

HUMAN BIOLOGICAL SCIENCES

STAGE 3

SOLUTIONS

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

31.

(a)

Hormone	Released from	Target organ	Main effect/s
Antidiuretic hormone (ADH)	Posterior lobe (1)	Kidneys/Collecting ducts/Nephron (1)	Reabsorption of water (1)
Growth hormone (GH)	Anterior lobe (1)	All cells (1)	Promote growth and protein synthesis (1)

(Need both)

(b) The posterior lobe of the pituitary gland does not secrete any hormones, it only releases them (1).

The hormones are made in the hypothalamus (1)

and pass to the posterior lobe of the pituitary via the infundibulum (1).

(c) (i) adrenaline/epinephrine (0.5) and noradrenaline/norepinephrine (0.5) from the adrenal medulla and glucocorticoids (cortisol) from the adrenal cortex (1)

(ii) Pancreas – increase insulin secretion (1)

Liver – converts glucose into glycogen (1)

32.

(a) Diagram to include correctly labelled:

phospholipid bi-layer (1)

hydrophilic head (1)

hydrophobic tail (1)

proteins (eg channel proteins) (1)

(b) Hydrophobic nature of inner membrane allows lipid-soluble substances to pass through membrane across the concentration gradient (1).

Channel proteins allow water-soluble molecules to pass through the otherwise hydrophobic membrane (1).

- (c) Steroid hormones are lipid soluble (1) and pass freely through cell membrane to bind to internal receptors such as the nucleus or mitochondria (1)
They influence the activity of genes (1)

Any three points = 3 marks

Amine hormones are water soluble (1) and bind to receptor sites on cell membrane (1)
They produce a secondary messenger to influence activity of enzymes (1)

Any three points = 3 marks

33.

- (a) (i) The new drug reduces the skin temperature of patients suffering heat stroke (1)
- (ii) Intra-venous administration (new drug or saline) (1)
- (iii) Skin temperature (1)
- (b) Neat and accurate (1)
Key (1)
Axes labelled correctly (Y-axis: skin temperature (°C); X-axis: time (min)) (1)
Line graph (1)
- (c) The new drug is effective at reducing the skin temperature of patients suffering heat stroke (1)
as the body temperature of the new drug treatment group returned close to normal within 40 min whereas in the saline treatment group it took more than an hour (1)
- (d) This group was needed (as a control) so that a comparison of the results from the new drug treatment group could be made to ensure the drug was effective (1)
- (e) Vasodilation is a normal response to increased body temperature where the increased blood flow through the skin (1)
increases the heat loss through radiation (and convection) (1)
The drug would enhance this normal physiological response (1)

34.

(a)

Structure	Effect of sympathetic stimulation	Effect of parasympathetic stimulation
Heart	Increase rate and strength of contraction (1)	Heart rate and stroke volume/ Decrease rate and strength of contraction / Cardiac output (1)
Liver	Increases breakdown of glycogen/glycogenolysis and release of glucose (1)	Increase uptake of glucose and synthesis of glycogen/glycogenesis (1)

(b) Parasympathetic – acetylcholine; Sympathetic – noradrenaline (1)

(c) **SIMILARITIES (Any 1 = 1 mark)**

Some substances function as both hormones and neurotransmitters (eg. Noradrenaline) (1)

Neurotransmitters and some hormones (eg adrenaline) are secreted by neurons (1)

Both are methods of communication within the body (1)

The effects on some target organs can be achieved by either/both hormones and neurotransmitters (eg noradrenaline and glucagon both act on liver to break down glycogen) (1)

DIFFERENCES (Any 1 = 1 mark)

Nervous system has electrical impulses and neurotransmitters whereas endocrine system has hormones (1)

Nervous system transmits its message along the membranes of neurons whereas endocrine system transmits its message in the bloodstream (1)

Nervous system affects muscle cells, gland cells or other neurons whereas the endocrine system may affect all cell types (1)

Nervous systems response is usually local and specific whereas the endocrine systems response is usually widespread and general (1)

Nervous system response time is rapid (milliseconds) whereas the endocrine systems response time is slow (seconds to days) (1)

Nervous system response is brief (stops when stimulus stops) whereas the endocrine system response is long lasting (may continue after stimulus has stopped) (1)

35.

- (a) (i) A range of variations exists within the gene pool of a given population / within the population, which shares a common gene pool. (1)
- (ii) A barrier forms that divides the population so that no interbreeding can occur / a barrier has formed that prevents gene flow. (1)
Each population now has its own separate gene pool (1)
- (iii) Each population is subject to different selection pressures (1)
This brings about changes in the gene frequencies of each gene pool (1)
Over long periods of time the differences in the two populations gene pool become so great they are no longer the same species (1)
- (b) Malaria (1)

36.

- (a) Cranium: Reduced prognathism (1)
Foramen magnum located centrally at base of the cranium (1)
Reduced jaw (1)
- Any two = 2 marks
- Pelvis: Wide /Broad (1)
Bowl shaped (1)
Forward tilt (1)
- Foot: Transverse arch (1)
Robust/Large tarsals (1)
Robust/Large hallux/big toe (1)
Permanently adducted hallux/big toe (1)
- Any two = 2 marks
- (b) Homo habilis: Simple tool kit (1) OR
Pebble tools/Oldowan culture (1)
- Homo neanderthalensis: Complex tool kit / Mousterian culture (1)
Great variety / cutters, scrapers, crushers (1)
Variety of materials such as wood/antler/ bone (1)
- (c) Homo erectus: Use of Fire (1)
Shelter construction (1)
Cooperative hunting (1)
Communication/simple language (1)

37.

- (a) (i) Natural passive (1)
(ii) Artificial active (1)
(iii) Artificial passive (1)
- (b) Antibiotics are chemicals that will kill bacteria (1)
They achieve this by altering metabolism/damaging cell membrane etc. (1)
No "memory" is produced (1)

Vaccines introduce antigen (1)

This stimulates the production of memory cells (1)

When antigen introduced again there is a quicker and faster response (1)

Antibodies and T-Cells are produced more quickly (1)

Any six = 6 marks

- (c) Testing on animals (1)
Testing in developing countries (1)
Use of embryos (1)

Any two = 2 marks

38.

- (a) A: Initiates movement (1)
B: Smooths actions/coordinates movement/subconscious learned movement (1)
C: Pathway for motor neurons to muscles (1)
- (b) D: Receive information and transfer to the cell body (1)
E: Speeds the transmission of an impulse/insulate the axon (1)
F: Transfer impulse to another neuron/effector (1)
- (c) (i) Impulse jumps down the axon/from node (of Ranvier) to (next) node (1)
(ii) Resting membrane potential is negative...- 70mV / stimulus crosses threshold (1)
(Stimulus) will result in Na⁺ "gates"/ion channels opening (1)
Na⁺ diffuses out of the neuron (1)
This creates a relatively positive charge on outside of neuron, hence depolarising it (1)
- (d) (i) The minimum stimulus needed to initiate an action potential/impulse (1)
(ii) The period during which an action potential / impulse cannot be generated(1)

39.

- (a) Double helix / twisted ladder (1)
Rungs: Paired bases / A with T and G with C (1)
Sides: Alternating sugar and phosphate units (1)

Any two = 2 marks

- (b) mRNA is single stranded (1)
Uracil replaces Thymine (1)
Ribose replaces deoxyribose sugar (1)
(Any 2 = 1 mark each)

- (c) Transcription:

Site: Nucleus (1)
Purpose: Copy DNA template onto mRNA/ complementary strand of mRNA is produced. (1)

Translation:

Site: Ribosomes / rough ER (A: cytoplasm) (1)
Purpose: To produce protein from base sequence on mRNA / to form a chain of amino acids / a polypeptide chain (1)

- (d) Genetic Engineering:

Restriction enzyme removes useful gene (1)
Restriction enzyme cuts open a plasmid in bacterial cell (1)
Ligase joins this gene to bacterial genome (1)
Bacteria begins to produce useful protein (1)

Any three = 3 marks

Stem Cell Therapy:

Multi/Pluripotent cell is obtained (1)
From embryo or adult bone marrow (1)
Cell is transformed / differentiated into useful cell (1)
Transformed cell is introduced into patient (1)

SECTION 3

40.

(a) Filtration occurs at the glomerulus (1)

Large substances (proteins and red blood cells) do not pass through (1)

Small substances (glucose, amino acids, salt, water) pass through freely (1)

Re-absorption of useful substances occurs in the proximal convoluted tubule/
loop of Henle (1) into the peri-tubular capillary network (1)

Tubular secretion occurs at the distal convoluted tubule (1)

Substances such as creatinine are added to the filtrate (1)

Also, adjustments in H^+ , K^+ and Na^+ occur (1)

The latter two under the influence of aldosterone (1)

Re-absorption of water occurs at the collecting duct (1)

Any seven points = 7 marks

(b) Water is lost from various body fluids (1)

Stimulus: Reduction in plasma volume / an increase in osmotic
concentration/pressure of extracellular fluid (1)

Receptor: Osmoreceptors in the hypothalamus detect the rising osmotic
concentration/pressure of the blood (1)

Nervous response:

Modulator: Stimulation of thirst centre in hypothalamus makes the person feel
thirsty (1)

Effector: Conscious feeling of thirst stimulates the person to drink (1)

Response: Fluid is absorbed by the alimentary canal and passed into plasma
(1)

Hormonal response:

Modulator: Posterior pituitary increases ADH levels (1)

Effector: Increases permeability of collecting ducts to water (1)

Response: Increased water reabsorption (1)

Negative feedback: Fluid returns from bloodstream to intercellular and
intracellular fluid (1) / Osmotic concentration/pressure returns to normal (1)

Any ten points = 10 marks

41.

a) Two marks / evolutionary force

Mutation (1)

Sudden change in the structure of gene introduces a new allele to the gene pool (1)

Migration (1)

As individuals join or leave a population the frequency of their alleles in the gene pool will increase or decrease (1)

Genetic Drift (1)

Allele frequencies change due to random, chance events (1)

Such as natural disasters etc (1)

It is most powerful in small isolated populations (1)

Non-directional / not influenced by selection (1)

Any 2 points = 2 marks

Natural Selection (1)

Those with most favourable variations more likely to survive (1)

More likely to have offspring (1)

Favourable alleles increase in frequency (1)

b) Select from options below. Three marks / comparative study

DNA Comparative Studies (1)

All living things use the same DNA code which supports that all living things are related to each other and have common ancestor (1)

Despite the common ancestor, the code in the DNA will be different for different species (1)

As new species gradually change/evolve they accumulate more and more differences in their DNA (1)

Species that are more distantly related have more differences in their DNA, whereas more closely related species share a greater proportion of the DNA (1)

Any 3 points = 3 marks

Mitochondrial DNA (1)

mtDNA has a higher mutation rate than nuclear DNA (1)

human mtDNA has been slowly diverging from common female ancestor and the amount of mutation is roughly proportional to the amount of time that has passed (1)

Useful in comparing individuals within a species and for species which are closely related (1)

Degree of similarity between mtDNA of two individuals indicates the closeness of their relationship (1)

Any 3 points = 3 marks

Protein sequences (1)

Protein sequences for certain genes are identical in individuals from the same species and different in those from different species (1)

As new species gradually change/evolve they accumulate more and more differences in their protein sequence (1)

The longer the time involved, the greater the number of amino acids that are different (1)

Ubiquitous proteins have been most insightful (1)

Any 3 = 3 marks

Comparative embryology (1)

Relatively easy to distinguish between adults of different species but not between embryos of different species (1)

Presence of similar structures during embryonic development indicates common ancestor (1)

More similar the structures of embryonic development the more closely related the species (1)

Any 3 points = 3 marks

Homologous Structures (1)

Organisms possessing organs that are similar in structure are likely to have a common ancestor (1 mark)

There is a basic pattern/structure with variations due to environmental differences (1)

Vestigial organs (1)

These are structures of reduced size that appear to have no function (1)

Evolutionary mechanisms explain the existence of these structures as what remains of organs that were functional in ancestral forms (1)

DNA Hybridisation (1)

Closely related species have more linking of complimentary base pairs when denatured single strands of DNA are joined (1)

Greater evolutionary distance correlates with less complimentary base pairing (1)

42.

(a) Bone: Haversian system (1)

Central canal containing blood vessels/nerves (1)

Osteocytes in lacunae (1)

Lamellae / inorganic matrix(1)

Protein/collagen matrix (1)

Cannaliculi channels between lamellae (1)

Any four = 4 marks

Muscle: Muscle fibre / cell made of myofibrils (1)

Myofibrils consist of myofilaments (1)

Thick filaments are myosin, Thin filaments are actin (1)

Thick and thin filaments arranged as a sarcomere unit (1)

Sarcoplasmic reticulum runs through muscle (1)

Cell nuclei/organelles pushed to the sides in muscle fibres (1)

(b) Immoveable: Bones held together by sutre/strong ligament (1)

Cartilagenous: Bones are separated by cartilage layer allowing restricted movement (1)

Freely Moveable/Synovial: Articular cartilage on bone surface (1)

Synovial fluid (1)

Articulating bones have complimentary shape (1)

(c) Axon terminal contains vesicles/neurotransmitters (1)

Neurotransmitter is Acetylcholine (1)

When impulse reaches terminal the axon becomes more permeable (1)

Neurotransmitters released and diffuse from axon terminals to muscle (1)

This causes depolarization of sarcoplasmic reticulum (1)

Calcium released (1)

Tropomyosin shifts exposing myosin binding sites (1)

This causes myosin to make cross bridges with actin (1)

Movement of myosin heads causes actin to slide over myosin (1)

Sarcomere/muscle shortens (1)

This pulls on bones either side of a joint (1)

Any seven = 7 marks