BA01 — Human Anatomy & Physiology

📖 BA01 · AFCAT General Awareness — Biology

★ Must-Master — 60–70% of AFCAT Biology

Every aircraft needs a fit pilot. AFCAT tests human biology because the IAF needs officers who understand the body they put under stress at high altitude. This single chapter contributes the majority of all AFCAT Biology questions. Work through each system in order: job → key parts → disease when it fails.

✈ **AFCAT Focus:** SA node = pacemaker; nephron = functional unit of kidney; insulin from beta cells; reflex arc = spinal cord (NOT brain); alveoli = gas exchange site; largest gland = liver; smallest bone = stapes; pituitary = master gland.

PART 1 — DIGESTIVE SYSTEM

1. Digestive System

Digestion breaks complex food into simple absorbable molecules. Each organ adds specific enzymes along the alimentary canal.

Organ	Secretion	Digestive Action	Key AFCAT Fact
Mouth	Salivary amylase (ptyalin); pH 7	Starch → Maltose	Digestion starts here
Stomach	Gastric juice: HCl + pepsin + mucus	Protein → Peptides; HCl kills bacteria	pH 2; muscular churning
Small Intestine	Bile + Pancreatic juice + Intestinal juice	All nutrients digested; absorbed through villi	Main absorption site; villi = surface area

Large Intestine	No digestive enzymes	Water & minerals absorbed; faeces formed	Colon absorbs water
Liver	Bile production	Glycogen storage; detoxification	Largest gland in body
Pancreas	Digestive enzymes (exocrine)	Insulin / Glucagon (endocrine)	Beta cells → insulin; Alpha cells → glucagon

PART 2 — CIRCULATORY SYSTEM

2. Circulatory System

Blood delivers oxygen, carries hormones, and neutralises pathogens. AFCAT tests blood composition and the famous pulmonary exception.

Component	Normal Count	Function	Key Fact
RBC (Erythrocytes)	4.5–5.5 million / mm^3	Carry O_2 via haemoglobin; some CO_2 transport	No nucleus (mature); life span 120 days
WBC (Leukocytes)	5,000–10,000 / mm^3	Immunity; fight infection; phagocytosis	Have nucleus; 5 types; count rises during infection
Platelets (Thrombocytes)	1.5–4 lakh / mm^3	Blood clotting; prevents excessive blood loss	No nucleus; smallest blood cell; life span 8–10 days
Plasma	55% of blood	90% water; carries food, hormones, fibrinogen	Universal internal transport medium

Heart — 4 Direct AFCAT Facts:

- **4 chambers:** Right atrium, Right ventricle, Left atrium, Left ventricle
- **SA node** (Sinoatrial node) in right atrium = natural pacemaker (~72 bpm)
- **Double circulation:** Pulmonary (heart ↔ lungs) + Systemic (heart ↔ body)

- **The trap:** Pulmonary *artery* = deoxygenated blood (away from heart to lungs); Pulmonary *vein* = oxygenated blood (lungs to heart) — opposite of the normal rule!

PART 3 — EXCRETORY & RESPIRATORY SYSTEMS

3. Excretory System — The Nephron

The kidney filters 180 litres of blood plasma daily but produces only ~1.5 L of urine. The functional unit is the nephron (~1 million per kidney).

Stage	Site	What Happens	AFCAT Key Point
Stage 1 — Ultrafiltration	Glomerulus inside Bowman's capsule	Blood filtered under pressure; water, glucose, urea, salts pass through	Proteins STAY in blood (too large to filter)
Stage 2 — Selective Reabsorption	Proximal Convoluted Tubule + Loop of Henle	Glucose, amino acids, water, useful salts reabsorbed back into blood	Glucose fully reabsorbed; absent in normal urine
Stage 3 — Tubular Secretion	Distal Convoluted Tubule + Collecting duct	Extra H^+, K^+, NH_3, drugs, excess ions secreted into filtrate	Final urine: urea + water + salts + creatinine

4. Respiratory System

Air Pathway: Nose → Pharynx → Larynx → Trachea → Bronchi → Bronchioles → **Alveoli** (gas exchange)

- O_2 diffuses: alveolus → capillary → binds haemoglobin → tissues
- CO_2: tissues → blood (bicarbonate) → alveolus → exhaled
- **CO danger:** Carbon monoxide binds haemoglobin 240× more than O_2 → blocks O_2 transport

PART 4 — NERVOUS, ENDOCRINE & SKELETAL

5. Endocrine System

Gland	Hormone(s)	Function	AFCAT Key Point
Pituitary (base of brain)	GH, TSH, ADH, FSH, LH, Prolactin	Controls all other endocrine glands	Master gland
Thyroid (neck)	Thyroxine (T_4), T_3	Regulates metabolism and body growth	Iodine needed; deficiency → Goitre
Adrenal (above kidneys)	Adrenaline (medulla), Cortisol (cortex)	Fight-or-flight response; stress regulation	Adrenaline = emergency hormone
Pancreas	Insulin (β-cells), Glucagon (α-cells)	Blood glucose regulation; insulin deficiency → Diabetes	Islets of Langerhans; β-cells make insulin

⚡ **Reflex Arc:** Stimulus → Receptor → Sensory neuron → **Spinal Cord** → Motor neuron → Effector. The brain is NOT involved — you pull your hand from fire BEFORE feeling pain.

6. Skeletal System

Feature	Detail
Total bones (adult)	206 (infant ~270; fuse during development)
Longest bone	Femur (thigh bone) — supports entire body weight
Smallest bone	Stapes (stirrup, middle ear) — ~3 mm; transmits sound
Hardest substance	Tooth enamel (calcium phosphate hydroxyapatite)

Ball-and-socket joint	Shoulder, Hip — full 360° rotation
Hinge joint	Elbow, Knee — flexion / extension only
Pivot joint	Atlas-axis — allows head rotation left / right
Fixed (suture) joint	Skull bones — no movement; protects brain
Skeleton functions	Support & shape · Protect organs (skull→brain; ribcage→heart+lungs) · Enable movement · RBC production (red marrow) · Ca & P storage

PART 5 — HEALTH & DISEASES

7. Diseases & Deficiency Conditions

Disease	Type	Causative Agent	Transmission	Key Fact
Malaria	Protozoan	Plasmodium (P. falciparum worst)	Female Anopheles mosquito	Attacks liver + RBCs
Tuberculosis	Bacterial	Mycobacterium tuberculosis	Airborne droplets (cough, sneeze)	BCG vaccine; affects lungs
Typhoid	Bacterial	Salmonella typhi	Contaminated food and water	Widal test for diagnosis
HIV / AIDS	Viral	Human Immunodeficiency Virus	Blood, sexual contact, mother to child	Destroys CD4 T-helper cells
Cholera	Bacterial	Vibrio cholerae	Contaminated water and food	Severe watery diarrhoea; ORS treatment

Vitamin / Mineral	Deficiency Disease	Main Symptom

Vitamin A (Retinol)	Night blindness / Xerophthalmia	Cannot see in dim light; dry cornea
Vitamin B_1 (Thiamine)	Beriberi	Nerve damage, muscle weakness
Vitamin C (Ascorbic acid)	Scurvy	Bleeding gums, poor wound healing
Vitamin D (Calciferol)	Rickets (children) / Osteomalacia (adults)	Soft, bent bones; bowed legs
Iodine	Goitre	Enlarged thyroid gland in neck
Iron	Iron-deficiency Anaemia	Fatigue, pale skin, low RBC count

📝 AFCAT PYQs — Human Anatomy & Physiology

Q1. Which is the functional unit of the kidney? AFCAT PYQ

(a) Nephron (b) Neuron (c) Alveolus (d) Glomerulus

✓ Answer: (a) Nephron

The **nephron** has ~1 million units per kidney. It performs filtration (glomerulus), reabsorption (PCT + loop of Henle), and secretion (DCT + collecting duct). The glomerulus is one part of the nephron, not the unit itself.

Q2. The natural pacemaker of the human heart is: AFCAT PYQ

(a) AV node (b) SA node (c) Bundle of His (d) Purkinje fibres

✓ Answer: (b) SA node

The **SA node** (sinoatrial node) in the right atrium fires spontaneously at ~72 bpm. Impulse: SA → AV node → Bundle of His → Purkinje fibres. When it fails, a surgical pacemaker is implanted.

Q3. Insulin is produced by which cells? AFCAT PYQ

(a) Acinar cells (b) Alpha cells (c) Beta cells (d) Delta cells

✓ Answer: (c) Beta cells of Islets of Langerhans

Beta (β) cells secrete insulin when blood glucose rises. Alpha cells secrete glucagon (raises glucose). Insulin deficiency → Type 1 Diabetes.

Q4. The pulmonary vein carries: Tricky

(a) Deoxygenated blood to lungs (b) Oxygenated blood from lungs to heart

(c) Deoxygenated blood to heart (d) Oxygenated blood to body

✓ Answer: (b) Oxygenated blood from lungs to heart

The **pulmonary vein** is the exception: it carries oxygenated blood FROM lungs TO the left atrium. The pulmonary artery carries deoxygenated blood from right ventricle TO lungs. AFCAT tests this reversal directly.

Q5. Malaria is transmitted by: AFCAT PYQ

(a) Male Anopheles (b) Female Anopheles (c) Female Aedes (d) Housefly

✓ Answer: (b) Female Anopheles mosquito

Only the **female Anopheles** needs a blood meal for egg production. Dengue = Aedes aegypti. The vector-disease pairing is directly tested in AFCAT.

🧠 Quick Memory Chart — BA01

❤️ Heart & Blood

- SA node = pacemaker (right atrium)
- 4 chambers; double circulation
- RBC: no nucleus; O_2; 120-day life
- Pulmonary vein = oxygenated (exception!)

⚗ Hormones & Nerves

- Pituitary = master gland
- Insulin (β-cells): lowers glucose
- Adrenaline: fight-or-flight
- Thyroxine: iodine; metabolism
- Reflex: spinal cord (NOT brain)

🏥 Diseases & Deficiency

- Malaria: Plasmodium + female Anopheles
- TB: Mycobacterium (airborne)
- Scurvy: Vit C | Rickets: Vit D
- Goitre: Iodine deficiency

- Plasma = 55% blood; 90% water

- Stapes = smallest bone; Femur = longest

📝 Practice Exercise

E1. Gas exchange in the lungs occurs in the:

(a) Trachea (b) Bronchi (c) Alveoli (d) Pharynx

E2. Which joint allows the greatest range of movement?

(a) Hinge (b) Pivot (c) Ball-and-socket (d) Gliding

Answers:

E1 → (c) Alveoli | E2 → (c) Ball-and-socket [shoulder and hip; full 360°]

📝 Mock Tests 🎯 Subject Quiz ✈️ Telegram