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 Give an account of the sequence of events which occurs as an impulse is propagated along an axon and is subsequently transmitted across a synapse. [13]

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

Propagation along an axon:

- at rest an axon membrane has a resting potential/polarised membrane
- whereby it is negative on the inside
- when stimulated the potential difference is reversed/it becomes positive on the inside/it becomes depolarised
- an action potential is evoked
- this causes a depolarisation of the neighbouring part of the axon membrane/ local circuits
- the original part of the axon recovers its resting potential/repolarised
- during this period of recovery that part of the axon cannot be stimulated/there is a refractory period
- reference to absolute and relative refractory period
- a transfer of action potentials represents an impulse/an impulse is a self-perpetuating action potential
- impulses are either "fired" or not "fired"/an "all-or-nothing" law applies/ threshold level required for stimulation
- impulses are speeded up if the axon has a large diameter (greater surface area for ion exchange)
- impulses are also speeded up if the axon is myelinated
- due to the association of Schwann cells
- since transmission "jumps" from node to node (of Ranvier)/transmission is saltatory

Transmission across a synapse:

- synaptic knob contains vesicles
- when an action potential reaches a synaptic knob Ca^{2+} ions enter
- vesicles are caused to move towards and fuse with the pre-synaptic membrane/resulting in exocytosis of a synaptic transmitter chemical
- which in most peripheral nerves is acetylcholine (Ach)
- the transmitter diffuses across the synaptic cleft
- the synaptic cleft is only about 20 nm in width
- at the post-synaptic membrane the transmitter attaches to receptors
- causing depolarisation of the post-synaptic membrane
- at excitatory post-synaptic potential occurs
- summation of synaptic knobs (spatial/temporal) may be needed to promote an EPSP
- if this is sufficient in magnitude an action potential is evoked
- continued stimulation of the post-synaptic membrane is prevented
- by the enzyme (e.g. cholinesterase) which causes breakdown of the transmitter substance/transmitter substance reabsorbed into the synaptic knob
- reabsorbed breakdown products (e.g. choline and ethanoic acid) synthesise transmitter substance using ATP [13]

9 Give an account of the role of photoreceptor pigments in the mammalian eye and in the control of flowering in plants. [13]

9 Thirteen points with at least six in each section.

Photoreceptor pigments in the mammalian eye:

- rods contain the photosensitive pigment rhodopsin
- when it absorbs light it breaks down into its constituent parts (opsin and retinine – to the trans-form)
- this results in a generator potential in the rod/(if this reaches a sufficient level) an impulse is fired in the sensory neurone (of the optic nerve) leading to the brain
- rhodopsin absorbs light of all colours/is responsible for black-and-white vision
- and is sensitive to light of low intensity/iodopsin requires a greater amount of light to break down
- cones contain the pigment iodopsin
- there are three different types of cone
- each with its unique form of iodopsin
- each type of iodopsin is mainly sensitive to one of the three primary colours of light/red, green or blue
- stimulation of the different cones, to different degrees (and so producing a different array of impulses to the brain) produces the variety of colours possible

Photoreceptor pigments in the control of flowering in plants:

- the pigment involved is phytochrome which is found in leaves
- two forms of inter-changeable phytochromes (P_{660} or P_R and P_{730} or P_{FR}) occur
- P_{660} is converted to P_{730} during the day/red light
- while P_{730} converts slowly to P_{660} during the night/far-red light
- a critical amount of P_{730} controls flowering/influences the production of "florigen"
- the accumulated level of P_{730} is determined by the period of darkness
- in long-day plants P_{730} promotes flowering/in short-day plants P_{730} inhibits flowering
- a long night allows conversion of P_{730} to P_{660}/long night triggers flowering in SDP
- a short night prevents complete conversion of P_{730} to P_{660} and so triggers flowering in LDP
- breaking the period of darkness with a period of light will reverse the above effects [13]

9 Give an account of antibody-mediated immunity and cell-mediated immunity including an explanation of their roles in the immune system. [13]

9 **Thirteen points (with at least six from each section).**

Antibody-mediated immunity:

- antibody-mediated immunity involves the B-lymphocytes
- B-lymphocytes recognise specific antigens (proteins, polysaccharides and glycoproteins) on the surface of pathogens/different B-lymphocytes carry different antigen receptors
- and divide to form a clone (in which the cells differentiate to form two types of cells)
- during which time there is no immediate antibody response/the delay allows the pathogen to cause illness
- plasma cells (derived from B-lymphocytes) synthesise and secrete antibodies
- the antibody reacts specifically with the antigen
- antibodies may also be obtained in young mammals via the placenta/colostrum
- marking (e.g. by opsonins) the pathogen carrying the antigen for destruction by macrophages and polymorphs/attaching to the antigens of neighbouring pathogens resulting in the agglutination or clumping of the pathogen (e.g. agglutinins)/other antibody-antigen reaction
- memory cells are also produced from the initial clone
- these do not produce antibodies but persist over a long period of time
- on subsequent infection from the same pathogen the memory cells rapidly clone
- producing plasma cells which synthesise and secrete antibodies rapidly
- such is the rapidity of the response that the host does not suffer from the symptoms of the infection

Cell-mediated immunity:

- cell-mediated immunity involves the T-lymphocytes
- T-lymphocytes have specific receptors on their cell surface membranes which attach to antigens on the surface of the non-self cell
- these T-lymphocytes become sensitised and divide to form a clone (in which cells differentiate to form a variety of cells)
- helper T-cells stimulate the production of plasma cells and so the secretion of certain types of antibodies
- helper T-cells also aid killer T-cells in the destruction of the non-self cells
- helper T-cells also stimulate the ability of macrophages to destroy the non-self cells (e.g. bacteria)
- killer T-cells (cytotoxic T-cells) destroy targeted (non-self) cells
- via the production of perforins which cause the targeted cells to lyse/via the production of nitric oxide (directly toxic)
- suppressor T-cells block B- and T-responses and so dampen the immune response (e.g. inhibit prolonged production of antibodies)
- memory T-cells persist to respond rapidly to further challenges by the same antigen
- the T-cell response is used against host cells which have been infected, e.g. viral infected cells which carry viral proteins on the cell-surface membrane
- or against tumorous (cancerous) cells
- or will react against transplanted tissue (in which the MHC proteins are non-self) [13]

Old June 2006 **(NO LONGER ON THE SPECIFICATION)**

9 Give an account of temperature regulation in endotherms (homoiotherms) and ectotherms (poikilotherms). [13]

9 Thirteen points (with at least five from each main section)

The advantage of thermoregulation – general points:

- organisms can remain active only if they maintain a high enough temperature to enable chemical reactions to occur at a reasonable rate
- though too high a temperature may denature the organism's enzymes

Temperature regulation in endotherms (homoiotherms):

- endotherms (homoiotherms) generate body heat metabolically/maintain this body temperature at a relatively high level
- since body temperature is generally higher than ambient temperature endotherms have an insulatory layer of subcutaneous fat (particularly high in polar mammals and birds)
- temperature in endotherms is regulated physiologically (as well as by behavioural means)
- the hypothalamus contains the thermoregulatory centre
- monitoring and controlling the temperature of the blood
- if too cold, heat is conserved by reducing blood flow through surface capillaries/vasoconstriction
- and stimulation of the hair (feathers) to stand erect
- erect hair traps a layer of still air which reduces heat loss (by convection)
- while heat is gained by the increasing rate at which heat is released by metabolism
- and by involuntary muscle contractions/shivering
- if too warm, heat loss from the skin is increased by vasodilation (of surface capillaries)
- so that more heat radiates from the surface of the skin
- while sweating/panting (in dogs) is stimulated
- the evaporation of sweat draws heat from the body
- increased surface area of extremities (e.g. large ears) of some mammals in hot climates/decreased surface area of extremities of animals in cold climates
- example of voluntary control (e.g. moving into shade)

Temperature regulation in ectotherms (poikilotherms):

- ectotherms (poikilotherms) depend on the environment for their body heat and their body temperature follows that of the surroundings
- many are able to regulate their body temperatures by controlling heat exchange with their environment
- they may have some degree of thermoregulatory control by behavioural means
- heat may be gained (in, for example, reptiles) by basking in the sun
- with maximal surface exposed to sun (i.e. the body lying at right angles to the sun's radiation)
- or conserved (as in honeybees) by clumping (honeybees also vibrate their wings to generate heat from their flight muscles)/heat may also be conserved by moving underground (where the temperature is not as variable)
- some have a dark colouration so that there is greater absorption of radiation
- heat may be lost by moving into the shade (e.g. lizard crawling under a rock)
- or by bathing (e.g. crocodiles moving into water)
- thermal gaping (heat lost as water evaporates from the mouth cavity)
- avoidance of excessive heat gain from a hot surface by body raising [13]

Old June 2006

4 Write an account of "the role of pigments in living organisms".

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

4 Three points from any three of the following plus any other four points

Photosynthetic pigments:
- photosynthetic pigments are found on the lamellae/thylakoids/grana (of chloroplasts)
- there are a variety of pigments including chlorophyll a and chlorophyll b
- and other accessory pigments including carotenoids/carotene and xanthophyll
- these are clustered into photosystems/antennae complexes
- these pigments absorb wavelengths mostly in the blue and red region/do not absorb green
- when photosynthetic pigments absorb light the energy level of electrons is raised
- their absorption spectra do differ however
- so the advantage of having different pigments is that a greater range of wavelengths is absorbed/utilised
- the energy is funneled from the pigments to a reaction centre within the complex
- from which excited electrons are passed to electron acceptors (plastoquinone and ferredoxin)/the electron transport chain

Photoreceptors and sight:
- the light-sensitive pigment rhodopsin ("visual purple") is found in rods
- absorption of light causes the breakdown of rhodopsin into opsin and retinal (retinene)
- this bleaching of rhodopsin results in a generator potential (which if sufficiently large results in an impulse in the sensory neurone leading to the brain)
- the light sensitive pigment in cones is iodopsin
- a greater amount of light is required to break down iodopsin/iodopsin can only operate in conditions of high light intensity
- there are three types of iodopsin each in a different type of cone cell
- each is sensitive to one of the primary colours/red, green or blue
- different colours are perceived according to the degree to which each of the three types of cone are stimulated
- this represents the trichromatic theory of colour vision

Phytochrome and flowering:
- the plant pigment phytochrome is found in leaves
- there are two forms, P_{660} (P_R) and P_{730} (P_{FR})
- P_{660} (P_R) maximally absorbs red light of mean wavelength 660 nm (converting to P_{FR})
- P_{730} (P_{FR}) maximally absorbs far-red light of mean wavelength 730 nm (converting to P_R)
- during daylight P_{660} (P_R) is converted to P_{730} (P_{FR}) (since there is more red than far-red light in sunlight)
- slow conversion of P_{730} (P_{FR}) to P_{660} (P_R) also occurs in darkness
- P_{730} (P_{FR}) is the active form of phytochrome in flowering
- in short-day plants P_{730} (P_{FR}) inhibits flowering/the removal of P_{730} (P_{FR}) (in a critically long dark period) allows flowering to occur
- in long-day plants P_{730} (P_{FR}) promotes flowering

Haemoglobin and myoglobin, and oxygen carriage:

- haemoglobin is a red oxygen-carrying pigment found in red blood cells
- four oxygen molecules are carried on a haemoglobin molecule
- each on an iron-containing haem group
- haemoglobin becomes saturated with oxygen in conditions of high oxygen partial pressure (in the lungs)
- and releases it when the oxygen partial pressure is low (in the tissues)
- oxygen will also be released if the carbon dioxide levels increase/pH is reduced/temperature increases

- myoglobin is an oxygen-carrying pigment found in red muscle
- it has a high affinity for oxygen/picking it up readily
- essentially it acts as an oxygen store
- releasing oxygen only when the partial pressure of oxygen is very low

Cytochromes and electron transport:

- cytochromes are red iron-containing proteins
- found on the cristae of mitochondria
- and on the lamellae of chloroplasts
- electrons are transferred along a chain of different cytochromes
- resulting in the synthesis of ATP
- via oxidative phosphorylation/photosynthetic phosphorylation

Pigments and insect attraction in plants:

- flowers often have bright colour to attract insects, etc.
- aid to pollination

Pigments for camouflage or warning colourants in animals:

- some animals use pigments for camouflage against potential predators
- some animals have bright colours to act as a warning to potential predators
- since they are poisonous (or possess a sting)
- some animals mimic these
- some animals expose bright regions of the body to startle any potential predator

Melanin:

- melanin is a black pigment found in the skin (and choroid)
- it absorbs UV light
- protecting the skin from excessive exposure to the sun (preventing light reflection onto the retina)
- in insects (and other animals) dark pigments absorb solar radiation/light colours reflect radiation
- helping the body to warm up (and increase metabolic activity)

Bile pigments:

- bile contains the pigments biliverdin/bilirubin
- they are products of haemoglobin breakdown/red blood cell destruction
- and are excreted from the intestine

Other appropriate pigment/other appropriate function: [13]

9 Give an account of the structure and function of skeletal muscle. [13]

9 Thirteen points (with at least six from each section)

Structure:

- skeletal or voluntary muscle consists of striated muscle
- striated muscle consists of hundreds of muscle fibres (each of which may be several centimetres long)
- the surface membrane of each muscle fibre is known as the sarcolemma
- enclosing the sarcoplasm (cytoplasm) containing many nuclei/many mitochondria
- within which are many parallel myofibrils with characteristic striations
- and a membrane-bound network, the transverse tubules (T-system) and sarcoplasmic reticulum
- each myofibril consists of overlapping thick and thin filaments
- the thick filaments consist of the protein myosin, while the thin filaments consist of the protein actin
- the thicker myosin filaments cause the darker striations/A-band
- within which is a slightly lighter H-zone (where there is no overlap with actin)
- the myosin filaments consist of fibrous proteins from which globular heads project
- where there are thin filaments only the bands are light/I-band
- within each I-band there is a Z line
- the distance between adjacent Z lines is known as a sarcomere

Function:

- striated muscle fibres are stimulated via motor (effector) neurones/neurogenic
- and across synapses/neuromuscular junctions (motor end plates)
- the sarcolemma is depolarised and an action potential occurs in the muscle fibre
- the action potential is propagated along the length of the sarcolemma as an impulse
- the impulse fires through the muscle fibre via the T-tubules and the sarcoplasmic reticulum
- calcium ions are released (from the sarcoplasmic reticulum) into the sarcoplasm
- the myosin heads (of the thick filaments) attach to the actin (of the thin filaments)
- forming actomyosin cross-bridges
- they rotate ("rock") back pulling the thin filaments over the thick filaments
- the heads then detach with ATP being used in the process
- the cycle of attachment, rotation and detachment is repeated/ratchet mechanism
- the thin filaments are pulled over the thick filaments so that the myofibrils shorten [13]

9 Give an account of causes, effects and possible remedies of each of the following examples of pollution.

- global warming
- acid rain
- eutrophication [13]

9 Thirteen points (with at least one cause, effect and remedy mark from each section)

Global warming:

- results from increased levels of carbon dioxide in the atmosphere
- due to the combustion of fossil fuels
- and deforestation since stored carbon is released
- other greenhouse gases include methane, nitrous oxide, CFCs and ozone
- reason for the increase of other greenhouse gas (methane from action of anaerobic bacteria/decomposition, nitrous oxide from artificial nitrate fertilisers/burning of fossil fuels, CFCs as an aerosol propellant/coolant in refrigeration units, ozone [tropospheric] from the effect of sunlight on pollutant gases from vehicle exhausts)
- 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/climatic change
- loss of diversity/habitat destruction/more photosynthesis
- global warming should result in the melting of the polar ice caps with a consequent rise in sea levels and coastal flooding
- remedies include the use of alternative power sources (such as nuclear or wind power) to reduce the reliance on fossil fuels
- and reforestation since ultimately there should be greater photosynthetic usage of carbon dioxide
- appropriate remedy for other greenhouse gas

Acid rain:

- combustion of fossil fuels will release SO_2/NO_x into the atmosphere
- where it reacts with water in clouds to form sulphurous acid/nitrous acid
- this may precipitate 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 aluminium ions
- aluminium is directly toxic to plant roots/aluminium causes mucus to coagulate on fish gills and consequent asphyxiation
- acidified lakes can be treated by adding tonnes of powdered lime to the water (raises pH and precipitates aluminium)
- remedies include the purification of fuel to partially remove the sulphur content of coal and oil/use of catalytic convertors in petrol engines
- and the use of alternative power sources (such as nuclear or wind power) to reduce the reliance on fossil fuels

Eutrophication:

- eutrophication refers to the condition of waterways such as lakes becoming nutrient-rich
- resulting from the leaching of excess artificial fertilisers from agricultural land
- sewage work effluent nutrients (from decomposition of organic matter)/ especially phosphates (from detergents)
- high levels of nutrients will result in massive growth of algae (algal blooms)
- algal blooms die when minerals exhausted in water body/poor light penetration kills underlying plants
- 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
- remedies include ensuring that artificial fertilisers are only used when they can be readily used (periods when plant growth will be active)/when heavy rain is not expected (reduced leaching)/artificial fertilisers not applied close to water bodies/use organic (slow-release) fertiliser
- and removal of phosphates from sewage work effluent
- use of denitrifying bacteria in water treatment to remove nitrate [13]

Old June 2005

4 Biological processes, whether at the biochemical level or the level of the cell, organism or ecosystem, are frequently cyclic.

Write an account of "biological cycles".

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

Biological processes, whether at the biochemical level or the level of the cell, organism or ecosystem, are frequently cyclic

Write an account of 'biological cycles'

Summer 05

AVAILABLE MARKS

Section B

4 **Thirteen points with at least three from each of three topics**

Krebs cycle:

- Krebs cycle is replenished when acetyl (co-enzyme A) combines with a 4 carbon acid to form a 6 carbon acid
- this 6 carbon acid is gradually converted to a 5 carbon acid and the 4 carbon acid
- during which two decarboxylase reactions take place/two molecules of CO_2 are produced
- importantly dehydrogenase reactions take place/to release hydrogen for the respiratory chain
- hydrogen is "carried" mostly (in three steps) by the co-enzyme NAD^+ and also (in one step) by FAD
- one ATP is directly synthesised during the cycle
- occurs in the mitochondrial matrix

The Calvin cycle:

- the Calvin cycle involves the fixation of carbon/when ribulose bisphosphate combines with carbon dioxide
- to form two molecules of glycerate phosphate (GP)
- the products of the light-dependant stage, NADPH and ATP, are required for the next step
- when glycerate phosphate is reduced to triose phosphate (phosphoglyceraldehyde)
- one sixth of the triose phosphate represents net production
- five sixths of the triose phosphate is recycled to ribulose phosphate (five molecules of triose phosphate produces three molecules of ribulose phosphate)
- further ATP is required to produce ribulose bisphosphate/occurs in the stroma chloroplast

The cell cycle:

- the major stage of the cell cycle is interphase during which the cell prepares for division
- during the G_1 phase new proteins are synthesised and organelles are produced
- during the S (synthesis) phase DNA replication takes place/chromatids are formed
- during the G2 phase centrioles (if present) replicate, mitochondria and chloroplasts divide, and there is a build up of ATP
- nuclear division/mitosis involves prophase, metaphase, anaphase and telophase
- during which chromosomes constrict, assemble at the equator of the spindle on which chromatids are subsequently separated
- two new cells are formed following cytokinesis (involving a cleavage furrow in animals or the formation of a cell plate in plant cells)

The generalised life cycle:

- in the haploid organism or haplophase, cells have only one set of chromosomes
- two haploid cells, representing the gametes, may fuse/fertilisation/syngamy
- this represents genetic mixing (and frequently the haploid cells involved are from different strains to ensure variability)
- the resulting diploid cell will have two sets of chromosomes
- the advantage of the diploid state or diplophase is that heterozygotes may be produced which have beneficial effects/many alleles may be maintained in the recessive state

- meiosis is the means of getting from the diploid to the haploid state
- in either or both the haplophase and diplophase an asexual cycle may take place

The moss life cycle:
- a haploid spore germinates and develops into a green filamentous structure called a protonema
- which matures into the leafy stage, the gametophyte/gametophyte is the dominant phase
- so called because it bears the gametangia, sperm being produced within antheridia while eggs are produced within archegonia
- fertilisation involves water, with droplets of water splashing sperm from the antheridial cups up into the archegonial cups/water is required for the sperm to swim up the archegonium and down the canal towards the egg in the venter
- the resulting zygote develops into the sporophyte
- this consists of a stalk and a capsule, and is nutritionally dependent on the gametophyte
- within the capsule spores are produced by meiosis

The tracheophyte (fern and angiosperm) life cycle:
- the dominant stage of the life cycle is the sporophyte/the sporophyte is the familiar plant (fern or angiosperm) with true roots, stems and leaves
- in the fern, the leaves bear clusters of sporangia/sori
- which produce haploid spores by meiosis
- a spore germinates and develops into a free-living haploid plant called a prothallus
- representing the gametophyte in which sperm are produced within antheridia while eggs are produced within archegonia
- water is required for the sperm to swim to the egg within the archegonium, the resulting zygote developing into the leafy sporophyte (which grows to obliterate the gametophyte)
- in the angiosperm, flowers contain anthers (in stamens) and ovaries (within carpels)
- the pollen sac (in the anther/stamen) acts as a microsporangium within which meiosis produces a microspore/pollen
- within the pollen tube mitotic divisions ultimately produce the male gametes
- the ovule (in the ovary/carpel) acts as a megasporangium within which meiosis produces a megaspore/embryo sac
- within the embryo sac the haploid cell undergoes three successive mitotic divisions to produce a variety of cells including the ovum
- fertilisation follows pollination, which is dependent on wind or insects, and the growth of a pollen tube down towards the embryo sac – it is independent of water

Carbon cycle:
- carbon is fixed when carbon dioxide is utilised during photosynthesis
- since the plant is autotrophic the carbon is fixed into all organic molecules not just carbohydrates/organic molecules are consumed by heterotrophs
- respiration, in all organisms, releases carbon dioxide when organic molecules are broken down
- decomposers are the major source of carbon dioxide in most ecosystems
- burning of fossil fuels is a significant source of carbon dioxide
- deforestation, since it reduces the amount of photosynthetic material, also causes an increase in the amount of atmospheric carbon dioxide/so contributes to the greenhouse effect

Nitrogen cycle:

- plants take up nitrate ion which is used in the synthesis of amino acids, proteins, nucleotides, etc.
- animals obtain their amino acids, etc., from the consumption of plants (directly if they are herbivores or indirectly if they are carnivores)
- organic nitrogenous compound are contained within dead organisms and egested (and excreted) material
- decomposing bacteria and fungi feed on this and release (on their own death) ammonium ions
- ammonium is converted to nitrate ion by nitrifying bacteria in the soil
- additional nitrogen enters the cycle through the action of nitrogen-fixing bacteria (which fix gaseous nitrogen)/nitrogen can be fixed by lightning
- nitrogen leaves the cycle through the action of denitrifying bacteria (which reduce the nitrate pool in the soil)

Population (predator-prey) cycle:

- prey populations increase exponentially in number when resources are readily available
- predator populations also increase exponentially when prey are readily available
- when the predator numbers are high, so many prey are taken that their numbers decrease
- a decrease in prey numbers is followed by a decrease in predator numbers
- low predator numbers allow the prey population to increase

Water cycle:

- water evaporates from water bodies
- water is absorbed by plants
- water is added to the atmosphere by transpiration from plants
- water condenses to form clouds/precipitation returns water to water bodies/soil

Cardiac cycle:

- diastole
- atrial systole
- action of AV-values (due to pressure differential)
- purpose of the chordae tendinae
- ventricular systole
- action of semilunar valves
- purpose of the "pockets" in the semilunar valves
- reference to excitation wave

Breathing cycle:

- inspiration involves contraction of the diaphragm/intercostal muscles
- increase in volume, decrease in pressure in the thoracic cavity
- air moves from high to low pressure
- exhalation results from relaxation of the diaphragm/intercostal muscles
- diaphragm is forced up into its domed position/ribcage falls
- air is forced out as pressure in the thoracic cavity increases and due to elasticity of the lungs

Old January 2004

9 Give an account of the structure and functioning of the eye with respect to the following.

- the iris and its role in the control of the amount of light entering the eye
- the lens and its role in the accommodation of light
- the retina and the functioning of rods and cones [13]

MARK SCHEME MISSING

9 Give an account of sensitivity in plants to include the following.

- phytochrome and the control of flowering
- auxin and shoot phototropism [13]

9 Thirteen points (with at least 5 from each control mechanism)

Phytochrome and the control of flowering:

- two forms of inter-changeable phytochromes (P_{660} or P_R and P_{730} or P_{FR}) occur
- P_{660} is converted to P_{730} during the day/red light, while P_{730} converts slowly to P_{660} during the night/or rapidly in far-red light
- a critical amount of P_{730} controls flowering/P_{730} is the active form
- the accumulated level of P_{730} is determined by the period of darkness
- active form of phytochrome influences the production of "florigen"
- in long-day plants P_{730} promotes flowering, in short-day plants P_{730} inhibits flowering
- a long night allows conversion of P_{730} to P_{660}/long nights trigger flowering in short-day plants/long nights remove P_{730} inhibition
- a short night prevents the complete conversion of P_{730} to P_{660} and so triggers flowering in long-day plants/P_{730} remains to promote flowering
- breaking the period of darkness with a period of light will reverse the above effects
- some plants are day neutral and so the phytochrome system is not involved in control of flowering

Auxin and shoot phototropism:

- auxin is produced in the shoot tip and moves down through the shoot
- auxin promotes cell elongation in plant cells
- auxin exerts its influence on cells in the zone of cell elongation in the shoot
- auxin is not inactivated by light
- unidirectional light causes movement of auxin to the shaded side of the shoot
- greater concentration of auxin on the shaded side stimulates greater cell elongation on that side
- cell elongation is dependent on the elasticity of the cell wall/auxin causes protons (H^+ ions) to move into the cell wall/auxin activates the enzyme hemicellulase/auxin causes cellulose fibres to slide more readily
- differential cell elongation/greater elongation on the shaded side causes curvature of the shoot tip towards the light source
- covering of the shoot tip prevents detection of the light source and so prevents the phototropic response to unilateral light
- normal, all-round lighting will produce an even distribution of auxin in the shoot resulting in even elongation of cells and straight growth of the shoot [13]

Old January 2002

8 Give an account of how the kidney operates as an organ of excretion and osmoregulation. Your account should include an explanation of the following.

- ultrafiltration
- selective reabsorption
- the role of the Loop of Henle
- the role of antidiuretic hormone (ADH) [13]

8 Any thirteen points

- kidney contains uriniferous tubules, each consisting of a Bowman's capsule and convoluted tubules (proximal and distal) in the cortex region
- with the convoluted sections being separated by a loop of Henle which runs deep into the medulla
- the kidney is supplied with blood via the renal artery (which is especially large so that approximately 20% of the blood in one circuit is directed towards the kidney)
- within the kidney each arteriole forms a "knot" of blood vessels – the glomerulus – enclosed within the Bowman's capsule
- the afferent blood vessel to the glomerulus is wider in diameter than the efferent vessel
- high pressure pulse wave due to ventricular contraction
- so that a head of pressure builds up in the glomerulus
- forcing fluid which is essentially blood plasma minus proteins into the capsular space
- explanation in terms of water potential components in glomerulus and capsule
- the basement membrane of the glomerulus endothelium acts as the barrier to this ultra-filtration
- in that the glomerulus endothelial cells have pores while the capsule endothelium is made up of podocytes which have gaps between them
- glucose (and amino acid) is fully reabsorbed by active transport in the proximal (first) convolution
- adaptations of tubular cells for active transport
- most water (approximately 80%) is reabsorbed (by osmosis) in the proximal convolution
- explanation in terms of water potential components in tubule and blood capillaries
- salts/Na^+ ions are especially reabsorbed (by active transport) in the distal convolution
- some substances are secreted into the tubule resulting in the elimination of toxic substances (e.g. creatine) and drugs (e.g. penicillin) or in the regulation of certain ions (e.g. K^+ ions) and pH (e.g. H^+ ions)
- the loop of Henle sets up a salt gradient whereby tissues deeper in the medulla region become particularly salty
- the length of the loop of Henle determines how concentrated the urine will be
- further water is drawn out of the filtrate as it moves through the collection ducts
- so that urine produced is hypertonic/ultimately up to 99% of water may be reabsorbed

- change in the concentration of the blood is detected by osmoreceptors in 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 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
- if the blood becomes more dilute, less ADH is secreted, less water is reabsorbed and so a copious amount of urine is produced [13]

Old June 2002

8 Give an account of how immunity is achieved. Your account should include an explanation of each of the following.

- Active immunity (antibody-mediated and cell-mediated)
- Passive immunity (natural and artificial routes)
- Role of vaccines [13]

8 Any thirteen points

- immunity is achieved actively following exposure to a particular antigen/ pathogen (bacteria, viruses, some fungi and protozoans)

Antibody-mediated (humoral) immune response:

- B-lymphocytes recognise specific antigens/different B-cells carry different antigen receptors
- B-lymphocytes respond by dividing (forming a clone)
- plasma cells are formed (derived from B-lymphocytes)
- these synthesise and secrete antibodies (to recognise and destroy the pathogen)
- the antibody reacts with the antigen
- marking the pathogen for destruction by polymorphs and macrophages/ causing agglutination of the antigen molecules resulting in the clumping of the pathogen
- memory cells are also formed
- on re-exposure to the same pathogen, these can develop into plasma cells, so enabling a rapid response to the pathogen
- memory cells remain providing long-lasting immunity

Cell-mediated immune response:

- T-lymphocytes have specific receptor molecules on their cell surface membrane/recognise infected, mutant or "foreign" cells
- once they have attached to their specific receptor antigen, T-cells become sensitised and divide (forming a clone within which there are different functional types of T-cell)
- killer T-cells destroy their target cells
- "helper" T-cells stimulate the action of killer T-cells/stimulate B-cells to divide and produce plasma cells
- suppressor T-cells block B- and T-cell responses/inhibit further production of antibodies
- memory T-cells respond to further challenges by the same antigen

Passive immunity:

- immunity may be achieved passively when antibodies are provided by the "mother"
- immunity is also achieved artificially (though passively) with the use of antiserum injections which contain specific antibodies
- this is particularly important when antibody levels have to be raised rapidly, e.g. when treating a snake bite
- some antibodies can cross the placenta
- while the first milk (colostrum) contains a range of antibodies providing immunity to a range of pathogens
- the high initial antibody level in the plasma rapidly declines (as they are denatured, or used up, in an immune response)
- no memory cells are formed and so the immunity does not remain (for longer than a few weeks)