle cell anemia.
      - Deficiency of red cell enzyme: Glucose 6-phosphate dehydrogenase deficiency.
   b. **Extrinsic:**
      - Antibody mediated: Erythroblastosis fetalis, transfusion reactions.
      - Mechanical trauma to RBC: Disseminated intravascular coagulation.
      - Infections: Malaria, hookworm.
      - Chemical injury: Lead (Pb) poisoning.
3. **Anemia due to impaired red blood cell production:**
   a. **Due to deficiency of essential elements of erythropoiesis**
      - Iron deficiency anemia
      - Megaloblastic anemia due to vitamin B_{12} and folic acid deficiency
      - Anemia due to vitamin C deficiency
      - Nutritional anemia due to protein energy malnutrition (PEM)
   b. **Due to disturbance of proliferation and differentiation of stem cells:**
      - Aplastic anemia
      - Anemia of renal failure due to erythropoietin deficiency

2. Prevent or minimize feto-maternal bleeding during removal of placenta.

Treatment: The best treatment for severe hemolytic disease is an exchange transfusion carried out soon after birth.

Q. What is the importance of determination of blood group?

Importance of determination of blood group:

1. To find out complete blood group in order to avoid transfusion reaction.
2. To identify criminals.
3. To determine paternity (by MN system).
4. To identify certain blood diseases.
5. Various experimental studies in hematological laboratories.

Q. What is the clinical importance of Rh typing?

Clinical importance of Rh typing:

1. To avid sensitization of a Rh— person by a Rh+ blood group.
2. Due to Rh incompatibility, hemolytic transfusion reaction occurs in Rh+ fetus growing in a Rh— mother. To deal with these conditions, Rh typing is a must.
3. No Rh— female at any stage before menopause should be given Rh+ positive blood. If given, she becomes sensitized (i.e. develops anti D) by the injected Rh+ blood. She is likely to destroy, subsequently any Rh+ fetus by anti D. in other words, the transfusion may make her permanently childless.

Q. What is cross matching? What is the importance of cross matching?

Cross matching: Cross matching is the testing for compatibility of a donor's and a recipient's blood prior to transfusion, in which serum of each is mixed with red blood cells of the other and observed for hemagglutination.

Types:

1. **Major cross matching:** Donor's antigen (RBC) and recipient's antibodies (plasma).
2. **Minor cross matching:** Recipient's antigen (RBC) and donor's antibodies (plasma).

Procedure:

Blood is collected from both donor's and recipient's
↓
Serum and red blood cells are separated from each other of both blood samples.
↓
The cells are diluted with normal saline.
↓
The donor's RBCs are mixed with recipient's serum. Then it is seen if agglutination takes place or not.
↓
Similarly, recipient's RBCs are mixed with donor's serum. Then it is seen if agglutination takes place or not.
↓
If there is no agglutination in steps 4 and 5, the two bonds are perfectly compatible and transfusion can be given.

Importance of cross matching:

1. It is a direct final check to detect whether there is any mismatching between the bloods of potential donor and potential recipient. Thus, perfectly compatible blood can be found out.
2. Transfusion reactions can be avoided.

Q. What are the indications of blood transfusion?

Indications of blood transfusion:

A. Whole blood
- **a. Surgical indications:**
  1. Severe hemorrhage

2. They synthesize and release-
    a. Chemotactic factors for macrophages.
    b. Thromboxanes and platelet-aggregating agents.
    c. Leukotrienes and prostaglandins that exert a moderate inflammatory effect.

B. Eosinophils:

1. They kill parasites by releasing hydrolytic enzymes, major basic proteins and probably reactive O_2 intermediates.
2. They reduce allergic reactions by releasing histamiase that degrade histamine.
3. Eosinophils are weak phagocytes and not sufficient to protect against pyogenic bacterial infections in neutropenic infections.

C. Basophils:

1. They secrete heparin that prevents intravascular blood coagulation.
2. They play important role in some types of allergic reactions by releasing histamine, brakykinin, serotonin, heparin etc.

D. **Monocytes:** Monocytes enter the tissues from blood and become tissue macrophages. Macrophages perform the following functions:

1. Phagocytosis.
2. Antigen presentation.
3. Production of cytokines such as IL-1, IL-8, TNF.

E. Lymphocytes:

1. Helper T cells activates cytotoxic T cell, B cells, macrophages and other antigen specific helper T cell.
2. Cytotoxic T cells kill virus-infected cells, tumor cells and allograft cells.
3. B cells produce antibodies. At first, B cells are converted to plasma cells. Then the plasma cells produce antibody.

Q. What is leukocytosis? List the causes of leukocytosis.

Leukocytosis: When WBC count is more than 11,000/mm^3 of blood, then it is called leukocytosis.

Causes:

Neutrophilic leukocytosis (Neutrophilia):

1. **Infection:** Bacterial, fungal.
2. **Trauma:** Surgery, burns.
3. **Infarction:** Myocardial infarct, pulmonary embolus, sickle cell crisis.
4. **Inflammation:** Gout, rheumatoid arthritis, ulcerative colitits, Crohn's disease.
5. **Malignancy:** Solid tumors, Hodgkin lymphoma.
6. **Myeloproliferative disease:** Polycythemia, chronic myeloid leukemia.
7. **Physiological:** Exercise, pregnancy.

Eosinophilic leukocytosis (Eosinophilia):

1. **Allergy:** Hay fever, asthma, eczema.
2. **Infection:** Parasitic.
3. **Drug hypersensitivity:** e.g., gold, sulfonamides.
4. Skin disease.
5. **Connective tissue disease:** Polyarteritis nodosa.
6. **Malignancy:** Solid tumors, lymphomas.
7. **Primary bone marrow disorders:** Myeloproliferative disorders, hyper-eosinophilia syndrome, acute myeloid leukemia.

Basophilic leukocytosis (Basophilia):

1. **Myeloproliferative disease:** Polycythemia, chronic myeloid leukemia.
2. **Inflammation:** Acute hypersensitivity, ulcerative colitis, Crohn's disease.
3. Iron deficiency.

Monocytosis:

1. Chronic infections.

— Posterior

3. AV node (Atrioventricular node)
4. AV bundle or the bundle of His and its right and left branches
5. Purkinje fibers

Q. Why is SA node called pace maker of the heart?

Pacemaker of the heart: Pacemaker makes or determines the pace of the race. Pace, I this instance, means the heart rate. SA node is called the pacemaker of the heart because its rate of discharge makes or determines the pace (rate) at which the heart is beating.

Causes:

1. **SA node normally discharges most rapidly:**
   Mechanism:
   SA discharges most rapidly
   ↓
   This impulse is transmitted to the AV node and other parts of the conductive system before they discharge spontaneously
   ↓
   As a result, these parts cannot generate impulse at their own rate rather they discharge at the rate of the SA node discharge
   ↓
   Then the impulse is transmitted to the myocardium
   ↓
   So, myocardium discharges at the rate of the SA nodal discharge
   ↓
   Thus the rate of discharge of SA node determines the rate at which the heart is beating.

2. The rate of impulse produced by the SA node is greater than any other part of the heart.

For these reasons, the heart beat is determined by the rate of the discharge of the SA node. Therefore, SA node is called the pacemaker of the heart.

Pacemaker potential: The rhythmically discharging cells of the heart show a slow but spontaneous rise in membrane potential up to the firing level. This is called pacemaker potential.

Synonym: Prepotential.

Mechanism of production: There are two types of Ca^{2+} channels in the heart, the T (for transient) channels and the L (for long lasting) channels. Ca^{2+} influx through the T channels increases the membrane potential of the pacemaker cells slowly up to the firing level. This slowly rising membrane potential is called pacemaker potential. Following pacemaker potential, Ca^{2+} influx through the L channels makes the depolarization. After depolarization, K^{+} efflux begins and brings about repolarization. After repolarization, again Ca^{2+} influx through the T channels makes the pacemaker potential.

Tissues having pacemaker potential: SA node, AV node and other junctional tissues of the heart.

Importance: When it reaches the firing level, it triggers the next impulse. Thus, this potential enables the cell to discharge spontaneously.

Q. Name the pacemaker tissues.

Pacemaker tissues:

1. Sinoatrial node
2. Atrioventricular node and
3. Purkinje fibers

Causes of hypoxia:

A. **Hypoxic hypoxia (anoxic hypoxia):**
    a. Inadequate oxygenation of the blood in the lungs due to extrinsic causes –
        1. Deficiency of O_2 in the atmosphere (e.g. in high altitude)
        2. Hypoventilation (neuromuscular disorders such as poliomyelitis)
    b. Lung diseases:
        1. Ventilation perfusion imbalance.
        2. Collapse of the lungs.
        3. Pneumothorax
        4. Asthma
        5. Emphysema
        6. Pulmonary edema
        7. Obstruction of the air passage
        8. Pneumonia
    c. Venous to arterial shunts (right to left cardiac shunts)
B. **Anemic hypoxia:**
    a. Anemia
    b. CO poisoning
    c. Abnormal Hb
C. **Stagnant or ischemic hypoxia:**
    a. Congestive cardiac failure
    b. Hemorrhage
    c. Shock
    d. Decreased venous return
D. **Histotoxic hypoxia:**
    a. Cyanide poisoning
    b. Narcotics

Definition of some terms:

Eupnea : It means normal breathing.
Dyspnea : Dyspnea is by definition difficult or labored breathing in which the subject is conscious of shortness of breath.
Apnea : Apnea means temporary cessation of breathing.
Hyperpnea : Hyperpnea is a general term for an increase in the rate or depth of breathing regardless of the patient's subjective sensations.
Tachypnea : It means rapid shallow breathing.
Bradypnea : It means slow breathing than normal.
Anoxia : It means total lack of O_2.
Hypoxemia : It means reduced O_2 in the blood.
Hypercapnia : It means excess CO_2 in the blood.
Hypocapnia : It means reduced CO_2 in the blood.

Cyanosis

Cyanosis is a clinical condition characterized by bluish coloration of skin and mucous membrane due to excessive amount of deoxygenated hemoglobin in the peripheral capillaries.

Table 65-2 Composition of Bile

Substance	Liver Bile	Gallbladder Bile
Water	97.5 g/dl	92 g/dl
Bile salts	1.1 g/dl	6 g/dl
Bilirubin	0.04 g/dl	0.3 g/dl
Cholesterol	0.1 g/dl	0.3 to 0.9 g/dl
Fatty acids	0.12 g/dl	0.3 to 1.2 g/dl
Lecithin	0.04 g/dl	0.3 g/dl
Na^+	145 mEq/L	130 mEq/L
K^+	5 mEq/L	12 mEq/L
Ca^{++}	5 mEq/L	23 mEq/L
Cl^-	100 mEq/L	25 mEq/L
HCO_3^-	28 mEq/L	10 mEq/L

From: Guyton and Hall.

Bleeding time: Bleeding time is a laboratory test to assess platelet function and the body's ability to form a clot. Bleeding normally stops within 1-9 minutes but may be longer in children (1-13 minutes) and tends to take slightly longer in females than in males.

Clotting time: Clotting time is the time required for blood to form a clot. The normal coagulation time in glass tubes is 5 to 15 minutes.

Mechanism of ventilation:

Ventilation or breathing is the movement of air through the conduction passages between the atmosphere and the lungs. The air moves through the passage because of pressure gradients that are produced by contraction of the diaphragm and thoracic muscles.

Pulmonary ventilation: Pulmonary ventilation is commonly referred to as breathing. It is the process of air flowing into the lungs during inspiration (inhalation) and out of the lungs during expiration (exhalation). Air flows because of pressure differences between the atmosphere and the gases inside the lungs.

Air, like other gases flow from a region with higher pressure to a region with lower pressure. Muscular breathing movements and recoil of elastic tissues create the changing in pressure that result in ventilation. Pulmonary ventilation involves three different pressures:

1. Atmospheric pressure
2. Intraalveolar pressure
3. Intrapleural pressure

Atmospheric pressure is the pressure of the air outside the body. Intraalveolar pressure is the pressure inside the alveoli of the lungs. Intrapleural pressure is the pressure within the pleural cavity. These three pressures are responsible for pulmonary ventilation.

Inspiration: Inspiration is the process of taking air into the lungs. It is the active phase of ventilation because it is the result of muscle contraction. During inspiration, the diaphragm contracts and the thoracic cavity increases in volume. This decreases the intraalveolar pressure so that air flows into the lungs. Inspiration draws air into the lungs.

Expiration: Expiration (exhalation) is the process of letting air out of the lungs during breathing cycle. During expiration, the relaxation of the diaphragm and elastic recoil of tissue decreases the thoracic volume and increases the intraalveolar pressure. Expiration pushes air out of the lungs.

Q. Define partial pressure and cardiac output.

Partial pressure: The pressure exerted by an individual gas in a mixture is known as its partial pressure. Dalton's law of partial pressure states that, the total pressure of a mixture of gases is equal to the sum of the partial pressure of the component gases.

$$P_{total} = P_1 + P_2 + P_3 + \ldots\ldots\ldots\ldots + P_n$$

Cardiac output: Volume of blood pumped by the heart per minute is called cardiac output.