Physiology

Sample Paper – 1

Questions:	25	**Duration:**	45 min
Total Marks:	100	**Marking:**	+4 / −1

Topics: Cardiovascular · Nervous · Endocrine · Digestive · Respiratory · Renal · Homeostasis

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Quick Reference

Instructions

- This paper has **25 questions** carrying **100 marks**.
- Each correct answer: **+4 marks**. Each wrong answer: **−1 mark**. Unattempted: **0**.
- Suggested time: **45 minutes**. All questions are single-correct MCQs.
- Covers: Cardiovascular, Nervous, Endocrine, Digestive, Respiratory, Renal systems, Homeostasis, Nutrition.
- Click a question number in the answer key to jump to its solution.

Q1. The largest artery in the human body, which carries oxygenated blood from the left ventricle to the systemic circulation, is the:

(A) Pulmonary artery
(B) Femoral artery
(C) Common carotid artery
(D) Aorta

Q2. The basic structural and functional unit of the nervous system, specialised for receiving, processing, and transmitting information via electrical and chemical signals, is the:

(A) Synapse
(B) Schwann cell
(C) Axon terminal
(D) Neuron

Q3. Haemoglobin is the oxygen-carrying protein in red blood cells. The iron-containing, non-protein component of haemoglobin that directly binds oxygen is called:

(A) Globin
(B) Haem
(C) Myosin
(D) Fibrinogen

Q4. Which pair of organs filters approximately 180 litres of blood plasma per day to produce urine through the processes of filtration, reabsorption, and secretion?

(A) Liver
(B) Kidneys
(C) Spleen
(D) Adrenal glands

Q5. Insulin — the hormone that facilitates cellular glucose uptake and lowers blood glucose concentration — is secreted by which cells?

(A) Alpha cells of the adrenal cortex
(B) Follicular cells of the thyroid gland
(C) Somatotroph cells of the anterior pituitary
(D) Beta cells of the islets of Langerhans in the pancreas

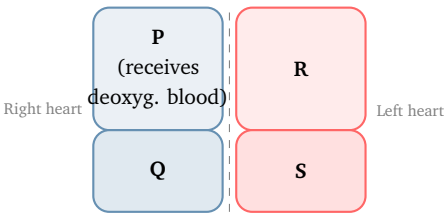
Q6. The type of cell division in which a single parent cell divides to produce two genetically identical daughter cells — the basis of somatic cell growth and tissue repair — is:

(A) Meiosis
(B) Apoptosis
(C) Mitosis
(D) Cytokinesis alone

Q7. The normal arterial blood pH in a healthy human adult is maintained within a narrow range. This range is:

(A) 7.35–7.45
(B) 6.80–7.20
(C) 7.50–8.00
(D) 7.00–7.30

Q8. The diagram below shows a schematic cross-section of the human heart with four chambers labelled P, Q, R, S. The chamber **P** (upper-right) receives deoxygenated blood returning from the body via the vena cavae. It is the:



(A) Right atrium
(B) Left atrium
(C) Right ventricle
(D) Left ventricle

Q9. Peristalsis — the rhythmic, wave-like muscular contractions that propel food along the gastrointestinal tract — is produced by which type of muscle?

(A) Cardiac muscle (involuntary, striated)
(B) Smooth muscle (involuntary, non-striated)
(C) Skeletal muscle (voluntary, striated)
(D) Elastic connective tissue

Q10. The primary site of digestion and absorption of nutrients (carbohydrates, proteins, fats, vitamins, and minerals) in the human digestive system is the:

(A) Small intestine
(B) Stomach
(C) Large intestine
(D) Oesophagus

Q11. Which vitamin is synthesised in the skin upon exposure to ultraviolet light, acts as a hormone, and is essential for intestinal calcium and phosphate absorption?

(A) Vitamin A (retinol)
(B) Vitamin B_{12} (cobalamin)
(C) Vitamin D (calciferol)
(D) Vitamin K (phylloquinone)

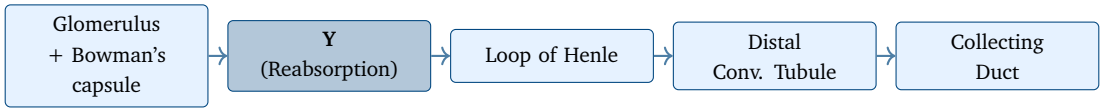
Q12. The conducting system of the heart initiates each cardiac cycle at the natural pacemaker of the heart, which is the:

(A) Sinoatrial (SA) node
(B) Atrioventricular (AV) node
(C) Bundle of His (AV bundle)
(D) Purkinje fibres

Q13. Haemoglobin — the oxygen-transport protein — is found within which type of blood cell?

(A) Erythrocyte (red blood cell)
(B) Neutrophil (white blood cell)
(C) Thrombocyte (platelet)
(D) Monocyte

Q14. The diagram below shows a simplified nephron. The tubular segment **Y** — immediately downstream of the glomerulus and Bowman's capsule, where most filtered glucose and amino acids are reabsorbed — is the:



(A) Collecting duct
(B) Loop of Henle
(C) Proximal convoluted tubule
(D) Distal convoluted tubule

Q15. During inspiration (inhalation), the diaphragm:

(A) Relaxes and moves upward, decreasing thoracic volume
(B) Contracts and moves downward, increasing thoracic volume
(C) Remains stationary while only intercostal muscles drive airflow
(D) Contracts and moves upward to push air into the lungs

Q16. When a nerve impulse reaches the axon terminal (presynaptic terminal), neurotransmitters are released from synaptic vesicles into the:

(A) Axon hillock
(B) Dendritic spine
(C) Node of Ranvier
(D) Synaptic cleft

Q17. Cortisol — a glucocorticoid that regulates stress responses, metabolism, and immune function — is secreted by the:

(A) Adrenal medulla
(B) Adrenal cortex (zona fasciculata)
(C) Anterior pituitary gland
(D) Hypothalamus

Q18. Thermoregulation — the maintenance of core body temperature through mechanisms such as shivering, sweating, and vasodilation/vasoconstriction — is primarily controlled by which brain structure?

(A) Cerebral cortex (frontal lobe)
(B) Cerebellum
(C) Hypothalamus
(D) Medulla oblongata

Q19. The 'fight or flight' stress response — characterised by increased heart rate, pupil dilation, bronchodilation, and adrenaline release — is initiated by which division of the autonomic nervous system?

(A) Parasympathetic nervous system
(B) Sympathetic nervous system
(C) Somatic nervous system (voluntary)
(D) Enteric nervous system (gut brain)

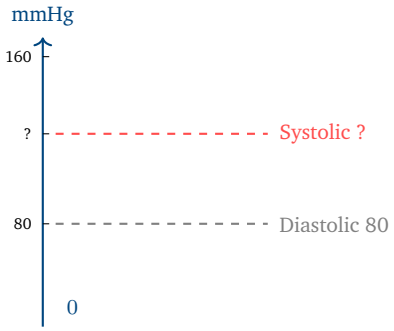
Q20. Antibodies (immunoglobulins) — the Y-shaped proteins that specifically bind to antigens and mark them for destruction — are produced and secreted by:

(A) Neutrophils
(B) Natural killer (NK) cells
(C) Macrophages
(D) Plasma cells (differentiated B lymphocytes)

Q21. Salivary amylase and pancreatic amylase both catalyse the hydrolysis of starch into maltose. The organ(s) that secrete amylase are:

(A) Salivary glands and pancreas
(B) Stomach only
(C) Small intestine villi only
(D) Liver (via bile)

Q22. The diagram below represents a sphygmomanometer blood pressure reading showing systolic and diastolic pressures. Normal blood pressure for a healthy adult at rest is:



(A) 120/80 mmHg
(B) 80/120 mmHg (reversed)
(C) 140/90 mmHg (borderline high)
(D) 100/70 mmHg

Q23. Anaemia is clinically defined as a condition characterised by:

(A) Excess red blood cells (polycythaemia)
(B) Abnormally elevated white blood cell count (leukocytosis)
(C) Deficiency of haemoglobin or reduction in the number of circulating red blood cells
(D) Elevated platelet count above the normal range (thrombocytosis)

Q24. Gas exchange between the alveoli and pulmonary capillaries — where oxygen moves from the air into the blood and carbon dioxide moves from the blood into the air — occurs by:

(A) Active transport (requiring ATP energy)
(B) Osmosis (movement of water across a membrane)
(C) Facilitated diffusion (using protein carriers)
(D) Simple diffusion (down concentration and partial pressure gradients)

Q25. Glycogen — the storage form of glucose in animals — is synthesised from excess blood glucose and stored primarily in:

(A) Adipose tissue and the brain
(B) Heart muscle and the lungs
(C) The liver and skeletal muscle
(D) The kidneys and spleen

Answer Key — Physiology Sample Paper 1

1	D	2	D	3	B	4	B	5	D
6	C	7	A	8	A	9	B	10	A
11	C	12	A	13	A	14	C	15	B
16	D	17	B	18	C	19	B	20	D
21	A	22	A	23	C	24	D	25	C

Detailed Solutions

Solution

Q1. (D) Aorta

The **aorta** is the largest artery in the body (diameter ≈ 2–3 cm). It originates from the left ventricle and arches over the heart (aortic arch) before descending through the thorax and abdomen. The pulmonary artery (Option A) carries deoxygenated blood to the lungs — uniquely, it is the only artery carrying deoxygenated blood.

Solution

Q2. (D) Neuron

A **neuron** is the basic unit of the nervous system. It consists of: cell body (soma) containing the nucleus, *dendrites* that receive signals, and an *axon* that transmits electrical impulses. Neurons communicate at *synapses* via neurotransmitters. The human brain contains ≈86 billion neurons.

Solution

Q3. (B) Haem

Haemoglobin consists of four polypeptide *globin* chains, each attached to a **haem** group. Each haem group contains one iron (Fe^{2+}) atom that reversibly binds one O_2 molecule. One haemoglobin molecule can carry four O_2 molecules. Oxygenated haemoglobin is bright red; deoxygenated haemoglobin is dark red/purple.

Solution

Q4. (B) Kidneys

The paired **kidneys** (each ≈ 11 cm long, 150 g) filter ≈1200 mL blood/min = 180 L plasma/day. Of this, ≈1.5 L is excreted as urine; 99% is reabsorbed. The functional unit is the *nephron* (≈1 million per kidney). Functions: excretion, acid-base balance, blood pressure regulation (RAAS), erythropoietin secretion, vitamin D activation.

Solution

Q5. (D) Beta cells of the islets of Langerhans in the pancreas

The pancreas has both exocrine (digestive enzymes) and endocrine functions. The islets of Langerhans contain: **Beta (β) cells** $\rightarrow$ insulin (lowers blood glucose), Alpha (α) cells $\rightarrow$ glucagon (raises blood glucose), Delta (δ) cells $\rightarrow$ somatostatin (inhibits both). Insulin deficiency/resistance causes diabetes mellitus.

Solution

Q6. (C) Mitosis

Mitosis produces two genetically identical daughter cells (2n $\rightarrow$ 2n). Phases: Prophase, Metaphase, Anaphase, Telophase (PMAT). Used for growth, repair, and asexual reproduction. *Meiosis* (Option A) produces four genetically unique haploid cells (2n $\rightarrow$ 4$\times$n) for sexual reproduction. *Apoptosis* (Option B) is programmed cell death.

Solution

Q7. (A) 7.35–7.45

Normal arterial blood pH is **7.35–7.45** (slightly alkaline). Values below 7.35 = *acidosis*; above 7.45 = *alkalosis*. Both extremes are life-threatening. Maintained by three buffer systems: bicarbonate (HCO_3^-/CO_2), protein buffers, and phosphate buffers, with respiratory and renal compensation.

Solution

Q8. (A) Right atrium

The heart has four chambers: **Right atrium (P)** receives deoxygenated blood via the superior and inferior vena cavae $\rightarrow$ Right ventricle (Q) pumps to lungs via pulmonary artery $\rightarrow$ Left atrium (R) receives oxygenated blood from pulmonary veins $\rightarrow$ Left ventricle (S) pumps to body via the aorta. The heart contracts $\approx$70 times/min at rest (cardiac output $\approx$5 L/min).

Solution

Q9. (B) Smooth muscle

The GI tract wall contains **smooth muscle** (involuntary, non-striated) in two layers: circular (constricts lumen) and longitudinal (shortens segment). Their coordinated alternating contractions produce peristalsis. Smooth muscle is also found in blood vessels, airways, and the urinary tract. It is controlled by the enteric and autonomic nervous systems.

Solution

Q10. (A) Small intestine

The **small intestine** (≈6–7 m long) is the primary site of digestion and absorption, facilitated by: (1) villi and microvilli (brush border) that increase surface area 600-fold, (2) digestive enzymes (pancreatic + brush border), and (3) bile from the liver. Sections: duodenum (digestion), jejunum (absorption), ileum (B_{12} and bile salt reabsorption).

Solution

Q11. (C) Vitamin D (calciferol)

Vitamin D is unique — it is synthesised in skin (7-dehydrocholesterol + UV-B → cholecalciferol) and activated in liver and kidneys. It acts as a hormone to increase intestinal calcium absorption. Deficiency causes *rickets* (children) or *osteomalacia* (adults). Vitamin A (retinol): vision/epithelium; B_{12}: nerve function/RBC; Vitamin K: blood clotting.

Solution

Q12. (A) Sinoatrial (SA) node

The **SA node**, located in the right atrial wall near the superior vena cava, is the heart's natural pacemaker — it spontaneously depolarises 60–100 times/min. The signal then travels to the *AV node* (delay 0.1 s), then down the *Bundle of His*, *bundle branches*, and finally the *Purkinje fibres* to stimulate ventricular contraction. The ECG P-wave represents atrial depolarisation from the SA node.

Solution

Q13. (A) Erythrocyte (red blood cell)

Erythrocytes (RBCs) are the most numerous blood cells (≈5 million/μL). They are biconcave, lack a nucleus and mitochondria (maximising haemoglobin content), and live ≈120 days. Each RBC contains ≈270 million haemoglobin molecules. Production (erythropoiesis) occurs in bone marrow, stimulated by erythropoietin from the kidneys.

Solution

Q14. (C) Proximal convoluted tubule (PCT)

The **PCT** is immediately downstream of the glomerulus and is the major reabsorption site: ≈65% of filtered Na^+/water, 100% of filtered glucose and amino acids, and most HCO_3^-. The PCT uses active transport (Na^+/K^+-ATPase). The Loop of Henle concentrates urine; the DCT is regulated by aldosterone; the collecting duct by ADH.

Solution

Q15. (B) Contracts and moves downward, increasing thoracic volume

During inspiration, the dome-shaped diaphragm **contracts and flattens** (moves downward), increasing thoracic cavity volume. This reduces intrathoracic pressure below atmospheric, causing air to flow into the lungs. External intercostals also contract. During expiration, the diaphragm *relaxes* and moves upward, decreasing lung volume.

Solution

Q16. (D) Synaptic cleft

At a chemical synapse: an action potential arrives at the axon terminal → voltage-gated Ca^{2+} channels open → Ca^{2+} influx triggers fusion of synaptic vesicles with the presynaptic membrane → neurotransmitters (e.g., acetylcholine, dopamine) are released into the **synaptic cleft** (20–40 nm gap) → bind to receptors on the postsynaptic membrane. The signal is then terminated by reuptake, diffusion, or enzymatic breakdown.

Solution

Q17. (B) Adrenal cortex (zona fasciculata)

Cortisol is a glucocorticoid produced by the *zona fasciculata* of the **adrenal cortex**. Regulated by ACTH from the anterior pituitary (HPA axis). Effects: raises blood glucose (gluconeogenesis), suppresses inflammation and immunity, mobilises fats. The adrenal *medulla* (not cortex) secretes adrenaline (epinephrine) and noradrenaline.

Solution

Q18. (C) Hypothalamus

The **hypothalamus** is the thermostat of the body, maintaining core temperature at ≈37°C. It detects blood temperature changes and triggers: *warming responses* (shivering, vasoconstriction, piloerection) when cold; *cooling responses* (sweating, vasodilation, panting) when hot. The hypothalamus also regulates hunger, thirst, sleep, and hormonal control via the pituitary.

Solution

Q19. (B) Sympathetic nervous system

The **sympathetic** division ("fight or flight") is activated by stress: increases heart rate, dilates pupils and bronchioles, redirects blood to muscles, inhibits digestion, and stimulates adrenaline release from the adrenal medulla. Uses noradrenaline (norepinephrine) at most effectors. The *parasympathetic* ("rest and digest") does the opposite, using acetylcholine.

Solution

Q20. (D) Plasma cells (differentiated B lymphocytes)

B lymphocytes, when activated by antigen, differentiate into **plasma cells** — the antibody factories. Each plasma cell can secrete thousands of antibodies per second. Plasma cells are short-lived (days to weeks) but some B cells become long-lived memory cells. Neutrophils and macrophages (innate immunity) phagocytose pathogens rather than producing antibodies.

Solution

Q21. (A) Salivary glands and pancreas

Salivary amylase (ptyalin) begins starch digestion in the mouth. It is inactivated by stomach acid. **Pancreatic amylase** continues starch digestion in the duodenum. Both convert starch $\rightarrow$ maltose $\rightarrow$ glucose (via maltase on the brush border). The stomach secretes pepsinogen (protein digestion) and lipase (fat), but not amylase.

Solution

Q22. (A) 120/80 mmHg

Normal adult blood pressure is **120/80 mmHg** (systolic/diastolic). Systolic pressure (120 mmHg) is the peak pressure during ventricular contraction (systole); diastolic pressure (80 mmHg) is the minimum pressure during cardiac relaxation (diastole). Hypertension is diagnosed at $\geq$130/80 (AHA 2017) or $\geq$140/90 (older guidelines). Pulse pressure = Systolic $-$ Diastolic = 40 mmHg.

Solution

Q23. (C) Deficiency of haemoglobin or red blood cells

Anaemia is defined as haemoglobin $<$ 13 g/dL (men) or $<$ 12 g/dL (women). Causes: iron deficiency (most common worldwide), B_{12}/folate deficiency (megaloblastic), chronic disease, haemolysis, haemorrhage, bone marrow failure. Symptoms: fatigue, pallor, dyspnoea. Treatment depends on cause — iron supplements, B_{12} injections, etc.

Solution

Q24. (D) Simple diffusion (down concentration/partial pressure gradients)

At the alveolar-capillary membrane (0.2–0.5 μm thick), gas exchange occurs by **simple diffusion** driven by partial pressure gradients: O_2 moves from alveoli (p_{O_2} 104 mmHg) into blood (p_{O_2} 40 mmHg); CO_2 moves from blood (p_{CO_2} 45 mmHg) into alveoli (p_{CO_2} 40 mmHg). No ATP is required. Fick's law governs the rate.

Solution

Q25. (C) Liver and skeletal muscle

Glycogen is stored primarily in the **liver** (≈100 g, released as blood glucose for systemic use) and **skeletal muscle** (≈400 g, used locally for muscle contraction). Hepatic glycogen maintains blood glucose between meals; muscle glycogen fuels exercise. Brain cannot store glycogen (uses blood glucose directly) and adipose stores fat, not glycogen.