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Body Fluids and Circulation Class 11 Notes | CBSE Biology Chapter 15

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Body Fluids and Circulation Class 11 Notes | CBSE Biology Chapter 15

Body Fluids and Circulation is Chapter 15 of CBSE Class 11 Biology — the chapter that explains how oxygen, nutrients, hormones, and waste are carried to every single cell of your body. It covers blood, lymph, the human heart, and the double-circulation pathway that keeps you alive every second. Master this chapter and a huge chunk of human physiology in NEET and your board exam suddenly clicks into place.

By the end of these notes you will be able to describe the composition of blood, explain ABO and Rh blood grouping, trace the cardiac cycle and read an ECG, and confidently answer questions on disorders like hypertension and coronary artery disease. This is a high-yield NEET chapter carrying roughly 6–8 marks in boards, and the foundation for the chapters on Breathing, Excretion, and Neural Control.

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Key Concepts

1. Body Fluids — Why Circulation Is Needed

Every cell needs a constant supply of nutrients and oxygen and a way to remove waste. To do this, the body uses fluids — chiefly **blood** and **lymph** — moved around by a transport system.

Blood is a specialised **connective tissue** (it has cells and a fluid matrix). Humans have a **closed circulatory system**, meaning blood flows inside vessels and is pumped by a muscular heart under high pressure.

2. Blood — Plasma and Formed Elements

Blood is made of a fluid part called **plasma** (about 55%) and cellular **formed elements** (about 45%).

Plasma

- About **90–92% water** and **6–8% proteins**.
- Major plasma proteins: **fibrinogen** (helps clotting), **globulins** (defence/antibodies), and **albumins** (osmotic balance).
- Also carries minerals (Na^+ , Ca^{2+} , HCO_3^- , Cl^-), glucose, amino acids, lipids, and hormones.
- Plasma without clotting factors (fibrinogen removed) is called **serum**.

Formed Elements

Cell	Key Facts	Function
Erythrocytes (RBCs)	5–5.5 million/ mm^3 ; biconcave, no nucleus in mammals; contain haemoglobin; lifespan ~120 days	Transport of O_2 and CO_2
Leucocytes (WBCs)	6000–8000/ mm^3 ; nucleated, colourless; granulocytes (neutrophils, eosinophils, basophils) and agranulocytes (lymphocytes, monocytes)	Defence and immunity
Thrombocytes (platelets)	1.5–3.5 lakh/ mm^3 ; cell fragments from megakaryocytes	Blood clotting

Key idea: **Neutrophils** (60–65%) are the most abundant WBCs and are phagocytic; **lymphocytes** (20–25%) produce the immune response. RBCs are produced in the red bone marrow.

3. Blood Groups — ABO and Rh

Blood groups are based on the presence or absence of **antigens (A and B)** on the surface of RBCs and **antibodies** in the plasma.

Blood Group	Antigen on RBC	Antibody in plasma	Can donate to	Can receive from
A	A	anti-B	A, AB	A, O
B	B	anti-A	B, AB	B, O
AB	A and B	none	AB	A, B, AB, O (universal recipient)
O	none	anti-A and anti-B	A, B, AB, O (universal donor)	O

Rh Grouping

- The **Rh antigen (Rh factor)** is similar to one found in rhesus monkeys. People with it are **Rh⁺**; those without are **Rh⁻**.
- **Erythroblastosis foetalis:** if an Rh⁻ mother carries an Rh⁺ foetus, her body may make anti-Rh antibodies. In a later Rh⁺ pregnancy these can cross the placenta and destroy foetal RBCs. It is prevented by giving the mother anti-Rh antibodies after the first delivery.

4. Coagulation (Clotting) of Blood

When you get injured, blood forms a clot to stop bleeding. This is a defence mechanism called **coagulation**.

A clot is a network of threads of the protein **fibrin** in which dead and damaged blood cells are trapped.

Simplified Clotting Cascade

- Injured tissues and platelets release factors that form **thrombokinas** (**thromboplastin**).
- Thrombokinas, with Ca^{2+} , converts inactive **prothrombin** → **thrombin**.
- Thrombin converts soluble **fibrinogen** → **insoluble fibrin**.
- Fibrin threads form a mesh that traps cells → the **clot**.

[DIAGRAM: Clotting cascade — Thrombokinas + Ca^{2+} → (Prothrombin → Thrombin) → (Fibrinogen → Fibrin) → clot.]

Note: Calcium ions (Ca^{2+}) and vitamin K are essential for normal clotting. Heparin is a natural anticoagulant.

5. Lymph (Tissue Fluid)

As blood passes through capillaries, some plasma leaks out into the spaces between cells. This colourless fluid is **lymph** (tissue fluid).

- Lymph is plasma **minus most large proteins and RBCs**; it does contain WBCs (lymphocytes).
 - It is collected by lymphatic vessels and returned to the blood.
 - **Functions:** exchange of nutrients, gases and waste between blood and tissues; absorption of fats from the intestine (via lacteals); part of the immune system.
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6. Human Circulatory System

The human circulatory (blood vascular) system consists of a muscular **heart**, a network of **blood vessels**, and the **blood** that flows through them.

- **Arteries:** carry blood away from the heart; thick, elastic walls; carry oxygenated blood (except the pulmonary artery).
 - **Veins:** carry blood toward the heart; thinner walls with valves; carry deoxygenated blood (except the pulmonary vein).
 - **Capillaries:** single-cell-thick vessels where exchange of materials occurs.
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7. Structure of the Human Heart

The heart is a four-chambered, fist-sized muscular organ in the thoracic cavity, enclosed by a double-walled membrane called the **pericardium**.

- **Two atria** (upper, thin-walled) and **two ventricles** (lower, thick-walled). The left ventricle is the thickest because it pumps blood to the whole body.
- **Tricuspid valve:** between right atrium and right ventricle.
- **Bicuspid (mitral) valve:** between left atrium and left ventricle.
- **Semilunar valves:** at the openings of the aorta and pulmonary artery. Valves prevent backflow of blood.

[DIAGRAM: Human heart — right atrium, right ventricle, left atrium, left ventricle; tricuspid, bicuspid and semilunar valves; aorta, pulmonary artery, vena cava, pulmonary veins.]

Conducting System (Nodal Tissue)

- **SA node (sinoatrial node):** the **pacemaker**; generates ~70–75 impulses per minute on its own.
- **AV node (atrioventricular node):** picks up the impulse and passes it on.
- **Bundle of His and Purkinje fibres:** spread the impulse through the ventricles, making them contract.

8. Cardiac Cycle

The **cardiac cycle** is the sequence of events in one complete heartbeat. At 72 beats per minute, each cycle lasts about **0.8 seconds**.

- **Atrial systole:** atria contract, pushing blood into ventricles (~0.1 s).
- **Ventricular systole:** ventricles contract; blood is pumped into the aorta and pulmonary artery (~0.3 s).
- **Joint diastole:** all chambers relax and fill with blood (~0.4 s).

Heart sounds: "**Lubb**" (first sound) is the closing of the tricuspid and bicuspid valves at the start of ventricular systole; "**Dupp**" (second sound) is the closing of the semilunar valves at the end of ventricular systole.

9. Cardiac Output

Cardiac output is the volume of blood pumped by each ventricle in one minute.

Cardiac Output = Stroke Volume × Heart Rate

- **Stroke volume:** volume of blood pumped per beat (~70 mL).
- At ~72 beats/min, cardiac output = $70 \times 72 \approx 5000 \text{ mL/min}$ (**about 5 litres**).
- A trained athlete's heart pumps more blood per beat, so it can maintain output at a lower heart rate.

10. Electrocardiograph (ECG)

An **ECG** is a graphical record of the electrical activity of the heart during a cardiac cycle.

- **P wave:** depolarisation (contraction) of the atria.

- **QRS complex:** depolarisation of the ventricles; ventricular contraction begins just after Q.
- **T wave:** repolarisation (relaxation/recovery) of the ventricles.

[DIAGRAM: ECG trace showing P wave, QRS complex and T wave along the baseline.]

Clinical use: Counting QRS complexes over a known time gives the heart rate; the shape of the waves helps doctors detect abnormalities.

11. Double Circulation

In humans, blood passes through the heart **twice** in one complete cycle around the body — this is **double circulation**. It keeps oxygenated and deoxygenated blood completely separate.

- **Pulmonary circulation:** right ventricle → pulmonary artery → lungs → pulmonary veins → left atrium. (Deoxygenated blood goes to the lungs to be oxygenated.)
- **Systemic circulation:** left ventricle → aorta → body tissues → vena cava → right atrium. (Oxygenated blood is delivered to the body.)

Hepatic portal system: a special vein carries blood from the intestine to the liver before it reaches the heart. **Coronary circulation** supplies blood to the heart muscle itself.

12. Regulation of Cardiac Activity

The heart beats on its own (myogenic), but its rate is fine-tuned by the body.

- A special **neural centre in the medulla oblongata** moderates cardiac function through the **autonomic nervous system**.
 - **Sympathetic nerves** increase heart rate, force of contraction, and cardiac output.
 - **Parasympathetic nerves (vagus)** decrease heart rate and cardiac output.
 - The hormone **adrenaline** also increases the heart rate (the “fight or flight” response).
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13. Disorders of the Circulatory System

Disorder	Description
Hypertension (high BP)	BP higher than 140/90 mmHg (normal ~120/80). Leads to heart disease and affects the kidneys and brain.
Coronary Artery Disease (CAD)	"Atherosclerosis" — narrowing of coronary arteries by deposits of calcium, fat, cholesterol and fibrous tissue, reducing blood flow to the heart muscle.
Angina (angina pectoris)	Chest pain due to insufficient oxygen reaching the heart muscle, often when the heart works harder.
Heart failure	The heart is unable to pump enough blood to meet the body's needs (congestive heart failure when fluid collects in the lungs).

Note: Do not confuse **heart failure** (heart cannot pump enough), **cardiac arrest** (heart stops beating), and **heart attack** (heart muscle is damaged, e.g. by a blocked coronary artery).

Weightage in Board & Entrance Exams

Exam	Typical Weightage	Most-Tested Areas
CBSE Board (Class 11)	6–8 marks	Blood composition, blood groups, cardiac cycle, double circulation
NEET	2–3 questions	Blood groups & Rh, ECG waves, cardiac cycle, conducting system, disorders
Other entrance (AIIMS-pattern)	1–2 questions	Clotting cascade, cardiac output, regulation of heart

[TABLE: Question-type split — VSA (1 mark): definitions, valves, ECG waves; SA (2–3 marks): blood groups, clotting, cardiac cycle; LA (5 marks): heart structure with diagram, double circulation.]

Important Definitions

Term	Definition
Plasma	Straw-coloured fluid matrix of blood (~55%), 90–92% water with proteins, ions and nutrients
Serum	Plasma from which fibrinogen (clotting factors) has been removed
Haemoglobin	Red, iron-containing pigment in RBCs that transports O ₂ and CO ₂
Universal donor	Blood group O — no antigens on RBCs, can donate to all groups
Universal recipient	Blood group AB — no antibodies in plasma, can receive from all groups
Coagulation	Formation of a fibrin clot to stop bleeding from a wound
Lymph	Colourless tissue fluid containing WBCs but lacking RBCs and large proteins
Cardiac cycle	One complete sequence of atrial systole, ventricular systole and diastole (~0.8 s)
Cardiac output	Volume of blood pumped by a ventricle per minute = stroke volume × heart rate
Double circulation	Blood passing through the heart twice per body circuit (pulmonary + systemic)

Solved Examples

Example 1

A person has stroke volume 75 mL and heart rate 80 beats/min. Calculate the cardiac output.

Answer: Cardiac output = stroke volume × heart rate = $75 \times 80 = 6000$ mL/min = **6 litres/min**.

Example 2

Why is blood group O called the universal donor?

Answer: Group O RBCs carry **neither antigen A nor antigen B**, so when O blood is transfused there are no surface antigens for the recipient's antibodies to attack. Hence O can be donated to all ABO groups.

Example 3

In one cardiac cycle of 0.8 s, how is the time distributed among the phases?

Answer: Atrial systole ≈ 0.1 s, ventricular systole ≈ 0.3 s, joint diastole ≈ 0.4 s. Total = **0.8 s**, which gives a heart rate of about 75 beats per minute.

Example 4

An Rh⁻ mother is pregnant with an Rh⁺ child for the second time. What complication may arise and why?

Answer: Erythroblastosis foetalis. Anti-Rh antibodies formed in the mother during the first Rh⁺ pregnancy cross the placenta in the second and destroy the foetal RBCs, causing anaemia and jaundice in the baby.

Example 5

Name the wave of the ECG that represents ventricular repolarisation and the one that represents atrial depolarisation.

Answer: Ventricular repolarisation = **T wave**; atrial depolarisation = **P wave**.

Example 6

Trace the path of a drop of deoxygenated blood from the right ventricle until it returns oxygenated to the left atrium.

Answer: Right ventricle → pulmonary artery → lungs (gas exchange, becomes oxygenated) → pulmonary veins → **left atrium**. This is the **pulmonary circulation**.

Important Questions for Board Exams

1-Mark Questions (VSA)

1. Name the pigment that gives blood its red colour.
2. Which node is called the pacemaker of the heart?
3. What is serum?
4. Name the valve present between the left atrium and the left ventricle.
5. Which blood group is the universal recipient?

2–3-Mark Questions (SA)

1. Differentiate between blood and lymph on the basis of composition and function.
2. Explain the events of the clotting (coagulation) of blood with the help of a simple cascade.
3. What is double circulation? How is it advantageous?
4. Distinguish between heart failure, cardiac arrest, and heart attack.

5-Mark Questions (LA)

1. Describe the structure of the human heart with a labelled diagram, including its chambers and valves.
2. Explain the cardiac cycle in detail, mentioning the duration of each phase and the origin of heart sounds.
3. Describe ABO and Rh blood grouping. Explain erythroblastosis foetalis and how it is prevented.

Quick Revision Points

- Blood = plasma (~55%) + formed elements (~45%); plasma is 90–92% water
- RBCs: biconcave, no nucleus (mammals), carry O_2 ; WBCs defend; platelets clot
- ABO groups based on antigens A/B on RBCs; O = universal donor, AB = universal recipient
- Rh^- mother + Rh^+ foetus → erythroblastosis foetalis (in second pregnancy)
- Clotting: thrombokinase + Ca^{2+} → prothrombin → thrombin → fibrinogen → fibrin → clot
- Heart: 4 chambers; tricuspid (right), bicuspid/mitral (left), semilunar at arteries
- SA node = pacemaker (~70–75/min); AV node → Bundle of His → Purkinje fibres
- Cardiac cycle ≈ 0.8 s; Lubb = AV valves close, Dupp = semilunar valves close
- Cardiac output = stroke volume $\times$ heart rate $\approx 70 \times 72 \approx 5$ L/min
- ECG: P = atrial depolarisation, QRS = ventricular depolarisation, T = ventricular repolarisation
- Double circulation = pulmonary + systemic; medulla + autonomic nerves regulate the heart
- Disorders: hypertension (>140/90), CAD/atherosclerosis, angina, heart failure

Next Chapter: Chapter 16 — Breathing and Exchange of Gases



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