Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

November 2019

Biology

Higher level

Paper 3

38 pages

Section A

Question			Marking point	Answers	Notes	Total
1.	a			*Similarities **[1 max]***		**2 max**
			a	both have similar design «input and output» ✓		
			b	both open systems ✓		
				*Differences **[1 max]***		
			c	vertical flow/«figure» A has pump but horizontal flow/«figure» B does not/flows naturally ✓	*Do not accept references to rate of flow or pressure as they are unknown.*	
			d	horizontal flow/«figure» B has a larger «surface» area **OR** horizontal flow/«figure» B has more plants ✓	*Accept vice versa.*	
			e	vertical flow/«figure» A has a pre-treatment «with sedimentation tank» before treatment but not horizontal flow/«figure» B ✓	*Accept vice versa.*	
	b		***a***	horizontal flow/«figure» B because it is larger **OR** horizontal flow/«figure» B contains more/several plants ✓		**1 max**
			b	horizontal flow/«figure» B because it works by natural flow **OR** horizontal flow/«figure» B because it works without a pump ✓	*Do not accept river instead of flow.*	

(continued...)

(Question 1 continued)

	c		***a***	type/number of plants ✓	*If more than two variables written, mark only the first two.*	**2 max**
			b	type of soil/substrate ✓		
			c	pH level ✓		
			d	initial concentration of nutrients ✓		
			e	timespan of experiment ✓		
			f	volume of water/influent **OR** flow rate ✓	*Do not accept amount instead of volume.*	

2.	**a**	**i**		negative correlation between the number of leaves <u>removed</u> and transpiration rate **OR** as more leaves are removed the transpiration rate drops ✓	*Do not accept type of correlation alone, as a description is required.* *OWTTE*	**1 max**
		ii	***a***	transpiration does not only occur in the leaves **OR** transpiration through stem/shoot ✓		**1**
	b			number of leaves **«**removed**»** ✓		**1**
	c		***a***	using a potometer ✓	*Accept transpirometer but not respirometer.*	**2 max**
			b	leafy shoot attached to a reservoir and a graduated **«**capillary**»** tube ✓		
			c	as transpiration increases water uptake **«**by roots**»** also increases ✓		
			d	distance/time for bubble **«**in capillary tube**»** to travel is used to measure transpiration rate ✓		

3.	**a**			0.36 mol dm^{-3}/M ✓	*Units required* *Allow a range of 0.35–0.37* mol dm^{-3}/*M.*	**1**
	b			osmolarity will increase «because the cells become dehydrated» **OR** the cells become hypertonic ✓	*Accept water potential of the tissue decreases.* *Do not accept "change" instead of "increase".*	**1**
	c		***a***	the change in mass indicates whether the tissue has gained/lost water ✓		**2 max**
			b	the pieces of tissue will not all be the same mass «at the beginning of the experiment» ✓		
			c	to compare the relative changes in mass ✓		
	d		***a***	water would move into the red blood cells ✓		**1 max**
			b	it would lyse **OR** swell **OR** burst ✓		

Section B

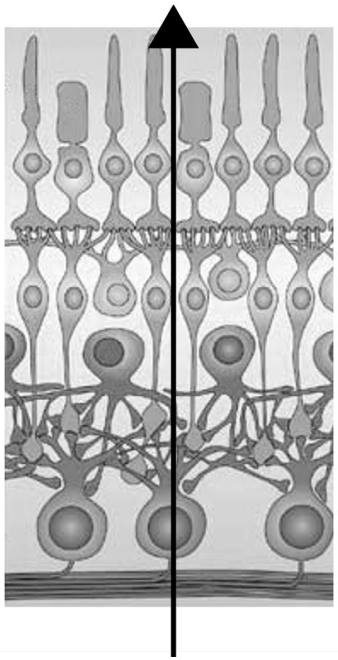
Option A — Neurobiology and behaviour

Question			Marking point	Answers	Notes	Total
4.	a		*a*	larger cerebral cortex in human brain ✓	*Do not accept larger brain for human as it is in the stem.*	1 max
			b	higher folding in human brain **OR** increased surface area in human brain ✓		
			c	angle of spinal cord more vertical in human **OR** angle of spinal cord more horizontal in sheep ✓		
	b		*a*	loss of unused neurons ✓	*Accept apoptosis or programmed neuron death.*	1 max
			b	loss of unused synapses **OR** reducing the number of synapses **OR** leaving more efficient synaptic configurations ✓	*Do not accept "connection" instead of "synapse".*	
	c			medulla «oblongata» ✓	*Do not accept "brain stem".*	1

(continued...)

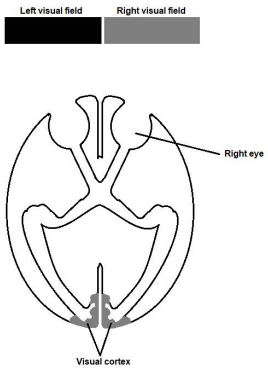
(Question 4 continued)

	d		***a***	the brain contains a very large number of neurons and therefore consumes large amount of energy ✓	*OWTTE*	**3 max**
			b	**«**large**»** requirement for oxygen/glucose to provide energy for **«**aerobic**»** cell respiration ✓		
			c	energy used to sustain the electric charges of neurons **OR** energy used to sustain the membrane potential of neurons **OR** energy used to produce neurotransmitters ✓		
			d	brain has continuous activity that requires continuous supply of oxygen/glucose ✓	*OWTTE*	

5.	**a**			 [Source: reprinted by permission from Springer Nature: Nature Reviews Neuroscience Parallel processing in the mammalian retina, Heinz Wässle, 2004, *Nat Rev Neurosci* **5**, 747–757 (2004) doi:10.1038/nrn1497]	*Accept any arrow pointing upwards.*	**1**
	b			A: bipolar cell B: ganglion cell ✓	*Both required.*	**1**
	c		***a***	mechanoreceptors «detect» pressure ✓	*Mark only the first answer if more than one receptor is mentioned.* *Accept valid other receptors with the correct function.*	**1 max**
			b	chemoreceptors «detect» chemical substances/pH ✓		
			c	thermoreceptors «detect» temperature ✓		

(continued...)

(Question 5 continued)

	d				*Accept any of these points made on an annotated diagram.*	**3 max**
			a	«right» eye receives information/stimuli/light from both «left and right» visual fields ✓		
			b	light from the left visual field goes to the right side of the retina ✓	*Accept vice versa.*	
			c	impulses «from retina» carried along the optic nerve ✓		
			d	«optic» nerves cross at «optic» chiasma ✓		
			e	impulses from the left side of the retina go to the left side of the brain ✓ 	*Accept vice versa.*	

6.	**a**			chemical substance that transmits message across synapses/from one cell to another ✓	*OWTTE* *Do not accept "connection" instead of "synapse".*	**1**
	b		***a***	interfere with neural transmission between areas of sensory perception and the CNS ✓		**3 max**
			b	blocks nerve transmission/impulses to pain centres in the CNS ✓		
			c	inhibit the function of an ion channel **«**sodium channel**»** in nerve cells ✓	*OWTTE*	
			d	no changes in awareness/consciousness/sense perception in other areas ✓	*Accept vice versa*	
			e	suppress excitatory synaptic transmission ✓		
			f	some increase the intensity of inhibitory synaptic transmission ✓		
	c		***a***	may cause the release of secondary messengers **«**in post-synaptic neuron**»** ✓		**2 max**
			b	secondary messengers can persist for long time ✓		
			c	**«**secondary messengers**»** may enhance the synaptic connections between neurons **OR** **«**secondary messengers**»** strengthen neural pathways **«**involved in memory/learning**»** **OR** **«**secondary messengers**»** increase the number of receptors in the postsynaptic membrane ✓	*OWTTE*	
			d	modulate/reduce/increase fast synaptic transmission **«**in the brain**»** ✓		

7.	**a**		***a***	innate behavior is independent of environment ✓		**1 max**
			b	innate behaviour is controlled by genes/inherited ✓		
			c	innate behaviour is present at birth **OR** doesn't change through time/experience ✓	*OWTTE*	
	b		***a***	**«**courtship behaviour**»** is inherited/innate **OR** variations exist ✓	*OWTTE*	**3 max**
			b	fittest animals have the best courtship behaviour ✓		
			c	**«**courtship behaviour**»** allows members of a species to identify each other **OR** **«**courtship behaviour**»** results in mate selection ✓	*OWTTE*	
			d	**«**courtship behaviour**»** increases chances of mating/reproductive success ✓		
			e	**«**courtship behaviour**»** also make organisms more vulnerable to predation ✓		
			f	**«**allows**»** best courtship to be passed on to the next generation/offspring ✓		

(Continued...)

(Question 7 continued)

	c		***a***	when an animal learns to associate a reward with a certain kind of behaviour **OR** trial and error learning **OR** positive reinforcement **OR** associative learning ✓	*OWTTE*	**2**
			b	example: animal training ✓		

8.	*General effects of any stimulant drugs:*	***[3 max]***	***6 max***
	a. addictive/causes tolerance/addiction ✓ b. increase dopamine release ✓ c. speed up activity of CNS/alertness/euphoria/suppress appetite ✓ d. have symptoms of withdrawal when stop «chronic» use ✓		
	Drug name:	***[1 mark]*** Award this mark for a stimulant drug only, e.g. nicotine, cocaine or amphetamines.	
	e. name of «chosen» stimulant drug ✓		
	Cocaine:	***Award [3 max]*** *for either cocaine, nicotine or amphetamines. Mark only the first drug explained.*	
	f. chronic use may cause psychological craving/paranoia/arrhythmia/hypertension/stroke ✓ g. cocaine attaches to dopamine pumps/transporters «on presynaptic membrane» **OR** blocks uptake/recycling **OR** causes dopamine to persist in the synaptic cleft ✓ h. amplifies synaptic transmission **OR** causes constant stimulation of postsynaptic neuron ✓		
	Nicotine:		
	f. nicotine stimulates synaptic transmission of cholinergic synapses ✓ g. causes strong mood changes ✓ h. large doses have a calming effect ✓		
	Amphetamines:	*Accept ecstasy instead*	
	f. chronic use can «permanently» damage dopamine system **OR** cause problems with memory/learning ✓ g. amphetamines/ecstasy stimulate synaptic transmission of adrenergic synapses ✓ h. longer lasting effect than cocaine ✓		

Option B — Biotechnology and bioinformatics

Question			Marking point	Answers	Notes	Total
9.	**a**			«frame 1 =» ATG «frame 2 =» TGC ✓ «frame 3 =» GCC	*All three required.* *Order of frames is not relevant.* *Do not accept RNA, e.g. AUG.*	**1**
	b			continuous stretch of codons «between start and stop codon» **OR** can contain introns **OR** sufficient nucleotides to code for a polypeptide chain ✓		**1**
	c		***a***	«marker genes» are attached to target genes and inserted into bacteria/host cells ✓	*OWTTE*	**3 max**
			b	«marker genes» confirm that the target gene has been successfully integrated into the genome/ plasmid ✓		
			c	«marker genes» for antibiotic resistance/fluorescence ✓		
			d	antibiotic is added to the media used to grow the bacteria **OR** UV light is used «to detect fluorescence» ✓		
			e	genetically modified bacteria will survive **OR** successful transgenic organisms will fluoresce **OR** allow researchers to identify the bacteria that have been modified ✓		

(Continued...)

(Question 9 continued)

	d			electroporation **OR** microinjection **OR** biolistics/gene gun/gunshot ✓		**1**

10.	**a**			blackwater **OR** brownwater/sewage **OR** feces **OR** organic solid waste **OR** paper pulp **OR** other biodegradable material ✓	*Do not accept methane and CO_2.*	**1**
	b			temperature: warm oxygen: low/anaerobic ✓	*Both required.*	**1**
	c		***a***	in batch culture product is withdrawn at the end of the «organisms » growth phases whereas in continuous culture product is withdrawn while the organism is growing / *OWTTE* ✓		**2 max**
			b	in batch culture all of the growth medium/nutrients are added at the beginning whereas in continuous culture, growth medium/nutrients are added at a constant rate / *OWTTE* ✓		
			c	batch culture is carried out in large scale fermenters whereas continuous culture could be in small scale ✓		
			d	continuous can run for a longer time than batch ✓		

(Continued...)

(Question 10 continued)

	d				*Award marks for identification of the factor and description of the effect.*	**2 max**
			a	aerobic conditions achieved by stirring/aeration ✓		
			b	buffers maintain pH ✓		
			c	moderate temperatures maintained by cooling jacket ✓	*Accept mention of 20-30°C.*	
			d	product is collected during stationary phase ✓		

11.	**a**			*Aims [1 mark]*		**2 max**
			a	the addition of organisms to remove environmental contaminants **OR** the addition of organisms to convert toxic compounds to non-toxic products ✓		
				*Methods **[1 max]***	*Accept other valid methods involving living organisms.* *Do not accept physical methods alone.*	
			b	physical and chemical procedures can be combined with bioremediation ✓		
			c	*e.g.* clean-up of oil spills using bacteria **OR** clean-up of heavy metals using plants and incineration ✓		
	b			to observe that it was stable **OR** to confirm that change was permanent **OR** to confirm that *merB* gene still present after many generations ✓		**1**

(Continued…)

(Question 11 continued)

	c		***a***	used to clean up oil **OR** used to clean up mercury ✓		**3 max**
			b	used after other clean-up methods have been used ✓		
			c	nutrient concentrations have to be sufficient to support the maximal growth rate of the bacteria throughout the clean-up operation ✓		
			d	converts methylmercury into inorganic mercury **«**less toxic**»** ✓		
			e	converts oil into CO_2, water and simpler compounds **«**non-pollutant**»** ✓		
			f	produces extracellular digestive enzymes **«**lipase**»** ✓		

12.	**a**			production of pharmaceuticals **OR** proteins used in therapy **OR** antibodies **OR** vaccines ✓		**1**
	b		***a***	gene therapy involves introducing a normal copy of a defective gene into an organism ✓		**3 max**
			b	virus/viral vector **«**genetically**»** modified for **«**safe**»** use ✓		
			c	insertion of desired gene/allele into viral genome/retrovirus ✓		
			d	an example is the use in SCID/lack of enzyme ADA in SCID ✓		
			e	removal of somatic cells ✓		
			f	introduction and insertion of the desired gene into the target cell **OR** modified virus can be introduced in the form of **«**inhaled**»** droplets **OR** the cells are introduced in the patient so that the desired gene can be expressed ✓		

(Continued...)

(Question 12 continued)

	c		***a***	«ELISA» uses antibodies to detect a target antigen «to a pathogen» ✓	*OWTTE*	**2 max**
			b	antigen attached to substrate ✓		
			c	the antibody «if present» will attach to the antigen ✓		
			d	«suitable» enzyme attached to antibody ✓		
			e	«enzyme» colour reaction shows the presence of antibodies to the antigen/pathogen ✓		

13.	***a***	used to test the presence or absence or a gene/allele **OR** used to diagnose the presence of a particular strain of virus/bacteria **OR** used to diagnose the presence of a specific mutation **OR** used to diagnose the presence of an expression of genes ✓		**6 max**
	b	DNA spots/probes/sequences attached to solid surface/microarray ✓		
	c	mRNA from healthy tissue/cell isolated and converted to cDNA **OR** mRNA from cancer tissue/cell isolated and converted to cDNA ✓		
	d	conversion to cDNA by reverse transcriptase ✓		
	e	fluorescent dye linked to complementary DNA/cDNA ✓		
	f	cancer cDNA colored with a different dye from the healthy cDNA ✓	*Accept named colour.*	
	g	cDNA binds to/hybridizes with probes «that have complementary base sequences» ✓		
	h	microarray rinsed to remove cDNA that has not hybridized ✓		
	i	microarray exposed to laser light which causes dye to give off light ✓		
	j	fluorescence shows which probes have hybridized **OR** fluorescence shows which sequences were in the tissue/sample ✓		
	k	hybridized probe shows gene expression **OR** hybridized probe helps in diagnosis of disease ✓		

Option C — Ecology and conservation

Question			Marking point	Answers	Notes	Total
14.	**a**		***a***	higher FCR implies less sustainability ✓	*Do not accept efficiency instead of sustainability.*	**2 max**
			b	salmon based diet is more sustainable/chicken is less ✓		
			c	salmon diet would have lower energy losses/chicken diet higher energy losses ✓		
			d	salmon diet will produce less waste/chicken more✓		
	b				*Needs one advantage and one limitation to obtain **[2]**.* *Do not accept mentions of trophic levels.*	**2 max**
			a	*Advantages:* food webs summarize all possible food chains **«**in the community**»** ✓	*OWTTE*	
			b	realistic representation ✓		
			c	*Limitations:* some communities/ecosystems are too complex to represent ✓		
			d	only shows qualitative information/not quantitative data **OR** saprotrophs/abiotic factors not taken into account ✓		

(Continued...)

(Question 14 continued)

	c		***a***	«research demonstrates that keystone species» have a «disproportionately» large effect on their environment relative to abundance **OR** «keystone species» maintain a balance in the «stable» numbers of each species within a community **OR** «keystone species» have a large impact in preserving and stabilizing the biodiversity by preventing overpopulation/monopoly/out competition ✓		**1 max**
			b	a keystone species' disappearance would start a domino effect/other species in the habitat would also disappear **OR** their loss leads to an imbalance in the food web **OR** their loss leads to a decrease in biodiversity ✓	*Do not accept protecting keystone species prevents disappearance of other species since it repeats the question.*	
	d		***a***	the role of an organism in its environment **OR** functional position of an organism in its environment ✓		**2 max**
			b	includes «spatial» habitat AND feeding activities AND interactions with other species in the community ✓	*All required.*	
			c	no two species can occupy the same niche ✓		
			d	a niche can be fundamental or realized ✓	*OWTTE*	

15.	**a**		***a***	both show cases of entanglement/ingestion ✓		**2**
			b	sea turtles similar number of species affected by entanglement/ ingestion while baleen whales more species affected by entanglement than ingestion **OR** higher percentage of sea turtles species affected by entanglement/ ingestion than baleen whales **OR** higher number of species of **«**baleen**»** whales than species of sea turtles ✓	*Do not accept answers quoting numerical values only.*
	b		***a***	plastic broken down into microplastics to be able to enter the food chain ✓		**1**
			b	plastic/microplastics become more concentrated at each trophic level ✓	*Accept descriptions of biomagnification involving any of the species in the table.*	

(Continued...)

(Question 15 continued)

	c		***a***	presence/absence indicate environmental conditions ✓	*Accept named environmental condition/pollution.*	**3 max**
			b	changes in the environment affect these species ✓	*Number of species or type of species.*	
			c	**«**relative**»** numbers of individuals/indicator species can be used to calculate a biotic index ✓		
			d	changes monitored over time ✓	*Accept example of time frame.*	
			e	changes can lead to measures to protect the environment ✓		
			f	example of an indicator species ***AND*** what it indicates **«**e.g. Tubifex for sediment pollution**»** ✓	*Award marks for a species, not a group.*	

16.	**a**			organisms remain in their own habitat **OR** protects a large number of organisms/species/habitats simultaneously **OR** protects natural interactions within the community **OR** **«**corridors**»** facilitates natural processes of evolution/adaptation ✓	*Mark only the first answer if many provided.*	**1**
	b		***a***	increases edge effect and thus biodiversity **OR** maintains genetic diversity **OR** prevent the negative effects of inbreeding ✓	*Mark only the first answer if many provided.*	**1 max**
			b	also help facilitate the re-establishment of populations after catastrophic events ✓	*Accept named catastrophic events e.g fires, diseases, etc.*	
			c	increases availability of food resources ✓		
	c		***a***	a stable/balanced ecosystem **OR** high species richness/evenness ✓		**1 max**
			b	ecosystem not under stress ✓		
			c	ancient ecosystem **OR** absence of changes ✓	*Accept final stage of succession, climax community.*	

(Continued…)

(Question 16 continued)

	d		***a***	size and shape determine the length of perimeter/edge **OR** smaller or irregular shapes have **«**relative**»** greater **«**perimeter and**»** edge than larger/round ✓	*OWTTE*	**3 max**
			b	perimeter determines importance of edge effect **OR** edge effect is the result of interaction between adjacent ecosystems **OR** edge effect results in abrupt change of habitats ✓		
			c	greater edge effect results in increased biodiversity **OR** greater edge effect leave organism exposed **«**to abiotic factors or predators**»** **OR** greater edge effect allows for the influx of new species/predators ✓	*Accept vice versa for smaller edge.* *Accept greater variety of resources or more ecological niches for biodiversity.*	
			d	large areas can conserve a greater number of habitats **OR** larger areas give more protection against human interference/influence/pollution ✓	*Accept vice versa for smaller areas.* *Accept greater variety of resources or more ecological niches for habitats.*	
			e	large areas make it easier for poachers to go undetected. **OR** smaller areas may have too few resources for long-term survival ✓		
			f	corridors promote movement between habitats /genetic variation **OR** smaller areas connected by corridors have greater edge effect than those without corridors ✓		

17.	**a**			iron/Fe ✓		**1**
	b		***a***	«*Rhizobium*» forms mutualistic/symbiotic relationship with roots/legumes ✓		**2 max**
			b	«*Rhizobium*» fixes «atmospheric» nitrogen ✓		
			c	converts it into ammonia «to be used by plants» ✓		
	c		***a***	normally shallow ✓		**2 max**
			b	low water visibility **OR** high levels of nutrients/phosphates/potassium **OR** low oxygen concentration **OR** high BOD ✓		
			c	high net primary productivity **OR** algal bloom **OR** low biodiversity ✓		

18.	***a***	named species ✓	*Do not award marks for group of animals eg birds.* *Do not award the mark for this point if the method doesn't apply for the species.*	**6 max**
	b	capture and count a sample of the population ✓		
	c	example of method of capture ✓		
	d	apply a mark that will not affect the survival of the animal «*e.g.* non-toxic paint spot/ear tag/leg ring/radio transmitter» ✓	*OWTTE*	
	e	release the organism into the environment ✓		
	f	allow time to become randomly dispersed ✓	*OWTTE*	
	g	capture «a second sample» and count the complete sample ✓		
	h	count the marked individuals in the second sample ✓		
	i	define formula to estimate the population size ✓	$N = \frac{n_1 \times n_2}{n_3}$ *where n_1 = first capture, n_2 = second capture, n_3 = number marked in second capture.* *Accept alternative displays of formula, e.g. different variables, wording displayed in a formula, etc.*	
	j	only estimates could be obtained ✓		

Option D — Human physiology

<table>
<tr><th colspan="3">Question</th><th>Marking point</th><th>Answers</th><th>Notes</th><th>Total</th></tr>
<tr><td>19.</td><td>a</td><td></td><td></td><td>
<table>
<tr><th>essential amino acids</th><th>non-essential amino acids</th></tr>
<tr><td>cannot be synthesized by the organism</td><td>can be made from other amino acids</td></tr>
<tr><td colspan="2">OR</td></tr>
<tr><td>need to be ingested in diet</td><td>don't need to be ingested in diet ✓</td></tr>
</table>
</td><td>Distinctive elements from the same line required to gain the mark.</td><td>1</td></tr>
<tr><td></td><td>b</td><td></td><td></td><td>Indian diet based on rice and wheat which have low levels of lysine
OR
low levels of meat/milk in Indian diet
OR
high levels of meat/milk in UK diet ✓</td><td></td><td>1 max</td></tr>
<tr><td rowspan="8"></td><td rowspan="8">c</td><td rowspan="8"></td><td>a</td><td>protein/muscle lost for energy ✓</td><td></td><td rowspan="8">2 max</td></tr>
<tr><td>b</td><td>lack of blood plasma proteins ✓</td><td></td></tr>
<tr><td>c</td><td>leading to tissue fluid retention/edema/swollen abdomen/kwashiorkor ✓</td><td></td></tr>
<tr><td>d</td><td>lethargic/little interest in surroundings ✓</td><td></td></tr>
<tr><td>e</td><td>thin muscles/flaky appearance of skin/sparse hair with lack of pigmentation ✓</td><td></td></tr>
<tr><td>f</td><td>physical/mental development retarded ✓</td><td></td></tr>
<tr><td>g</td><td>lack of menstrual cycle ✓</td><td></td></tr>
</table>

(Continued…)

(Question 19 continued)

<table>
<tr>
<td></td>
<td>d</td>
<td></td>
<td></td>
<td>cod/fish liver oil
OR
oily fish «accept correctly named example»
OR
egg yolk
OR
«fortified/enriched» dairy product ✓</td>
<td>Allow any two sources for the mark.
Mark only the first two.
Do not accept sunlight, as source has to be dietary, nor dietary supplements.
Reject fish alone.

Check examples on the Internet if necessary.

i.e. milk/cheese/yoghurt.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>e</td>
<td></td>
<td></td>
<td>
<table>
<tr><th>cause</th><th>symptom</th></tr>
<tr><td>body becomes resistant/not responsive to insulin</td><td>hyperglycemia/high glucose content in blood/urine</td></tr>
<tr><td>pancreas does not produce enough insulin</td><td>thirst</td></tr>
<tr><td></td><td>frequent urination</td></tr>
<tr><td></td><td>other valid symptom ✓</td></tr>
</table>
</td>
<td>Both one cause from left column and one symptom from right column required for the mark.
For the cause, do not accept risk factors, e.g. high sugar intake/obesity, lack of exercise, genetic predisposition, etc.
Other valid symptoms could be: slow-healing sores, dizziness, tiredness, red/swollen gums, kidney/back pain, nerve damage, erectile dysfunction.</td>
<td>1</td>
</tr>
</table>

20.	**a**			as age increases liver transplant due to cancer increases ✓		**1**
	b	**i**	***a***	hemoglobin taken up by Kupffer cells ✓	*Do not accept confusion between erythrocytes and hemoglobin.*	**3 max**
			b	broken down into heme and globins ✓		
			c	globin hydrolysed/broken down to amino acids ✓		
			d	iron removed from heme group **OR** heme broken down to form bilirubin/bile pigment ✓		
		ii	***a***	storage of nutrients ✓	*Accept only the first answer if more than one are provided.*	**1 max**
			b	regulation of blood glucose levels ✓	*e.g. glucose to glycogen and vice versa.*	
			c	production/secretion of bile ✓	*Do not accept production of bile <u>pigments</u> from hemoglobin in the liver.*	
			d	detoxification ✓		
			e	synthesis of plasma proteins *e.g.* albumin ✓		
			f	synthesis and regulation of cholesterol ✓		

(Continued...)

(Question 20 continued)

	c			cellulose/lignin/fibre **OR** bacteria ✓		**1**

21.	**a**			improvement in medical care **OR** healthier diet **OR** decrease in blood cholesterol/pressure **OR** decrease in cigarette smoking **OR** increase in exercise ✓	*Accept improvements in medication. Accept other answers relating to greater awareness about health issues.*	**1**
	b		***a***	used in life-threatening cardiac conditions/arrythmia/ventricular fibrillation ✓		**2 max**
			b	delivers therapeutic/small dose/shock of electrical energy ✓		
			c	depolarizes the heart muscle **OR** allows normal rhythm to be re-established ✓		
	c		***a***	**«**heart sounds**»** produced by the closing of the valves ✓		**3 max**
			b	first sound **«**lub**»** is due to **«**closure of**»** the atrioventricular valves ✓	*Accept bicuspid/mitral and tricuspid.*	
			c	second sound **«**dub**»** is due to **«**closure of**»** the semilunar valves ✓	*Accept pulmonary/aortic valves.*	
			d	sequence of sounds from a healthy heart is lub dub **«**pause lub dub pause**»** ✓	*OWTTE*	

<table>
<tr><td>22.</td><td>a</td><td></td><td></td><td colspan="2">growth hormone/drug no longer present «in blood»
OR
lack of hormones reduce «gained» muscle mass/strength ✓</td><td>OWTTE</td><td>1</td></tr>
<tr><td rowspan="5"></td><td rowspan="5">b</td><td rowspan="5"></td><td></td><td>steroid hormones</td><td>peptide hormones</td><td rowspan="5">Award [1 mark] for each complete row, up to [3 max].
Apply ECF the second time <u>plasma</u> is omitted and award the mark</td><td rowspan="5">3 max</td></tr>
<tr><td>a</td><td>enter the cell/pass through the <u>plasma</u> membrane</td><td>do not enter the cell/pass through the <u>plasma</u> membrane ✓</td></tr>
<tr><td>b</td><td>bind to receptor in cytoplasm</td><td>bind to receptor on <u>plasma</u> membrane surface ✓</td></tr>
<tr><td>c</td><td>act directly on DNA</td><td>act through second messenger/cAMP ✓</td></tr>
<tr><td>d</td><td>directly affect gene transcription</td><td>influence enzyme activity/protein kinase ✓</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">c</td><td rowspan="2"></td><td>a</td><td colspan="2">endocrine gland ✓</td><td></td><td rowspan="2">2</td></tr>
<tr><td>b</td><td colspan="2">«ductless gland that» secretes hormones directly into the bloodstream ✓</td><td></td></tr>
</table>

23.	***a***	exercise increases the rate of cellular respiration ✓		**6 max**
	b	increases production of CO_2 ✓		
	c	increased CO_2 causes increased acidity in blood **OR** decrease pH ✓		
	d	chemoreceptors in aorta/ carotid artery/medulla oblongata detect change in pH ✓		
	e	impulse/signal/message to breathing centre **OR** impulse/signal/message to medulla oblongata ✓		
	f	impulse/signal/message to to diaphragm for more frequent contraction **OR** impulse/signal/message to intercostal muscles for more frequent contraction ✓		
	g	increase ventilation rate for more gas exchange ✓		
	h	long term effects of increased lung surface area **OR** vital capacity ✓		
	i	training decreases ventilation rate over time ✓		