Quality of written communication:

2 marks: The candidate expresses ideas clearly and fluently through well-linked sentences, which present relationships and not merely list features. Points are generally relevant and well-structured. There are few errors of grammar, punctuation and spelling.

9 Sustainable farming practices promote both the conservation and fertility of soils and also biodiversity in terrestrial (land-based) habitats.

(a) Describe and explain how sustainable farming practices help promote the conservation and fertility of soils. [8]

(b) Describe and explain how sustainable farming practices help promote biodiversity in terrestrial (land-based) habitats. [8]

9 (a) Any eight from

- maintaining hedgerows protects against soil erosion
- through roots binding soil particles together
- protection against wind/rain
- ploughing/terracing across slopes reduces soil erosion/prevents run-off
- polyculture/crop rotation/intercropping reduces risk of development of mineral-deficient soils
- as different crops have different mineral requirements
- use of nitrogen-fixing plants promotes soil fertility
- increased use of organic fertiliser (or appropriate example)
- improves soil crumb structure/releases nutrients slowly
- improved aeration/drainage
- reduces denitrification/promotes nitrification/promotes nitrogen fixation
- mixed livestock reduces demands on soil
- other appropriate response [8]

(b) Any eight from

- maintaining hedgerows provides range of species/habitats/food/shelter/ act as wildlife corridors
- low stocking rates protect hedgerows/pasture
- polyculture/crop rotation encourage more complex food webs/creates more habitats
- decrease build-up of pests
- integrated pest management schemes to reduce harm due to pesticides (explanation of how pesticides cause harm which reduces biodiversity (e.g. killing non-pest insects/build-up in food chains/bioaccumulation)
- example of IPM (e.g. natural predator/non-persistent pesticides/sterile males of pest species)
- predator strips promote the numbers of natural predators of pests
- selective breeding/genetically modified varieties of crops with improved pest resistance
- reducing herbicides conserves farmland plant species
- decreased use of fertiliser
- set-aside areas create a range of habitats
- example of government initiative to promote biodiversity (e.g. Biodiversity Action Plans)
- other appropriate response [8]

Jan 2014 **9** The kidney is a homeostatic organ important in excretion and osmoregulation.

(a) Describe and explain the processes of ultrafiltration and reabsorption in excretion in the kidney. [11]

(b) Using osmoregulation in the kidney as an example, explain the term homeostasis and outline the essential components of homeostatic mechanisms. [5]

9 (a) Ultrafiltration (up to any six from)

- the blood entering the glomerulus is at high (hydrostatic) pressure
- due to the short distance from the heart/the afferent arteriole being thicker than the efferent arteriole/the coiling of the capillaries in the glomerulus
- smaller components of the blood (e.g. glucose, amino acids, salts, water, urea) are filtered out of glomerulus into the Bowman's capsule
- larger components (e.g. blood cells and plasma proteins) are retained
- ultrafiltration aided by pores in capillary walls
- the basement membrane is the effective filter
- between the podocytes in wall of Bowman's capsule
- filtration is opposed by the more negative solute potential of the plasma protein

Reabsorption (up to any six from)

- useful products (e.g. glucose, amino acids) are selectively reabsorbed in the proximal tubule
- by facilitated diffusion/active transport
- proximal tubule cells adapted by presence of microvilli to increase surface area/ abundant mitochondria to provide ATP/release energy for active transport
- urea is not reabsorbed (but some diffuses back into the blood)
- water is reabsorbed by osmosis
- allowing concentration of urea to increase down the proximal convoluted tubule
- small proteins are reabsorbed by pinocytosis
- additional water is reabsorbed from the collecting ducts (descending limb of loop of Henlé/distal convoluted tubule) [11]

(b) Homeostasis is the maintenance of constant (steady state) conditions in the body/maintains the blood water potential at a constant level;

Any four from

- osmoreceptors (sensors) in the hypothalamus allow blood water/solute potential to be monitored
- if deviation from the set point/normal water (solute) potential a corrective mechanism takes place to return water/solute potential to normal value
- if water/solute potential decreases more ADH is released (if water/solute potential increases less ADH is released)
- increased ADH will lead to more water being reabsorbed in the collecting ducts (decreased ADH will lead to less water being reabsorbed in the collecting ducts)
- homeostatic mechanisms have a negative feedback system
- as water/solute potential returns to normal/set point the effect of the corrective measure is reduced – explained in a water/solute potential context (as water/solute potential rises towards normal the level of ADH released decreases or converse) [5]

9 The mammalian eye is highly adaptable: capable of accommodating images of objects which are close-up or far-away; providing detailed colour images during daytime when the light intensity is high; and yet able to perceive images when the light intensity is low. Some species of nocturnal mammals have eyes that are highly specialised to function only in the very low light intensities during the night.

(a) Describe and explain how the typical mammalian eye provides a detailed colour image of close-up objects in high light intensities. [10]

(b) Explain how the eye is adapted to provide vision in low light intensities, and suggest how the eyes of nocturnal mammals are specialised. [6]

9 (a) Any ten from

- the cornea and the lens are both involved in the convergence of light/ combine to focus light onto the retina
- the lens is responsible for accommodation/fine control of light rays
- for a close up object the ciliary muscles contract reducing tension in the suspensory ligaments
- allowing the lens to become thicker
- causing the greater convergence/refraction/shorter focal length required
- in high light intensities the circular muscles in the iris contract (radial muscles relax) to reduce the diameter of the pupil
- reducing the amount of light entering the eye
- protecting the retina from damage
- the choroid layer prevents internal reflection (which would distort vision)
- cones contain the photosensitive pigments that function in high light intensities
- each cone synapses with individual bipolar neurones/cones show no convergence
- giving greater visual acuity/greater resolution
- there are three types of cone thereby providing colour vision
- each type has a different type of iodopsin sensitive to red, green or blue light
- colour vision depends on the degree of stimulation of each type of cone
- the presence of two eyes provides binocular vision/gives stereoscopic vision/good depth perception [10]

(b) Any six from

- rods contain the photosensitive pigment rhodopsin which is broken down/bleached in low light intensities
- several rods synapse with one bipolar neurone/rods exhibit retinal convergence
- allowing summation of (generator) potentials (transmitter substances) to produce an impulse in the bipolar neurone/allows threshold to be reached
- providing greater sensitivity
- pupil is dilated/large to allow as much light as possible to stimulate the retina (enter eye)
- pupil dilation is due to contraction of radial muscle in the iris
- large eyes/pupils
- to maximise the amount of light reaching the retina/photosensitive cells
- mainly rods present/no cones
- other appropriate response (e.g. layer at back of eye to reflect light back through retina) [6]

Jan 2013

9 **(a)** Give an account of the efficiency of light absorption by plants and the subsequent transfer of energy within food chains. [10]

(b) Discuss how farmers are able to maximise the productivity of plants and animals. [6]

9 **(a)** **Any ten from**

- <1% of solar energy used by producers
- due to reflection in atmosphere/absorption in atmosphere/missing leaves
- (of light energy reaching leaves) some is reflected/some misses chlorophyll molecules/some wrong wavelength
- loss due to biochemical inefficiency in photosynthesis (heat)
- GPP = NPP + respiration
- transfer between plant and primary consumer between 5–20% typically
- some material not consumed by (primary/secondary) consumer explained, e.g. roots, bones, hair, horn
- cellulose not digested
- some excreted (or by explanation)
- loss of energy by respiration
- greater loss by endotherms
- transfer between primary consumer and secondary consumer may be greater than between producer and primary consumer
- less energy available at each successive trophic level/reference to short food chains
- energy losses to decomposer chain [10]

(b) **Any six from**

- NPP higher if energy losses reduced due to respiration/increased GPP
- use of fertilisers to increase plant growth
- use of pesticides to reduce effect of pests reducing plant productivity
- use of herbicides to reduce competition from other plants affecting productivity
- plastic ground cover to increase temperature/reduce competition
- other methods of increasing plant productivity explained (e.g. increased lighting in glasshouses, crop rotation, legumes, use winter cereals, AI – with appropriate explanation) (Any **two**)
- high energy foods (silage)/high protein foods
- importance of efficient stocking levels/seed density
- keeping livestock in warm conditions so less energy used in generating heat/less heat loss
- confinement to reduce energy loss in movement
- profit a balance of increased productivity and increased investment [6]

June 2012

9 An immune response is the way in which the body responds to invasion by a specific antigen. Modern medicine has further developed procedures to influence the body's ability to respond to invading antigens.

(a) With reference to antibody-mediated immunity, acquired naturally and artificially, describe how humans are protected against disease. [10]

(b) Tissue to be transplanted (e.g. donor kidneys) contain antigens which may promote an unwanted immune response. Outline the process of transplant rejection and discuss the strategies used to reduce rejection. [6]

9 (a) Any ten from

- antibody-mediated immunity combats 'free' microorganisms/viruses in blood/tissue fluid (cell-mediated immunity combats microorganisms/ viruses in cells)
- involves B-lymphocytes
- specific B-lymphocyte has receptor to invading antigen/responds to (sensitised by) a particular antigen
- division of B-lymphocyte produces plasma and memory cells
- plasma cells produce antibodies
- antibodies are globular proteins (that can form specific shapes)
- reference to complementary shape between antibody and antigen *[must be complementary not similar or implied]*
- causes agglutination/clumping (or other role of antibody-antigen interaction explained)
- antibody-mediated responses subject to delay following infection
- memory cells remain in blood to provide long-term immunity
- memory cells allow rapid/greater (secondary) response
- illness can be avoided by vaccinations with attenuated/weakened pathogen
- passive immunity involves donation of an antibody from another source
- provides rapid immunity/short term immunity
- particularly effective in babies from antibodies contained in mother's milk/in adults when very ill (affected by 'new' antigens that immune system not programmed for) [10]

(b) Any six from

- tissue rejection is a T-lymphocyte response/cell-mediated response
- antigens stimulate the production of a variety of T-cells
- killer T-cells destroy 'foreign' tissue
- through production of perforins/nitric acid/enzymes
- will not occur if transplanted tissue is from an identical twin as antigens are the same
- concept of the importance of tissue-typing (matching) before transplanting
- immune responses can be inactivated by irradiation (X-rays)/ immunosuppressant drugs
- fewer T-cells to respond/reduced ability to respond/inhibit DNA replication
- but patient more susceptible to infection due to suppressed immune system [6]

Jan 2012

Quality of written communication is awarded a maximum of 2 marks in this section.

9 **(a)** Describe and explain the link between human activity and water pollution. [10]

(b) Discuss the strategies used to minimise the effects of human activity on water pollution. [6]

9 **(a)** **Any ten from**

- (increased) combustion of fuels releases SO_2/NO_2
- reaction with water (in clouds) forms acid rain
- releases aluminium (from bedrock)
- which causes mucus to coagulate on fish gills (resulting in asphyxiation)
- in acidified waters, trout eggs fail to hatch (below pH of 4.5)
- (excess levels of) artificial fertiliser may enter waterway causing eutrophication/rich in nitrate or phosphate/detergent with phosphate
- enter waterways due to leaching/being applied in rain/on sloping ground/too close to waterways
- algal blooms develop
- leakage of slurry/(untreated) sewage/silage effluent into waterway/milk
- (organic matter) fed on by (saprophytic) bacteria (decomposers) which uses up oxygen/increases BOD
- and consequent reduction in biodiversity/loss of fisheries
- high oestrogen levels in domestic sewage affects aquatic fauna
- possible toxic residues of veterinary medicine/industrial spillage/oil spills
- health risk from contamination of drinking water (by toxic algae)
- pesticides leaching into water
- warm water from industrial (cooling) systems has reduced oxygen levels
- other appropriate response/zebra mussels transported by boats [10]

(b) **Any six from**

- reduce dependence on fossil fuels/energy efficiency/alternative fuels/ encourage industries to add filters to chimneys (reduce acid rain)/ catalytic converters
- add lime to acidified lakes
- monitor water bodies (indicator species)
- apply fertiliser/slurry to match soil/crop requirements (soil tested for nutrient levels)
- only apply fertiliser/slurry immediately prior to growth/appreciate the need for closed periods
- avoid applying fertiliser/slurry when rain expected/or close to waterways/ploughing across slope to reduce run off
- European Nitrates Directive is legislation restricting the use of fertilisers in agriculture/education (DARD NI Code of Good Agricultural Practice for the Prevention of Pollution in water)/grants
- appropriate storage facilities for slurry/silage effluent
- use of more organic fertiliser noting benefits (e.g. slower release of nutrients)
- ensure efficient treatment of sewage/remove phosphate before allowing sewage effluent into waterway/use phosphate-free detergents
- construct reed beds to treat (lightly contaminated) farm waste/straw to reduce algal bloom
- method of reducing pesticide use described (e.g. polyculture, use of predator strips)
- responsibility of industries/Government legislation to ensure pollutants do not enter waterways (e.g. cooling of warm water from power stations)
- other appropriate response [6]

Quality of written communication is awarded a maximum of 2 marks in this section. [2]

9 Give an account of

(a) the kidney and excretion [11]

(b) osmoregulation and the kidney [5]

9 **(a)** **Any eleven from**

- blood entering glomerulus is under high hydrostatic pressure
- because the afferent arteriole is wider than the efferent arteriole
- consequently ultrafiltration occurs from the glomerulus to Bowman's capsule
- composition of the filtrate is the same as plasma minus plasma proteins
- because some molecules are too big to pass through the basement membrane/the basement membrane acts as the filter
- the lining of the capsule is otherwise leaky due to the structure of podocytes
- water potential/solute potential of plasma is lower than that of the filtrate due to the presence of the plasma proteins
- which causes a solute potential (osmotic) gradient from filtrate to blood
- the hydrostatic pressure in blood must be high enough to overcome this osmotic gradient
- throughout the rest of the nephron/tubule toxic substances remain in the filtrate, while useful substances are reabsorbed
- within the proximal tubule glucose/salts/amino acids are reabsorbed by active transport (selectively reabsorbed)
- microvilli/brush border in the proximal tubule increase the surface area for this reabsorption
- and numerous mitochondria provide the energy for active transport
- water potential gradient is from proximal convoluted tubule to capillary network/hydrostatic pressure within capillary network is greatly reduced
- so that water leaves by osmosis
- small proteins are reabsorbed by pinocytosis
- the loop of Henlé produces a high osmotic gradient in the medulla (lowers the water potential in the medullary tissue)
- which allows water to be reabsorbed from the collecting ducts as they pass through the medulla
- salts actively reabsorbed from distal convoluted tubule/urea or creatinine absorbed into the distal convoluted tubule [11]

(b) **Any five from**

- water potential/concentration of blood is monitored by osmoreceptors in the hypothalamus
- low water potential/concentrated blood causes secretion of ADH
- ADH is then released into the blood from the pituitary gland
- in the kidney ADH increases the permeability of the collecting ducts (and distal tubule)/opening aquaporins
- so that increased amounts of water can be reabsorbed
- results in a concentrated urine
- drinking water raises the water potential of the plasma [if the blood is dilute the loss of water in the urine lowers the water potential of the plasma]
- when the water potential of plasma returns to normal/is high the levels of ADH secretion is reduced [5]

Allow reverse argument for osmoregulation, beginning with high water potential in blood and resulting in a large volume of dilute urine.

9 *Quality of written communication is awarded a maximum of 2 marks in this section.* [2]

Give an account of the various immune responses following the entry of bacteria and viruses into the blood at the site of a wound. [16]

9 Any sixteen from:

- blood flowing out of a wound limits the entry of microbes/local dilation of arterioles brings extra blood/plasma to the site
- which brings polymorphs and monocytes to the site
- these phagocytes engulf and ingest bacteria
- involves lysosomes/hydrolytic enzymes
- clotting will prevent further entry
- specific responses are antibody-mediated (humoral) immunity responding to free pathogens
- and cell-mediated immunity responding to infected cells
- all foreign cells have antigens on their surfaces
- that are recognised as "non-self" by the body
- lymphocytes have receptor sites/recognise specific antigens
- some of the invading bacteria will be recognised by memory cells
- which are capable of developing into plasma cells on re-exposure to a previously encountered antigen
- resulting in a rapid response to the infection (a secondary response)
- B-lymphocytes divide by mitosis
- producing plasma cells which secrete antibodies
- which then react with the complementary antigen
- causing agglutination (clumping) of the invading cells (making it easier for phagocytes to engulf them)/marking the invading cells for destruction by polymorphs (phagocytes)/other appropriate description of antibody action
- specific memory cells are also produced/"new" pathogens will stimulate a slower response
- body cells subsequently infected by viruses present a surface antigen (that is recognised as "non-self")
- these antigen presenting cells are recognised by T-lymphocytes
- which divide (by mitosis) to form three different types of cells
- killer T-cells destroy the infected cells
- by attaching to the antigens/using enzymes/porferins to destroy the cell membranes
- helper T-cells stimulate B-lymphocytes and intensify the response
- eventually the response will be reduced by T-suppressor cells [16]

Quality of written communication is awarded a maximum of 2 marks in this question. [2]

9 Give an account of the generation of an action potential, impulse transmission along an axon and subsequent transmission to a post-synaptic neurone. [16]

Sixteen points, minimum of six points from each part.

Generation of an action potential and transmission of the nerve impulse:

- at rest the membrane of an neurone is polarised/has a resting potential
- has a potential difference of about -70mV / is negative on the inside
- stimulation must be strong enough to reach a threshold potential
- this causes an action potential in which the inside becomes positive / potential difference is reversed / membrane is depolarised / influx of Na^+ ions
- which results in sequential depolarisation of the neighbouring part of the axon membrane / local circuits
- the action potential is 'all or nothing' in its generation / below the threshold the action potential (impulse) does not fire / above the threshold there is no increase in magnitude of action potential
- after which the membrane becomes repolarised / recovers its resting potential
- causing a refractory period during which no further stimulation of the axon is possible / which ensures a one-way movement of the action potential
- this propagation of action potentials along a neurone is the transmission of the impulse
- speed of transmission is faster in axons with a wider diameter
- speed is also faster along myelinated neurones (with nodes of Ranvier)
- as there is saltatory conduction / the action potential "jumps" from node to node

Transmission across a synapse:

- when an action potential reaches the synaptic knob it causes an influx of Ca^{2+} ions
- this causes synaptic vesicles to move towards the pre-synaptic membrane
- and fuse with it, resulting in exocytosis of the transmitter substance
- which is generally acetylcholine (ACh) in peripheral nerves
- the acetylcholine diffuses across the cleft / travels across the 20nm wide cleft
- and attaches to receptors on the post-synaptic membrane
- this causes an influx of Na^+ ions / depolarises the post-synaptic membrane
- causing an excitory post-synaptic potential (EPSP)
- an action potential is evoked if the EPSP reaches threshold level / if enough receptors are stimulated / if enough transmitter is received
- summation (spatial/temporal) of neurotransmitter from several synaptic knobs may be needed to promote an action potential
- the acetylcholine is broken down by acetylcholinesterase (AChE)
- which prevents continued stimulation of the post-synaptic membrane
- the choline and acetyl components diffuse back towards the pre-synaptic membrane where they are reabsorbed and used in the synthesis of acetylcholine

For each point award equivalent descriptions. [16]

January 2010

9 *Quality of written communication is awarded a maximum of two marks in this section.* [2]

Give an account of the functioning of the mammalian eye to include the role of the following:

- the iris
- the lens
- rods
- cones [16]

A minimum of three from each section

The iris:
- light hitting the retina causes a response in the iris / the iris controls the amount of light entering the eye
- in bright light circular muscles in the iris contract (and radial muscles relax) to reduce the diameter of the pupil / amount of light entering the eye
- this protects the retina from damage
- in dim light the radial muscles contract (and circular muscles relax) to dilate the pupil / increase the amount of light entering the eye
- to ensure sufficient light can reach the retina to stimulate photoreceptors

The lens:
- the lens is for fine adjustment of the convergence of light onto the retina (at the front the transparent cornea is responsible for much of the refraction/convergence of light) / the lens is responsible for accommodation of light onto the retina
- for a distant object tension in the eyeball (ciliary body relaxed) causes the suspensory ligaments to become taut and thus pull the lens into a thinner shape
- which means it is less converging / less refracting / has longer focal length
- for a near object the ciliary muscles contract which reduces the tension on the suspensory ligaments
- without tension the elastic lens becomes fatter
- thus causing greater convergence / greater refraction / a shorter focal length

The rods:
- rods contain the photosensitive pigment rhodopsin which is readily broken down (bleached) in low light intensity
- if threshold level is reached an action potential is initiated in the receptor neurone
- in bright light (normal daylight) rods remain bleached (rhodopsin broken down)
- the opsin and retinine only recombine when darker conditions prevail - the time taken for this is known as dark adaptation
- several rods synapse with one bipolar neurone / rods exhibit retinal convergence (and so sensitivity)
- the resultant convergence allows summation of generator potentials / transmitter substance so that in dimmer light a threshold level is reached
- convergence results in a lack of visual acuity / poor resolution

The cones:
- cones contain the pigment iodopsin which is only broken down in high light intensity
- each cone synapses individually with bipolar neurones
- which gives cones greater visual acuity / greater resolution
- there are three types of cone
- each type of cone has a different type of iodopsin sensitive to red, green or blue light
- the variety of colours we perceive depends on the relative amount of stimulation of each of these three types [16]

9 Give an account of the carbon and nitrogen cycles, and of how human activity involving carbon- and nitrogen-compounds can have adverse effects on the environment. [13]

9 Thirteen points, with at least six in each section.

The cycles:

Carbon cycle:
- much carbon is "locked" in organic molecules especially cellulose
- respiration releases carbon dioxide
- particularly of decomposers
- photosynthesis removes carbon dioxide from the atmosphere

Nitrogen cycle:
- decomposers release ammonium
- converted by nitrifying bacteria to nitrate
- taken up by plants
- used to manufacture proteins/nitrogenous organic compounds
- denitrifying bacteria in anaerobic conditions remove nitrate converting it to ammonia/nitrogen gas
- nitrogen fixing bacteria convert nitrogen from the atmosphere into organic form

Adverse effects on the environment:

Greenhouse effect (global warming):
- results from increased levels of carbon dioxide in the atmosphere
- due to the combustion of fossil fuels
- and deforestation since less carbon dioxide is absorbed by this hugely productive ecosystem
- longer wavelength infra-red is absorbed by greenhouse gases and re-radiated back towards the Earth's surface
- global warming results in extremes in weather patterns
- global warming should result in the melting of the polar ice caps with a consequent rise in sea levels and coastal flooding

Acid rain:
- combustion of fossil fuels will release NO_2 into the atmosphere
- where it reacts with water in clouds to form nitrous acid which may be precipitated as acid rain some hundreds of miles from the source of production
- acid rain results in the defoliation and death of trees
- mainly due to the acidity resulting in an imbalance of soil nutrients (some minerals such as calcium and magnesium become more soluble and are leached out of the soil)
- the acidification of soils causes a release of aluminum ions
- aluminium is directly toxic to plant roots/aluminium causes mucus to coagulate on fish gills and consequent asphyxiation

Eutrophication:

- eutrophication refers to the condition of waterways such as lakes becoming nutrient-rich
- resulting from the leaching of nitrogenous fertilisers from agricultural land
- high levels of nutrients will result in massive growth of algae (and blue-green algae) forming algal blooms which die
- decomposition of the dead algae by bacteria causes anoxia in lakes
- resulting in fish kills and death of other aquatic organisms
- further, high nitrate (and nitrite) levels in drinking water have been linked with possible health risks [13]

9 Give an account of chemical communication in organisms with particular reference to anti-diuretic hormone in mammals and auxin in plants. [13]

9 Thirteen points, with at least five on each of ADH and auxin.

General aspects of chemical communication:
- chemicals released in one part of the organism
- having an effect in another part of the organism
- chemical communication tends to be associated with longer term effects

ADH in mammals:
- changes in the concentration of the blood is detected by osmoreceptors (in the hypothalamus)/osmoregulation is controlled via the hypothalamus
- if the blood becomes more concentrated (e.g. as a result of sweating during exercise or hot weather) then anti-diuretic hormone/ADH is secreted
- ADH is produced by the hypothalamus
- secreted into the pituitary body (posterior lobe) from where it is subsequently released
- ADH causes the collecting ducts to be more permeable to water
- so that more water is reabsorbed from the collecting ducts
- leaving the urine especially concentrated
- if the blood becomes more dilute, less ADH is secreted, less water is reabsorbed and so a copious amount of dilute urine is produced

Auxins in plants:
- auxin is produced in the shoot tip
- and moves down the shoot (to the zone of elongation)
- auxin stimulates cell elongation
- cell elongation is dependent on the elasticity of the cell wall/osmotic uptake of water
- auxin causes protons (H^+ ions) to move into the cell wall
- causing cellulose fibres to slide more readily
- unidirectional light causes movement of auxin to the shaded side
- greater concentration of auxin on the shaded side stimulates differential cell elongation
- greater elongation on the shaded side causes curvature of the shoot towards the light/phototropism [13]

8 Give an account of homeostasis in mammals with particular reference to temperature regulation and osmoregulation.

[13]

8 Thirteen points, with at least five points in each of temperature regulation and osmoregulation

General aspect of homeostasis:
- homeostasis is the maintenance of steady states/stable conditions
- involving negative feedback
- a change in the level of a factor under control is the signal for a corrective change (feedback)
- a rise in the level of a factor leads to fall in that factor (negative)/converse

Temperature regulation:
- the hypothalamus contains the thermoregulatory centre
- monitoring and controlling the temperature of the blood
- if the temperature of the blood is lower that "normal" then there is a decrease in the rate of heat loss by reducing blood flow through surface capillaries/ vasoconstriction
- and stimulation of the hair to stand erect trapping a layer of still air
- while heat is gained by increasing the rate at which heat is released by metabolism/involuntary muscle contractions/shivering
- heat is also conserved by voluntary means, e.g. burrowing, huddling, extra clothes
- if the temperature of the blood is higher than "normal", then heat loss from the skin is increased by vasodilation so that more heat radiates from the surface of the skin
- while sweating draws heat from the body
- cooling may also be induced by moving into shade (voluntary response)

Osmoregulation:
- the hypothalamus contains osmoreceptors
- monitoring the water potential of the blood
- if the blood becomes more concentrated (e.g. as a result of sweating during exercise or hot weather) then anti-diuretic hormone/ADH is secreted
- ADH is produced by the hypothalamus
- but secreted into the pituitary body (posterior lobe) from where it is subsequently released
- ADH causes the collecting ducts to be more permeable to water
- so that more water is reabsorbed from the collecting ducts
- leaving the urine especially concentrated/increases the ψs of the blood
- if the blood becomes more dilute, less ADH is secreted, less water is reabsorbed and so a copious amount of dilute urine is produced [13]

4 Write an account of the release, capture and transfer of energy in biological systems.

Your account should show understanding of, at least, three topics which you have studied. [13]

4 Thirteen points (covering at least three sections)

Energy release in respiration:
- glucose is broken down in glycolysis/converted to pyruvate with a yield of ATP (two per glucose)
- further breakdown in Krebs cycle releasing hydrogen/ATP
- transfer of hydrogen/electrons along carriers/the respiratory chain/ETC
- coupled to oxidative phosphorylation/ATP synthesis
- lipids/fatty acids/protein/amino acids as respiratory substrates
- lipids (fats) as much richer in energy than either protein or carbohydrate

Energy capture in photosynthesis (light harvesting aspects):
- light energy is trapped by photosystems/chlorophyll
- consist of a mixture of pigments (two from chlorophyll a/chlorophyll b/ xanthophyll/carotene)
- absorbing light at slightly different wavelengths/maximising the range of wavelengths utilised in photosynthesis
- though generally mostly red and blue wavelengths are absorbed/green light generally not absorbed
- when a chlorophyll molecule absorbs light the energy level of an electron is raised/energy absorbed by chlorophyll molecules (within the photosystem) is funnelled to the reaction centre
- when the reaction centre (chlorophyll a) becomes excited an electron is emitted/picked up by an electron acceptor

Energy conversion in photosynthesis (light-dependent reactions):
- energised electron (received from Photosystem II) is passed through the cytochrome carrier chain/ETC
- with the synthesis of ATP
- electrons are passed to PS I which is further energised/reference to two photosystems
- from where the energised electron is used to reduce $NADPH^{+}$
- to produce NADPH

Energy conversion in photosynthesis (light-independent reactions):
- ATP acts as an energy source in the Calvin cycle
- while NADPH acts as reducing power
- both are involved in the conversion of glycerate phosphate (GP) to triose phosphate (glyceraldehyde phosphate/GALP)
- triose phosphate may be converted into other carbohydrates/represents production during photosynthesis
- most triose phosphate is used to recycle ribulose phosphate/ribulose bisphosphate
- ATP is needed for the conversion of ribulose phosphate to ribulose bisphosphate

Energy capture by producers (ecological aspects):

- of the total radiation arriving to earth, most is absorbed (e.g. by clouds) or reflected
- of the radiation incident on a leaf, only some (about 50%) is of a wavelength suitable for use in photosynthesis
- of this photosynthetically active radiation (PAR), some is reflected or transmitted (not absorbed by chloroplasts)
- of the light absorbed by chlorophyll, only some (about 20%) is converted to chemical energy in the products of photosynthesis
- the rest is dissipated as heat in photosynthetic reactions
- within the producer some energy is used in respiration/reference to net production (gross production less respiration)

Energy transfer through trophic levels:

- energy is transferred through food chains
- of the food eaten by primary producers much of the material is not digested and appears as faeces
- of the food that is absorbed most is used in respiration/energy is lost as heat
- less than 10% is used in new growth
- transfer through consumers tends to be more efficient since animal matter is more nutritious/digestible
- the inefficiency of energy transfer means that food chains have rarely more than four links

Heat energy release/transfer:

- in endotherms (homoiotherms/mammals/birds) extra heat is released to generate a high body temperature/heat loss from a warm body
- the constancy of which is maintained by physiological means
- the result is that endotherms have a high metabolic rate/have a high fuel consumption
- ectotherms (poikilotherms) gain heat from their immediate environment (e.g. sun)
- and attempt to control heat gain/loss by behavioural means
- a relatively high temperature is important in maximising enzyme-controlled (metabolic) reactions/a high temperature is avoided to ensure that enzymes are not denatured (bonds broken)

ATP usage:

- energy is released when ATP is hydrolysed
- energy needed for protein synthesis/bonding of amino acids
- muscle contraction/release of myosin bridge from actin filaments
- functioning of membrane (protein) pumps
- initial steps of glycolysis
- other appropriate usage

Other appropriate energy conversion [13]