of two distinct parts namely a) plasma and b) formed elements. In terms of percentage, plasma constitutes 55% and the rest by the formed elements 45% (Fig. 1.1). Among the formed elements there are red blood cells, white blood cells and platelets. Major part of the formed element is contributed by the red blood cells. And the haematocrit or PCV (packed cell volume) value is normally given as 45%.

Plasma

All the formed elements of blood are in the suspended state in plasma. Plasma is made up 91-93% of water and organic and inorganic constituents form the remaining percentage.

Haematocrit (PCV - Packed cell volume - Fig. 1.1)

It is the percentage volume of blood that is contributed by red blood cells alone. In order to get the haematocrit value blood mixed with proper anticoagulant should be taken in a Wintrobe's tube and centrifuged for 30 minutes at 3000 rpm. At the end of 30 minutes there will be three different layers in the tube. Bottom most layer is made up of erythrocytes, middle layer is known as buffy coat composed of white blood cells and platelets and upper straw yellow-colored fluid layer is plasma. Normal PCV is about 45% in adult and in children it is slightly more.

When there is hemoconcentration PCV increases. Hemoconcentration occurs when there is dehydration of the body e.g.

- Severe vomiting
- Diarrhea
- Severe burns

In hemodilution PCV decreases e.g.

- Severe anemias

Functions of blood

- **Respiratory function:** Transport of oxygen to the tissues from lungs and carbon dioxide from tissues to the lungs.
- **Excretory function:** Carrying of metabolic wastes like urea, uric acid and creatinine to the kidney for excretion from the body.
- **Nutritive function:** Supply of the absorbed nutritive substances from the alimentary tract to almost all the parts of body.
- **Regulation of body temperature:** Help in the thermal balance of the body by contributing for the various physical and physiological mechanisms of heat transfer along the thermal gradient.
- **Protective function:** With the help of leucocytes and antibodies present in plasma, blood helps the body to sustain resistance against infections.

Specific gravity is the relative density of blood to that of water. The specific gravity of blood and its components is as follows:

Whole blood is about	1055 – 1060
Plasma alone	1025 – 1030
Formed elements only	1085 – 1090

PLASMA

As stated earlier apart from water, the other substances present in plasma are organic and inorganic in nature.

Some of the important organic substances are

- ***Plasma proteins***
- ***Urea***
- ***Uric acid***
- ***Creatinine***
- ***Glucose***
- ***Free fatty acids.***

d. Accumulation of fluid in the tissue spaces at the site of injury may increase the pressure around the vessel wall and exert a compressor force on the wall of blood vessel.

2. **Blood coagulation:** The phospholipid substance released by damaged platelets will help in the formation of prothrombin activator in the intrinsic system of blood coagulation.

3. **Clot retraction:** The decrease in the size of clot as the time elapses and the change in the texture of clot is due to clot retraction. Clot retraction is aided by a protein present in platelets namely thrombasthenin.

4. **Phagocytosis:** The immune complexes, carbon particles are phagocytosed.

Purpura

- Hemorrhagic spots seen below the skin, mucus membrane.
- This occurs especially in thrombocytopenia
- In purpura the bleeding time is increased, but clotting time remains normal.
- The normal bleeding time is about 1-4 min.
- The definition of bleeding time is interval from the onset of bleeding till the spontaneous arrest of bleeding from the capillaries.
- In hemophilia bleeding time will be normal.

COAGULATION OR CLOTTING OF BLOOD

The conversion of fluid blood into semisolid jelly like mass is known as coagulation or clotting of blood. The process of clotting involves a number of substances, which are called factors.

There are 3 basic steps in the coagulation of blood:

- Formation of prothrombin activator
- Conversion of prothrombin to thrombin
- Conversion of fibrinogen to fibrin and clot formation

Two mechanisms which can bring about the formation of prothrombin activator are

- Intrinsic mechanism/system
- Extrinsic mechanism/system

In intrinsic mechanism all the factors required for this reactions are present in blood itself and in extrinsic mechanism the factors present in blood and some coming from damaged tissue are contributing. But for the first step (prothrombin activator formation), all the other steps (conversion of prothrombin to thrombin and fibrinogen to fibrin) are common for both intrinsic and extrinsic mechanisms of blood clotting.

Factor No.	Name
I	Fibrinogen
II	Prothrombin
III	Tissue thromboplastin (TF)
IV	Ca^{++}
V	Proaccelerin
VI	ABSENT
VII	Proconvertin
VIII	Antihemophilic factor
IX	Christmas factor
X	Stuart Prower factor
XI	Plasma thromboplastin antecedent
XII	Hageman's factor
XIII	Fibrin stabilizing factor

In addition to the above some of the other factors that have role in coagulation of blood are Kallekrien, High molecular weight kininogen , Von Willebrandt factor.

Cortical nephrons	Juxtamedullary nephrons
% of nephrons 85	15
Most of the parts of nephron are in cortex only	Begins at the junction of the cortex and medulla
Length of LH short	Long
Accompanied by peritubular capillary network	Vasa recta

The interstitial osmolarity is around 300 mosm/l of water in the cortex and it increases gradually from the junction of cortex and medulla and in the deepest part of medulla it is about 1200 mosm/l of water.

The kidney brings about the homeostasis of the body by the operation of the following processes.

- ***Unselective filtration (happens in glomerulus)***
- ***Selective reabsorption***
- ***Selective secretion***

Reabsoption and secretion are brought about by the renal tubules.

Reabsorption refers to the return of substances from the filtrate in the lumen of renal tubules back into circulation.

Secretion means further addition of substances from the circulation into filtrate of renal tubules.

Most of the times the reabsorption/secretion will be occurring across the epithelial cells lining the renal tubules. Hence it is known as transcellular. When reabsorption occurs at the junction of the adjacent epithelial cells it is known as paracellular.

Renal circulation: Some of the special features

- Normal blood flow is about 1200 ml/min
- Hydrostatic pressure in the glomerular capillaries will be as high as 45 mm Hg.
- Confluence of glomerular capillaries forms efferent arteriole and this arteriole branches to form capillaries accompanying renal tubules. So there is portal circulation.
- 90% of blood flows through cortex, 7-9% through the medulla.
- There is well-developed auto regulation of blood flow in the kidney.
- Contributes for the counter current system operation.
- There are two sets of capaillaries. One set (glomerular capillaries) for filtration and another set (capillaries accompanying renal tubules) for reabsorption/secretion.
- Cell lining of arteriole contributes for the formation of juxtaglomerular apparatus.

Renal fraction is the ratio of cardiac output that flows into the kidneys. Normally it is about 25 %. The renal blood flow can be measured by ***applying Fick's principle.*** The substance normally used to measure renal blood flow is PAH (para amino hippuric acid). The renal plasma flow will be about 700 ml and the renal blood flow will be 1200 ml/min.

GLOMERULAR FILTRATION

Glomerular Filtration Rate (GFR)

It is the rate at which the filtration occurs in all the two million nephrons per minute. Normal value is about 125 ml/min ± 10 ml or 180 L/day. In female it is about 10% less than in males.

The type of filtration occurs in the kidney is known as ***ultrafiltration as all substances present in plasma get filtered except plasma proteins.***

stitium gradually decreases the osmolality of the tubular fluid.The thick ascending limb of loop of Henle is impermeable to water. The osmolality of the filtrate reaching the beginning of distal convoluted tubules will be either hypo-/iso-osmotic. Finally when this filtrate passes through the collecting duct, due to the action of anti diuretic hormone, water keeps getting reabsorbed and the urine will attain a higher osmolality. In addition to facilitating water reabsorption, anti diuretic hormone will also help for urea to diffuse from the collecting duct into the interstitium which ultimately gets recycled as it diffuses from the interstitium to ascending limb of loop of Henle.

Counter-current exchanger (Fig. 2.9)

Much like the loop of Henle of juxtamedullary nephrons, which is embedded in the hyperosmotic interstitium in renal medulla, the vasa recta, which accompany the renal tubules of these nephrons, are also exposed to this hyperosmotic situation. Unlike the epithelial cells of renal tubules that are selectively permeable, the endothelial cells lining the vasa recta is freely permeable. Because of this when plasma flows through the descending limb of vasa recta, there will be slight influx of ions like sodium chloride and a simultaneous efflux of water into the interstitium. These processes ensure equilibration of osmolality of plasma with the interstitium. In the asceding limb the reversal of the events bring about a decrease of the osmolality of plasma. Finally the plasma leaving the vasa recta may have an osmolality of 325 mOsm/L as against a inflow plasma osmolality of 300 mOsm/L of water.

Secretion

Some of the substances are also secreted into the renal tubules at different parts. hydrogen ion is secreted at almost all the parts of the tubules whereas potassium is secreted at distal convoluted tubules. Some amount of creatinine also gets secreted and hence the creatinine clearance value is more than glormerular filtration rate.

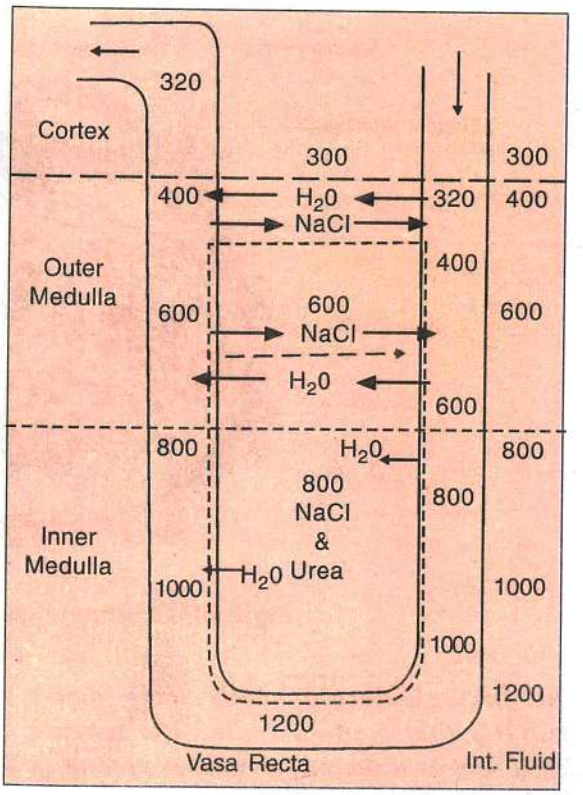

Fig 2.9 Counter-current exchanger

Diuretics are substances, which increase the urine output. Some of the commonly used diuretics are loop diuretics, spironolactone and acetazolamide. The loading of body with water can increase the urine output as well.

JUXTAGLOMERULAR APPARATUS

Juxtaglomerular apparatus (Fig. 2.10)

This is specialized structure in the kidney, which is composed of 3 different types of cells namely

- ***Specialized smooth muscle cells of the arteriolar walls – juxtaglomerular cells.***
- ***Specialized epithelial cells lining the distal convoluted tubules – macula densa.***
- ***Between the above two there are certain other cells known as Lacis cells.***