1.3 DESCRIBE INTERCELLULAR COMMUNICATION

SHORT ESSAYS

1. Explain the types of intercellular communication. Mention one physiological significance of each.

Types of Intercellular Communication

Also called cell junctions.

1. Tight Junctions (Fig. 1.10)

- Also called zona occludens, it is an intercellular occluding junction between two cells which does not allow passage of macromolecules.
- Each tight junction consists of one-half ridge from each cell and the junction occupies the space between the two cells.
- They only allow specific molecules to pass through it.

Physiological importance

i. ***Blood–brain barrier:*** Tight junctions between capillaries form blood–brain barrier which does not allow penetration of chemicals across it thus protects the brain from harmful chemicals present in the blood.

ii. ***Gastrointestinal tract:*** Tight junctions in the epithelium of the mucosa of the stomach do not permit entry of substances to be absorbed excepting a few lipid-soluble substances like alcohol.

iii. ***Renal tubular cells***
- Tight junctions are present on the luminal side of the tubular cells which allow Na^+ ions and water to diffuse in.
- They are sensitive to ADH and control the amount of water absorption.

2. Gap Junctions (Fig. 1.11)

- These are intercellular junctions that allow passage of ions and smaller molecules between two cells.
- These are present in the cardiac muscle and basal epithelium of the gut mucosa.

Physiological significance

- They help in fast conduction of action potential. As a result, multiple cells with gap junctions function as a single unit—syncytium. These are found very commonly in smooth muscles of viscera like gut, bile ducts, uterus and many blood vessels.

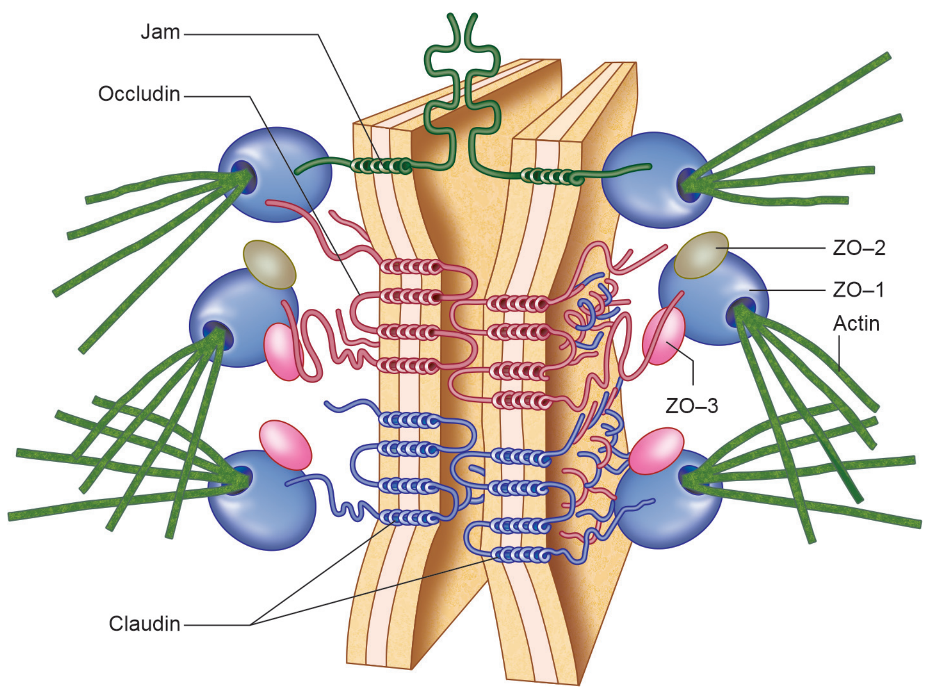

Fig. 1.10

1.6 DESCRIBE THE FLUID COMPARTMENTS OF THE BODY, ITS IONIC COMPOSITION AND MEASUREMENTS

SHORT ESSAYS

1. Define osmosis. When RBCs are suspended in hypotonic solution what happens to the cells? Mention 2 examples for isotonic solutions.

Osmosis

- Osmosis is defined as passive movement of water molecules across a semipermeable membrane from a region of higher concentration to a region of lower concentration along the concentration gradient.
- It should flow towards the region of higher concentration of solutes.
- 0.9% solution is considered isotonic. Solutions with concentration of NaCl lesser than that are considered hypotonic and concentration more than 0.9% are considered hypertonic.

RBC Suspended in Hypotonic Solution

- When RBCs are suspended in hypotonic solution, water enters the RBC and causes lysis of the cell. This is called osmotic fragility.
- Normal osmotic fragility of nRBC is 0.45% for older RBCs and 0.35% for younger RBCs.

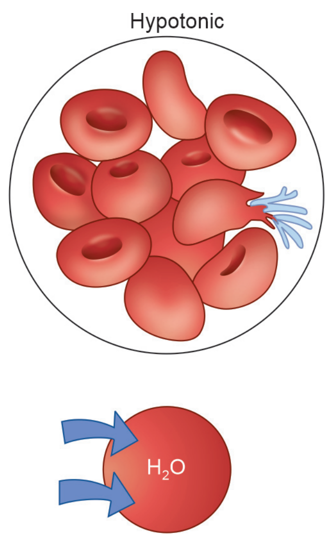

Fig. 1.16

Examples for Isotonic Solutions

- 0.45% saline is considered half-normal saline. It is used in conditions called diabetic ketoacidosis to rehydrate the cells.

2. Respiratory Mechanism

- When pH of the blood falls, there is an increase in hydrogen ions.
- It combines with bicarbonate in blood to form, H_2O and CO_2.
- CO_2 is easily blown out by hyperventilation by the lungs. Hyperventilation is caused by chemoreceptors which are triggered by hydrogen excess.

3. Renal Mechanisms (Fig. 1.19)

- In presence of acidosis, kidneys excrete hydrogen ions and retain bicarbonate ions.
- In cases of metabolic acidosis, kidneys play an important role in preventing metabolic acidosis, by excreting excess H^+ ions
- It is done by 3 methods:

i. ***Bicarbonate mechanism***
   - Excess bicarbonate and H^+ in urine combine to form H_2CO_3 (unstable). It dissociates to form H_2O and CO_2 which enter the tubular cell.
   - In presence of carbonic anhydrase, they form H_2CO_3 which is catalyzed into H^+ and HCO_3^-
   - Bicarbonate ions enter the interstitium
   - The H^+ ions are exchanged for Na^+ at the luminal end.

ii. ***Phosphate mechanism***
   - In the tubular lumen, Na_2HPO_4 splits into Na^+ and $NaHPO_4^-$
   - In the tubular cell, $H_2O + CO_2 = H_2CO_3$. It splits immediately into H^+ and HCO_3^-
   - The H^+ is exchanged for Na^+
   - The H^+ combines with $NaHPO_4^-$ to sodium dihydrogen phosphate

iii. ***Ammonia mechanism***
   - Ammonia is generated with the tubular cell from glutamine.
   - It is transported to the tubular lumen in exchange for Na^+
   - The hydrogen that is normally excreted combines with ammonia to form ammonium
   - Thus, for each molecule of ammonia formed one H^+ is excreted and NCO_3^- is retained.

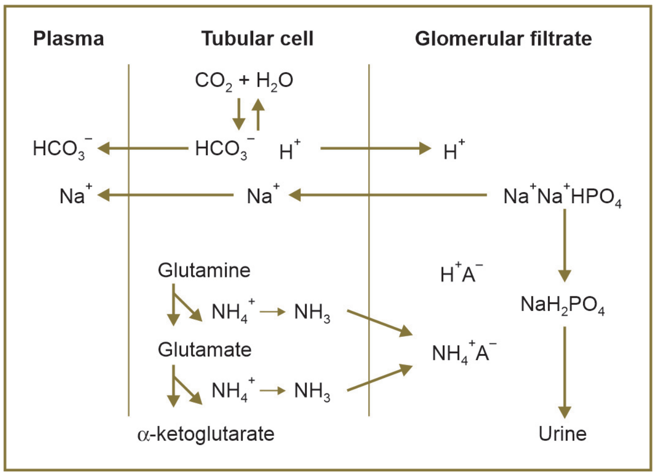

Fig. 1.19

- Globulins help in maintaining red blood cells suspended in the plasma. It is called suspension stability.
- They serve as reserve proteins in case of prolonged fasting.
- They help in formation of trephones which are required for nourishment of leukocytes.

3. **Fibrinogen**
   - Helps in coagulation
   - They increase the tendency for rouleaux formation. It is important factor for ESR measurement.
   - They help in maintaining red blood cells suspended in the plasma. It is called suspension stability.
   - They serve as reserve proteins in case of prolonged fasting.
   - They help in formation of trephones which are required for nourishment of leukocytes

SHORT ANSWERS

1. What is the importance of albumin-globulin ratio? What is its normal value? Mention two conditions where this ratio gets reversed.

Albumin-Globulin Ratio

It is the ratio of plasma levels of albumin to globulin.

Normal Value

It is normally 2:1

Importance

- Albumin is primarily produced by liver and has a half-life of 21 days.
- It is not excreted in urine and if found in urine signifies renal dysfunction.
- So, a decrease in albumins seen in liver dysfunction like hepatitis and cirrhosis and in kidney diseases like diabetic nephropathy, nephrotic syndrome and others.
- Also, albumin has more oncotic pressure compared to globulin. As a result, in states of decreased albumin in blood, there is more water retention leading to pedal edema, ascites and pulmonary edema.

A:G ratio is reversed in:
1. Cirrhosis of liver (decreased albumin production)
2. Multiple myeloma increased (globulin production).

2. What is oncotic pressure? What determines the oncotic pressure?

Oncotic Pressure

- It is osmotic pressure exerted by the plasma proteins in blood
- It is the pressure exerted by solutes in a fluid and tends to draw fluid from another solution separated by a semipermeable membrane.
- Increased oncotic pressure indicates increased pressure to draw fluid into the solution.
- Normal values
  - Normal colloidal osmotic pressure of plasma is 28 mm Hg
  - 19 mm is exerted by plasma proteins
  - 9 mm by Donnan effect (sodium, potassium, and other cations)

Determinants of Oncotic Pressure

- **Number of molecules of the solute:** More the molecules, more is the oncotic pressure.
- **Its permeability through the membrane:** Lesser the permeability, more is the pressure exerted.
- **Pore size in the basement membrane of capillaries:** In certain conditions, these may be increased due to damage to the endothelium.

Albumin

- It is a highly negative charged plasma protein with high concentration in plasma.
- It is the smallest of all plasma proteins and thus maximum in concentration per unit volume.
- It is the main determinant of colloidal osmotic pressure or oncotic pressure and contributes to 80% of the total oncotic pressure.