IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

Biology
Higher level and standard level

Specimen paper 1s, 2s and 3s

For first examinations in 2009

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IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

BIOLOGY
HIGHER LEVEL
PAPER 1

SPECIMEN PAPER

1 hour

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.

1. What do error bars on graphs show?

A. If the data is correct or not.

B. How variable the data is.

C. Which result is closest to the true result.

D. What statistical technique was used to eliminate incorrect results.

2. What is the correct order of increasing size for the following biological structures?

I. The width of a virus
II. The width of a bacterium
III. The thickness of a cell surface membrane
IV. The diameter of a eukaryotic cell

A. I → III → II → IV

B. I → III → IV → II

C. III → I → II → IV

D. III → II → I → IV

3. Which of the following structures are present in **both** plant and animal cells?

I. Cell wall
II. Chloroplast
III. Mitochondrion

A. I only

B. I and II only

C. I and III only

D. III only

4. In viewing an electron micrograph of a cell, ribosomes, pili and a single circular chromosome are observed. What other structure is likely to be present?

A. The rough endoplasmic reticulum (rER)

B. Mitochondria

C. A nuclear membrane

D. A plasmid

5. Which of the following is a feature of exocytosis but **not** endocytosis?

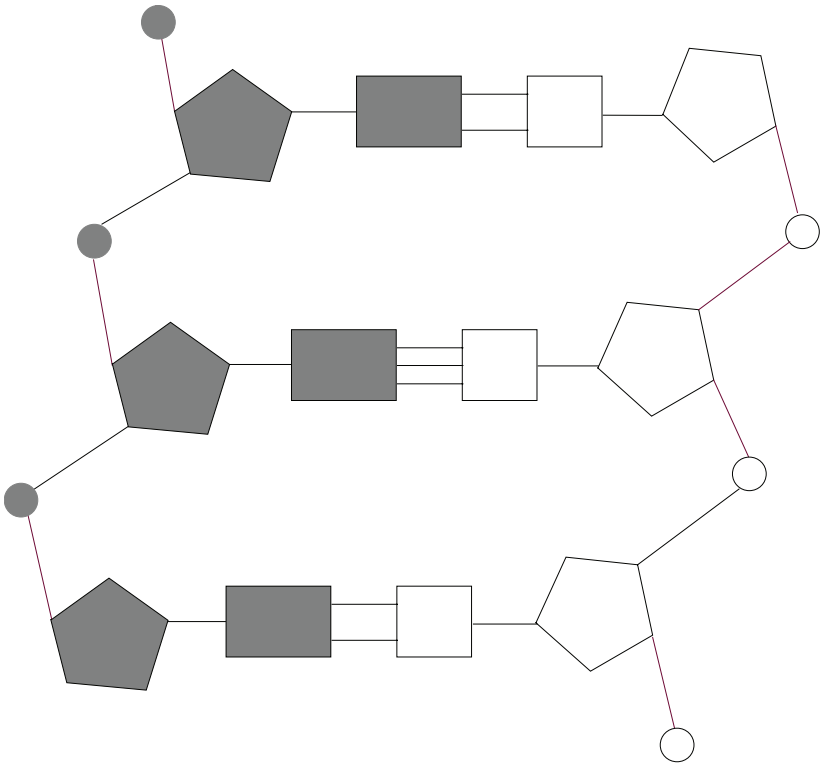
A. Shape changes of a membrane

B. Vesicle formation

C. Use of ATP

D. Secretion

6. The diagram shows part of a molecule produced by replication of DNA. What is the significance of the shaded and the unshaded regions?



A. The shaded parts are DNA and the unshaded parts are mRNA.

B. The shaded parts contain adenine and thymine and the unshaded parts contain guanine and cytosine.

C. The shaded part is a codon and unshaded part is an anticodon.

D. One of the parts has been newly synthesised and the other was part of a pre-existing DNA molecule.

7. If mRNA has a codon CAU, what is the corresponding anticodon on the tRNA molecule?

A. CAT

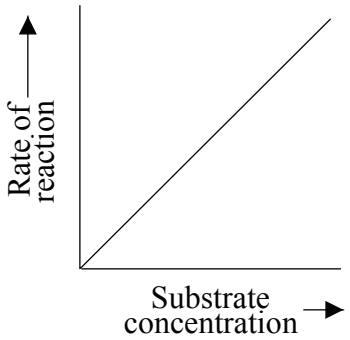
B. GUA

C. CAU

D. GTA

8. Which graph shows the relationship between the substrate concentration and the rate of an enzyme controlled reaction?

A.



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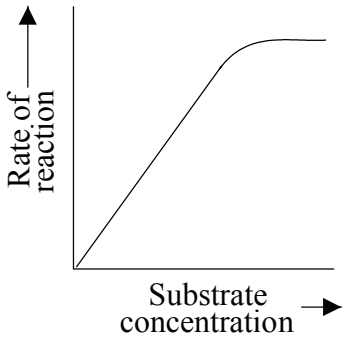
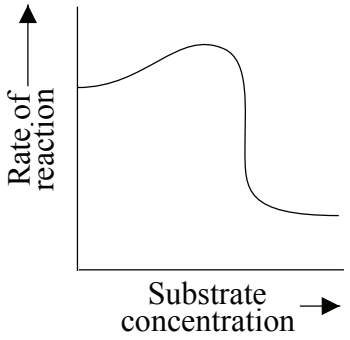
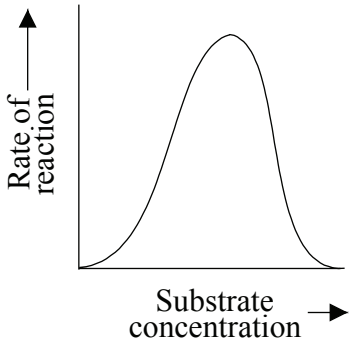


C.



D.



9. Humans can respire aerobically and anaerobically. Which are products of **both** aerobic cell respiration and anaerobic cell respiration **in humans**?

A. pyruvate and ATP

B. pyruvate and lactate

C. ATP and carbon dioxide

D. lactate and carbon dioxide

10. If the amount of DNA in a haploid gamete is represented by ×, what is the net quantity of DNA in a cell from the same organism at the start of meiosis?

A. 0.5 ×

B. ×

C. 2 ×

D. 4 ×

11. A parent organism of unknown genotype is mated in a test cross. Half of the offspring have the same phenotype as the parent. What can be concluded from this result?

A. The parent is homozygous dominant for the trait.

B. The trait being inherited is polygenic.

C. The parent is heterozygous for the trait.

D. The parent is homozygous recessive for the trait.

12. How are plasmids used in biotechnology?

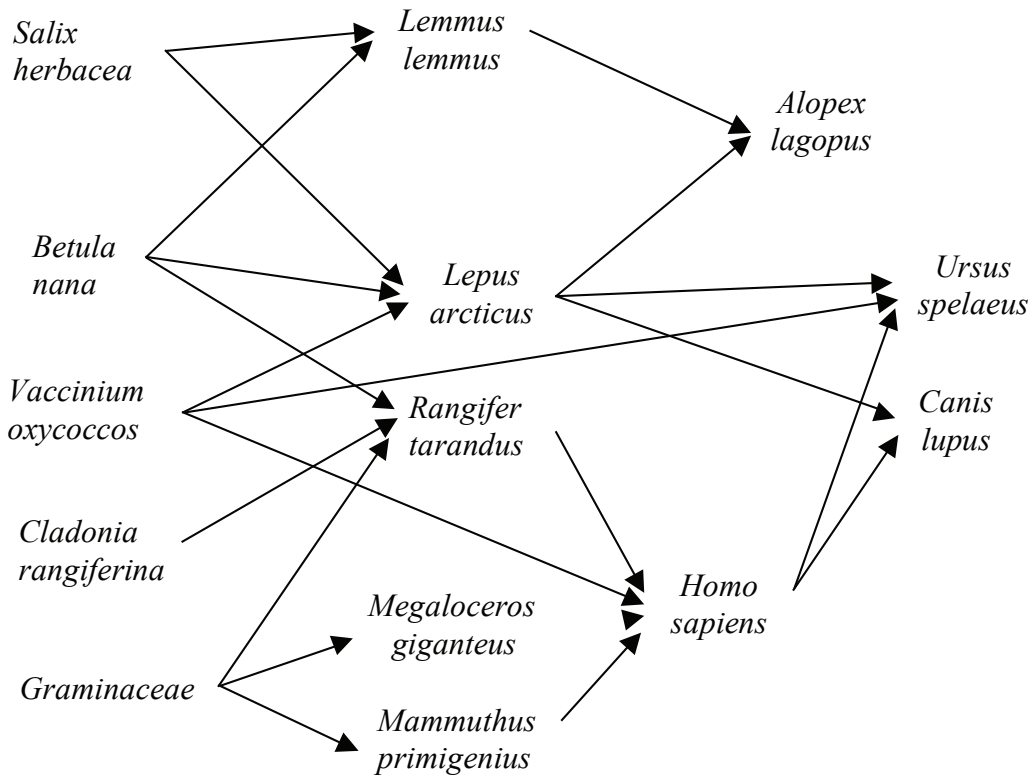
A. For respiration in prokaryotes

B. For photosynthesis in eukaryotes

C. For protein synthesis in prokaryotes and eukaryotes

D. For gene transfer

13. The food web below shows a community in central France 24 000 years ago.



Which statement is a correct description of *Ursus spelaeus*?

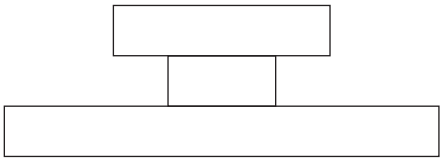
A. It is an omnivore which feeds on *Lemmus lemmus*.

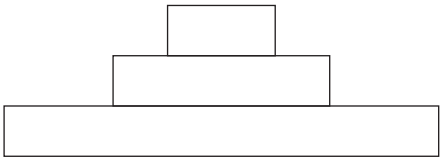
B. It is a producer preyed upon by *Vaccinium oxycoccos*.

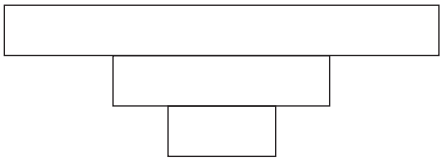
C. It is a top carnivore and a primary consumer.

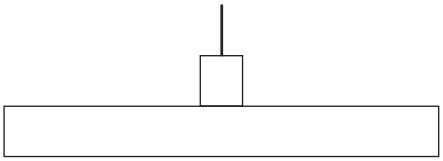
D. It is a decomposer and it competes with *Rangifer tarandus.*

14. Which diagram shows the flow of energy through a community with three trophic levels?

A. 

B. 

C. 

D. 

15. According to the precautionary principle, what should happen if there are fears that eating a food might cause a health problem?

A. People should be warned about the possible health problem.

B. The company producing the food should be warned about the possible health problem.

C. People who have fears about the food should test it to see if it causes a real health problem.

D. The company producing the food should test the food to prove that it does not cause a health problem.

16. Which group of organisms in the carbon cycle converts carbon into a form that is available to primary consumers?

A. Decomposers

B. Detritus feeders

C. Producers

D. Secondary consumers

17. Which phylum does an animal belong to, if it has stinging tentacles and a mouth, but no anus?

A. Annelida

B. Cnidaria

C. Porifera

D. Platyhelminthes

18. Which vessel carries deoxygenated blood?

A. The coronary artery

B. The pulmonary artery

C. The aorta

D. The pulmonary vein

19. William Harvey discovered that blood flows away from the heart in arteries and back to the heart in veins. What hypothesis could be developed from this discovery?

A. The human body contains both arteries and veins.

B. Blood vessels link up arteries to veins.

C. How blood moves from arteries into veins.

D. Veins are connected to the left side of the heart and arteries to the right side.

20. What name is given to the molecules that bind to foreign proteins that enter the body?

A. Antigens

B. Antibodies

C. Allergens

D. Antibiotics

21. Which muscles contract to cause air to pass out from the lungs through the bronchioles?

A. Internal intercostal muscles and diaphragm

B. Internal intercostal muscles and abdomen wall muscles

C. External intercostal muscles and diaphragm

D. External intercostal muscles and abdomen wall muscles

22. What causes a resting potential to develop in a neuron.

A. Diffusion of sodium and potassium ions

B. Active transport of sodium and potassium ions

C. Active transport of sodium and diffusion of chloride ions

D. Active transport of potassium ions and diffusion of chloride ions

23. The levels of hormones vary during the menstrual cycle in women. Each hormone reaches its maximum level at a different time in the cycle. In what sequence do the hormones reach their maximum level, if the cycle begins at the start of menstruation?

A. LH, progesterone, FSH, estrogen

B. FSH, progesterone, LH, estrogen

C. LH, estrogen, FSH, progesterone

D. FSH, estrogen, LH, progesterone

24. How is *in vitro* fertilization different from natural fertilization in humans.

A. *In vitro* fertilization involves artificial injection of sperm into the uterus

B. *In vitro* fertilization only involves one parent

C. *In vitro* fertilization happens outside the body

D. *In vitro* fertilization uses stem cells instead of eggs

25. What are pyrimidines in DNA?

A. Types of nucleotides

B. Types of base pairs

C. Types of sugars

D. Types of bases

26. Which enzyme removes the RNA primer during replication?

A. RNA primase

B. DNA polymerase I

C. DNA ligase

D. Helicase

27. Consider the metabolic pathway shown below.

$$V \xrightarrow{1} W \xrightarrow{2} X \xrightarrow{3} Y \xrightarrow{4} Z$$

If there is end-product inhibition, which product would inhibit which enzyme?

	Product	Enzyme
A.	X	4
B.	W	3
C.	W	2
D.	Z	1

28. What is the net production of ATP, per molecule of glucose during the fermentation of glucose to lactate?

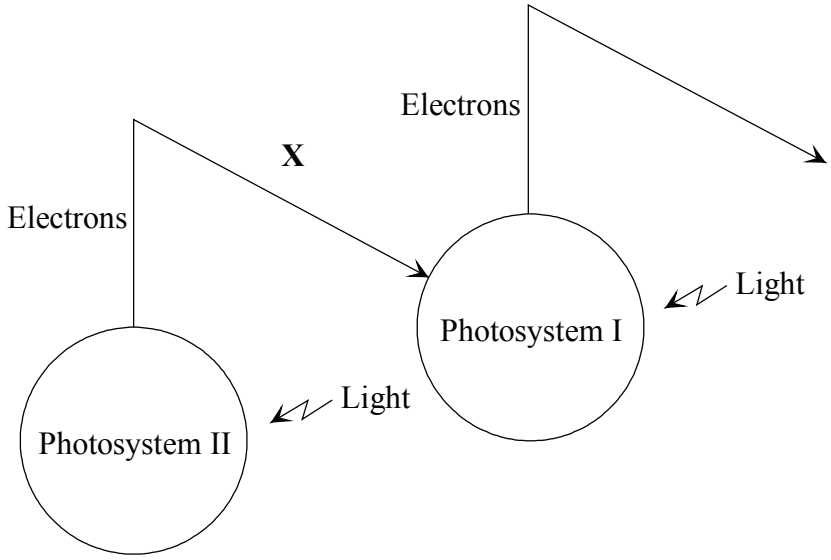
A. 36 molecules

B. 4 molecules

C. 2 molecules

D. None

29. The diagram below summarises the light-dependent reactions in photosynthesis. What is occurring at **X**?



A. ADP + phosphate → ATP

B. $NADP^{+} \rightarrow NADPH + H^{+}$

C. $H_2O \rightarrow O^{2-} + 2H^{+}$

D. $NADPH + H^{+} \rightarrow NADP^{+}$

30. What is the first identifiable product of carbon dioxide fixation in photosynthesis?

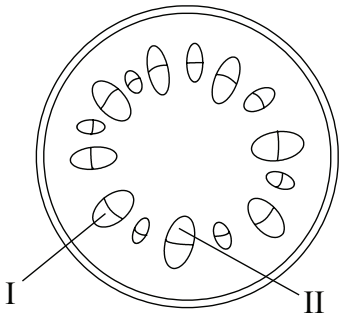
A. Ribulose biphosphate (RuBP)

B. Glycerate 3-phosphate (GP)

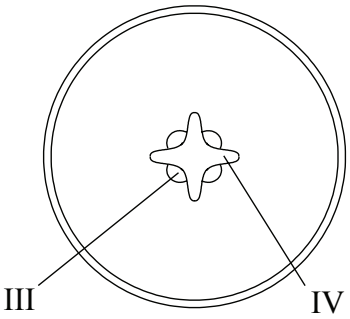
C. Triose phosphate (TP)

D. Acetyl CoA

31. The diagrams below show the distribution of tissues in the stem and root of a dicotyledonous plant. Which tissues are xylem?



Stem



Root

A. I and III

B. I and IV

C. II and III

D. II and IV

32. When a plant is transpiring, water rises up in the xylem vessels from the roots to the leaves. This flow of water is called the transpiration stream. What property of water is essential for the transpiration stream to happen?

A. When water evaporates it removes heat and therefore causes cooling.

B. Water is a good solvent so inorganic particles can be carried up in the transpiration stream.

C. Water has a high specific heat capacity.

D. Water molecules are cohesive and therefore can be pulled up.

33. What prevents a long day plant from flowering in winter?

A. Too much P_{fr} is converted to P_r at night

B. Too much P_{fr} is converted to P_r during the day

C. Too little P_r is converted to P_{fr} at night

D. Too little P_r is converted to P_{fr} during the day

34. Two genes, A and B, are linked together as shown below.

$$\frac{A\ b}{a\ B}$$

If the genes are far enough apart such that crossing over between the alleles occurs occasionally, which statement is true of the gametes?

A. All of the gametes will be Ab and aB.

B. There will be 25 % Ab, 25 % aB, 25 % ab and 25 % AB.

C. There will be approximately equal numbers of Ab and ab gametes.

D. The number of Ab gametes will be greater than the number of ab gametes.

35. What can be exchanged by crossing over?

A. Alleles can be exchanged between non-homologous chromosomes.

B. Alleles can be exchanged between non-homologous chromatids

C. Alleles can be exchanged between non-sister chromatids.

D. Alleles can be exchanged between sister chromatids.

36. Which is **not** true of active immunity?

A. It can be produced by exposure to a disease causing organism.

B. It can be produced artificially.

C. It can be produced by a virus.

D. It can be transferred via the colostrum.

37. What is a similarity between ligaments and tendons?

A. They are attached to bone at both of their ends.

B. They can resist tension forces without breaking.

C. They are non-living structures.

D. They secrete synovial fluid.

38. Where does vasopressin (ADH, anti-diuretic hormone) have its main effect in the kidney?

A. Proximal tubule

B. Bowman's capsule

C. Loop of Henle

D. Collecting duct

39. What is the function of Sertoli cells?

A. They nourish developing sperm.

B. They produce testosterone.

C. They nourish interstitial cells.

D. They form the basement membrane.

40. Which statement most accurately describes the acrosome reaction?

A. The release of enzymes which allow the sperm to reach the egg.

B. The release of carbohydrate which prevents the entry of sperm into the egg.

C. The release of carbohydrate which allows the sperm to reach the egg.

D. The release of enzymes which prevent entry of extra sperm into the egg.

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PROGRAMA DEL DIPLOMA DEL BI

SPEC/4/BIOLO/HPM/ENG/TZ0/XX/M

MARKSCHEME

SPECIMEN PAPER

BIOLOGY

Higher Level

Paper 1

2 pages

1.	B	16.	C	31.	D	46.	–
2.	C	17.	B	32.	D	47.	–
3.	D	18.	B	33.	A	48.	–
4.	D	19.	B	34.	D	49.	–
5.	D	20.	B	35.	C	50.	–
6.	D	21.	B	36.	D	51.	–
7.	B	22.	B	37.	B	52.	–
8.	B	23.	D	38.	D	53.	–
9.	A	24.	C	39.	A	54.	–
10.	D	25.	D	40.	A	55.	–
11.	C	26.	B	41.	–	56.	–
12.	D	27.	D	42.	–	57.	–
13.	C	28.	C	43.	–	58.	–
14.	D	29.	A	44.	–	59.	–
15.	D	30.	B	45.	–	60.	–

IB DIPLOMA PROGRAMME
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PROGRAMA DEL DIPLOMA DEL BI

BIOLOGY
HIGHER LEVEL
PAPER 2

Specimen Paper

2 hours 15 minutes

Candidate session number

0	0							

INSTRUCTIONS TO CANDIDATES

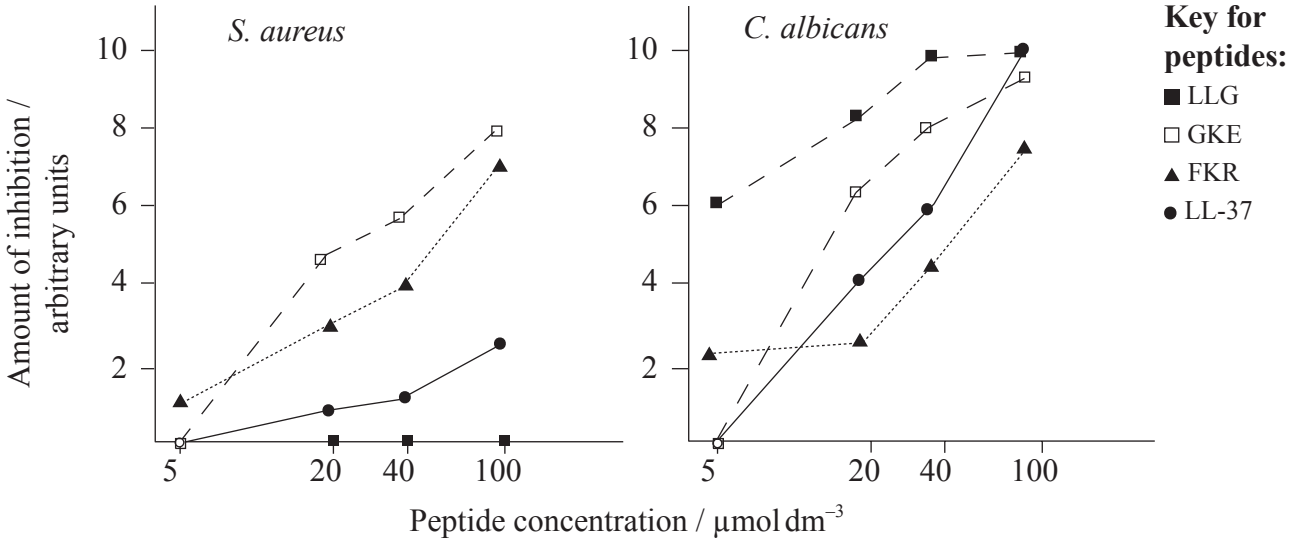
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all of Section A in the spaces provided.
- Section B: answer two questions from Section B. Write your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the numbers of the questions answered in the candidate box on your cover sheet and indicate the number of sheets used in the appropriate box on your cover sheet.

SECTION A

*Answer **all** the questions in the spaces provided.*

1. Antibiotic peptides occur naturally on the surface of human skin. One of these peptides, called LL-37, and three other similar synthetic peptides were investigated to assess both their antibiotic properties and effect on human cells.

The graphs show the antibiotic effect of the peptides against two microbes, *S. aureus* and *C. albicans*. The technique involves measuring the inhibition of growth of the microbes.



[Source: T Sigurdardottir, *et al.*, (2006), *Antimicrobial Agents and Chemotherapy*, **50** (9), pages 2983–2989]

(a) Describe the effect of the FKR on *C. albicans*. *[2]*

. . . . . .

. . . . . .

(b) Compare the effects of the peptide LLG on *S. aureus* and *C. albicans*. *[2]*

. . . . . .

. . . . . .

(c) Evaluate the effectiveness of LL-37 against the two microbes. *[3]*

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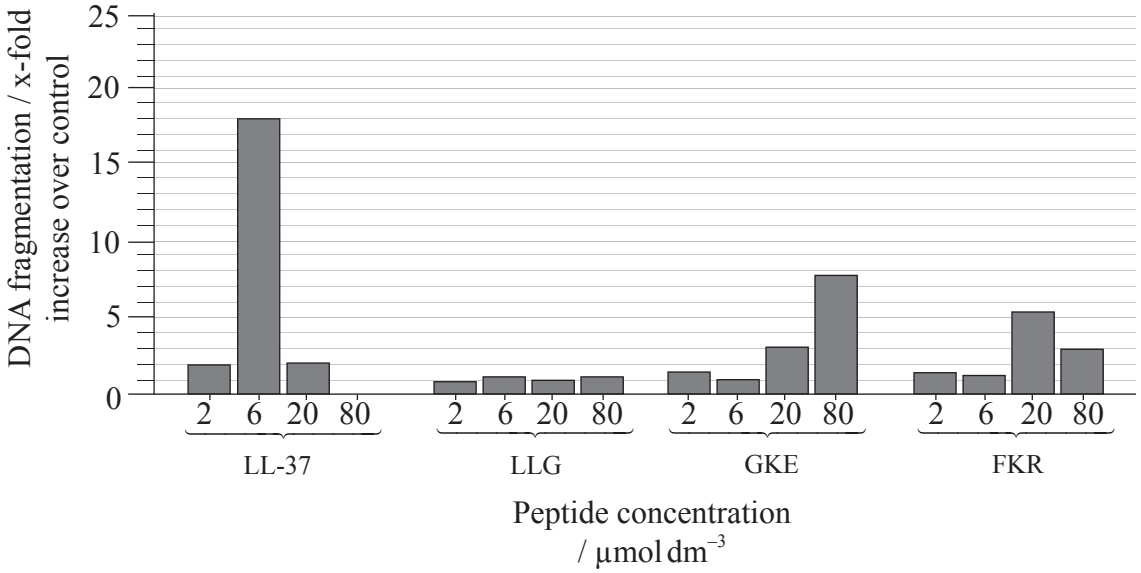
(This question continues on the following page)

(Question 1 continued)

There is concern that the peptides could damage living human cells. One form of damage is fragmentation of DNA. Human cells were incubated for 16 hours with each peptide at varying concentrations. The amount of DNA fragmentation was measured.



[Source: T Sigurdardottir, *et al*, (2006), *Antimicrobial Agents and Chemotherapy*, **50** (9), pages 2983–2989]

(d) State which peptide causes the least damage to DNA. *[1]*

. . . . . .

(e) Calculate the percentage increase in DNA damage that results when the concentration of LL-37 increases from 2 μmol dm^{-3} to 6 μmol dm^{-3}. Show your working. *[2]*

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(f) Discuss the hypothesis that synthetic peptides are most suitable for controlling *S. aureus* infection inside the human body. *[4]*

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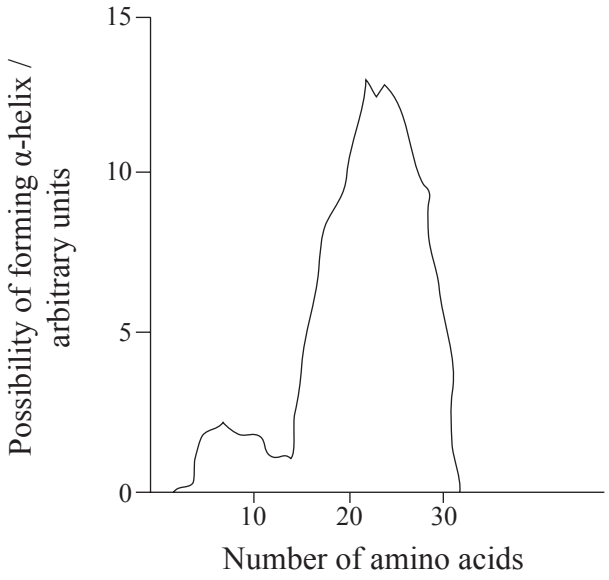
(This question continues on the following page)

(Question 1 continued)

The shape of the secondary structure of a peptide can be predicted from its amino acid composition. The figure shows the theoretical likelihood of the peptide LL-37 forming an α-helix, based on the properties and position of its 37 amino acids.



[Source: T Sigurdardottir, *et al.*, (2006), *Antimicrobial Agents and Chemotherapy*, **50** (9), pages 2983–2989]

(g) In addition to the α-helix, state a type of shape commonly formed as the secondary structure of proteins. *[1]*

. . . . . .

(h) Analyse the data to determine the region of LL-37 most likely to form a helical shape. *[2]*

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(i) Draw and label the structure of a peptide bond between two amino acids. *[2]*

2. (a) State **two** types of meristem found in plants. *[1]*

. . . . . .

. . . . . .

(b) Outline **two** differences in structure between monocotyledonous and dicotyledonous plants. *[2]*

Structure	Monocotyledonous	Dicotyledonous

(c) State **two** methods by which terrestrial plants support themselves. *[1]*

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. . . . . .

(d) Explain how auxin controls the response of a plant to light. *[3]*

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3. (a) State the **two** classes of compounds that compose chromosomes in animal cells. *[1]*

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(b) Outline how meiotic division results in almost an infinite genetic variation in the gametes produced. *[2]*

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(c) In a species of plant, tall is dominant to short and the production of round seeds is dominant to that of wrinkled seeds. The alleles are unlinked.

A plant heterozygous for both characteristics is crossed with a plant homozygous for tall with wrinkled seeds.

Use the letters:

T – allele for tall
t – allele for short
R – allele for round seed
r – allele for wrinkled seed.

Determine the phenotypes and genotypes of the offspring of this cross. *[2]*

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(d) State how chromosome number can increase in human beings. *[1]*

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SECTION B

*Answer **two** questions. Up to two additional marks are available for the construction of your answers. Write your answers on the answer sheets provided. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.*

4. (a) Draw a labelled diagram showing the structure of a motor neurone. *[4]*

(b) Outline how heartbeat is controlled as the body goes from rest to hard exercise. *[6]*

(c) Explain how skeletal muscle contracts. *[8]*

5. (a) Draw a labelled diagram showing the structure of a plasma membrane. *[4]*

(b) Outline the role of chlorophyll and the effects of temperature, light intensity and carbon dioxide concentration on the rate of photosynthesis. *[6]*

(c) Explain the production of energy during aerobic respiration from pyruvate that has been produced by glycolysis. *[8]*

6. (a) Draw a labelled graph showing a typical sigmoid growth curve. *[4]*

(b) Outline the consequences of an increased greenhouse effect on arctic ecosystems. *[6]*

(c) Explain how natural selection leads to evolution. *[8]*

7. (a) Draw a labelled diagram showing the structure of the digestive system. *[4]*

(b) Outline the need for enzymatic hydrolysis in the digestive process. *[6]*

(c) Explain how the kidney prevents the body from losing important materials absorbed from the digestive system. *[8]*

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SPEC/4/BIOLO/HP2/ENG/TZ0/XX/M

MARKSCHEME

SPECIMEN PAPER

BIOLOGY

Higher Level

Paper 2

8 pages

Section A

1. (a) at lower concentration inhibition is low;
as concentration rises from 5 – 20μmol dm^{-3} there is very little increase in inhibition;
from 20μ mol dm^{-3} inhibition increases in a linear manner;
a valid comparison with another of the peptides; ***[2 max]***

(b) no effect on *S. aureus*, inhibits growth of *C. albicans*;
no change on *S. aureus* as concentration increases, inhibition of *C. albicans* increases with concentration; ***[2]***

(c) at lowest (experimental) concentration (LL-37) does not have effect on either;
as concentration increases so does inhibition;
greater inhibition of *C. albicans*;
effective against *C. albicans* but not/less effective on *S aureus*; ***[3 max]***

(d) LLG ***[1]***

(e) $18 - 2 = 16$ / $\frac{16}{2} \times 100\%$ / $8 \times 100\%$;
800%; ***[2]***

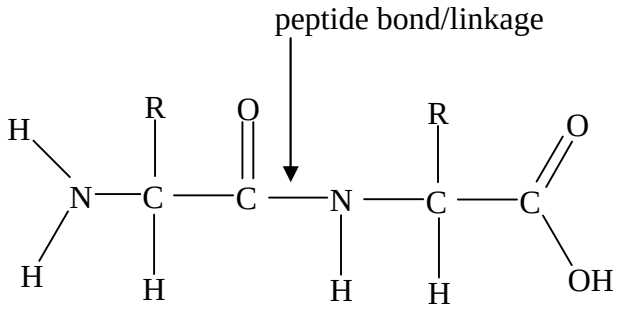
(f) LLG/naturally occurring peptide less effective;
LL-37 less effective than GKE/FKR;
LL-37 damages DNA (significantly) at more than 6μmol dm^{-3};
LL-37 may kill cells at higher concentrations;
GKE/FKR could be used at lower concentrations;
GKE/FKR cause slight DNA damage at lower concentrations;
GKE is (slightly) more effective;
GKE causes increased DNA fragmentation at higher concentrations; ***[4 max]***

(g) β-sheet / β-pleat ***[1]***

(h) sharp peak, strong chance around 20-25;
smaller peak, strong chance at around 4-6;
no likelihood above 32/33/at end of molecule;
appropriate description e.g. chance increases from 13/14 to 20/25; ***[2 max]***

(i) dipeptide showing N terminal and C terminal ends;
a hydrogen and an R group attached to each α carbon;
a link between the carbon of the C=O group of one amino acid and the nitrogen of the N-H of the other correctly labelled; ***[2 max]***

e.g.



2. (a) apical and lateral ***[1]***

(b)

Structure	*Monocotyledonous*	*Dicotyledonus*
leaf	parallel veins	branched (net of) veins;
seed	one cotyledon	two cotyledons;
flower	floral parts in multiple of 3	floral parts in multiple of 4 or 5;
stem	scattered vascular bundles	ring of vascular bundles around central pith;
root	adventitious roots	branched tap roots;

*Award **[1]** for each correct line* ***[2 max]***

(c) *Award **[1]** for any **two** of the following:*
cellulose cell wall / turgor / lignin / lignified xylem ***[1]***

(d) auxin produced at apical meristem/tip;
transported to growing area/zone of cell growth;
lateral transport to cells on shade side;
results in cell expansion;
shoot "grows" towards light source;
experimental detail; ***[3 max]***

3. (a) DNA and protein ***[1]***

(b) crossing over/chiasmata;
shuffles alleles;
random orientation of chromosomes;
at metaphase I:
at metaphase II; ***[2 max]***

(c) all four genotypes shown: TTRr, TTrr, TtRr, Ttrr;
phenotype individually identified/2 tall round and 2 tall wrinkled; ***[2]***
Cannot use genotype letters by themselves to mean phenotypes e.g. cannot state that the phenotype of a tall round plant is TR etc.

(d) non-disjunction ***[1]***

Section B

4. (a) *Award **[1]** for each of the following clearly drawn and correctly labelled.*
cell body - complete with nucleus and dendrites;
axon - shown longer than the longest dendrite, with the membrane drawn as a continuous line;
myelin sheath - surrounding the axon, showing nodes of Ranvier;
motor end plates - not covered by myelin sheath and ending in a button/dot; ***[4]***

(b) heart muscle is myogenic/pacemaker;
rise in CO_2 detected in medulla of brain;
nerve impulse sent to pacemaker;
sympathetic/parasympathetic control;
modifies heart beat;
SA node initiates contraction of atria;
impulses (from SA) cause AV node to contract ventricles;
transmitted through Purkinje fibres;
output rises;
CO_2 level falls;
Allow converse of above ***[6 max]***

(c) (skeletal) muscle is composed of myofibrils;
operational unit is a sarcomere;
viewed as a series of light and dark bands;
thin actin fibres;
thick myosin fibres;
arrival of action potential;
release of Ca^{2+};
from sarcoplasmic reticulum;
exposes binding sites of myosin fibres;
ATP used to break cross bridges between myosin and actin fibres;
hydrolysis of ATP resets myosin head;
causing sliding of actin and myosin; ***[8 max]***

5. (a) *Award **[1]** for each of the following clearly drawn and labelled correctly.*
a double layer of lipid/phospholipid molecules - with hydrophilic heads and hydrophobic tails;
an integral protein - passing completely through the lipid bilayer;
a peripheral protein - shown on the surface and not penetrating the lipid bilayer;
an integral protein with a pore passing through its entire length / a glycoprotein with the carbohydrate components shown/cholesterol as component in bilayer; ***[4]***

(b) chlorophyll is composed of a number of pigments;
absorb different colours of light;
mainly red and blue absorbed;
green light reflected;

temperature increases rate;
up to a point where enzymes denature;

light intensity increases rate;
up to a point where maximum absorbance can occur;

carbon dioxide increases rate;
up to a point where fixation is at a maximum; ***[6 max]***

(c) *Krebs cycle:**[3 max]***
in matrix of mitochondrion;
decarboxylation;
oxidation/removal of hydrogen by NAD and FAD;
substrate level phosphorylation;

*Electron transport chain:**[5 max]***
transfer of hydrogen to inner membrane carriers;
hydrogen ion pumped across inner membrane;
creates a concentration gradient;
electron transferred between carriers;
chemiosmosis;
hydrogen ion passes down concentration gradient;
through ATPase complex;
oxygen is final acceptor forming water; ***[8 max]***

6. (a) *Award **[1]** for each of the following clearly drawn and correctly labelled.*
clear ruled axes, labelled time on the *x*- and population size on the *y*- axis;
exponential phase annotated to indicate rapid population growth because of abundant resources;
transitional phase annotated to indicate a developing shortage of resources and increase competition between members of the population;
plateau phase annotated to indicate a population now constrained by resource availability / natality equals mortality; ***[4]***

(b) melting of permafrost;
increased detritus decomposition;
expansion of temperate species / reduced range for arctic species;
example of an affected species;
examples of human activity;
rise in sea levels;
change in climatic patterns;
loss of ice habitat;
more pests/pathogens;
disturbance to food chains/webs/trophic levels; ***[6 max]***

(c) parents produce more offspring than required to keep numbers constant;
more are produced that the environment can support;
example of an environmental condition;
these offspring show variation;
some are better adapted than others to the environment;
these tend to survive to breed themselves;
characteristics are inheritable;
so the new generation has these characters too;
this leads to changes in the population as a whole;
these changes constitute evolution; ***[8 max]***

7. (a) *Award **[1]** for each structure correctly drawn and labelled.*
esophagus – attached to both mouth and stomach;
stomach – j-shaped sac attached to esophagus and u-shaped portion of small intestine;
large intestine – wider diameter than small intestine, attached to small intestine;
pancreas – leaf-shaped, in u-shaped region of small intestine with small duct connected to small intestine;
liver – large, triangular, to left of stomach;
gall bladder – small sac drawn on top of liver with tube connected to small intestine at same region as duct from pancreas;
anus – at end of large intestine but narrower in diameter; ***[4 max]***

(b) large molecules cannot be absorbed;
mechanical digestion only to break down food physically;
enzymes breakdown large molecules into smaller ones (that can be absorbed);
need several enzymes as they are substrate specific;
enzymes speed up the rate of digestion considerably;
higher speeds at low/normal body temperature;
named example of enzyme;
example of named enzyme's action; ***[6 max]***

(c) important that some products of digestion not lost;
products in the blood stream;
ultrafiltration in the glomerulus;
fenestrated capillaries/podocytes;
basement membrane acts as the filter;
proteins too large to pass through;
importance of proximal convoluted tubule;
reabsorption of salts/glucose/ions/after named substance;
microvilli;
details of active transport;
osmosis is the reabsorption of water;
detail of osmoregulation; ***[8 max]***

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BIOLOGY
HIGHER LEVEL
PAPER 3

SPECIMEN PAPER

1 hour 15 minutes

Candidate session number

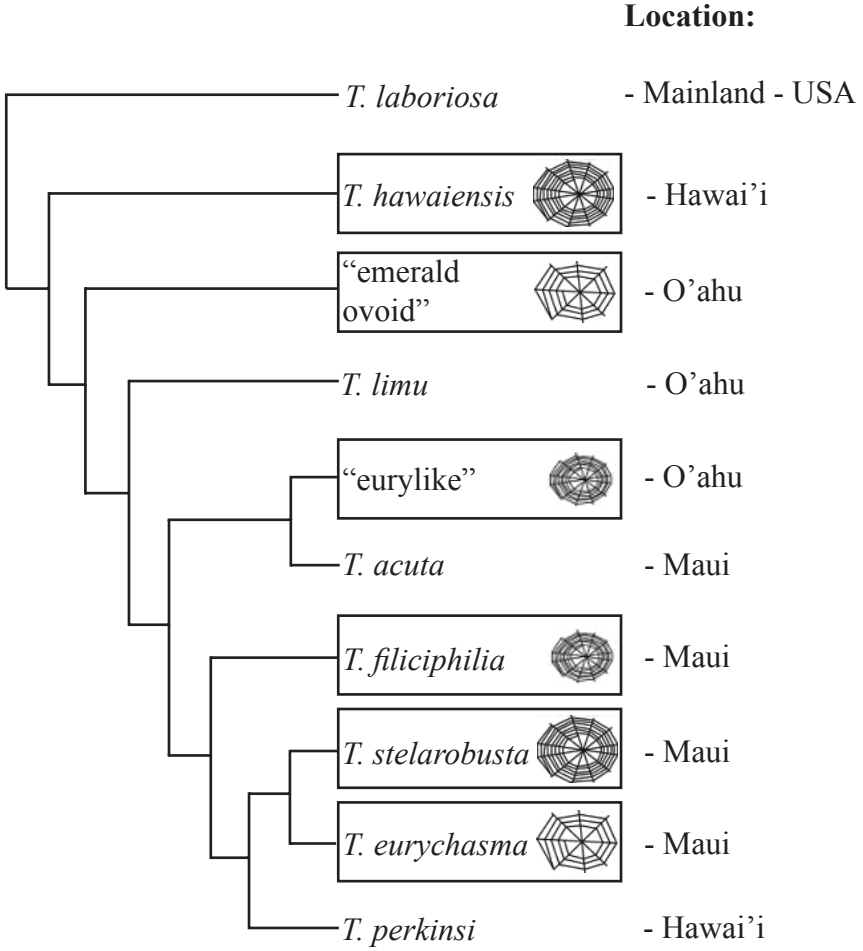
0	0							

INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the candidate box on your cover sheet and indicate the number of answer sheets used in the appropriate box on your cover sheet.

Option D — Evolution

D1. The cladogram below shows how closely related a group of species of spiders are on the Hawaiian island group. Two of the species have not been given a scientific name. Three pairs of the spiders spin very similar webs. These are shown on the diagram. The island on which the spider lives is also indicated.



[Source: T A Blackledge and R G Gillespie (November 2004), *Proceedings of the National Academy of Sciences*, **101**, (46), pages 16228–16233]

(a) Deduce whether spiders that spin similar webs or spiders that live on the same island are more closely related. *[2]*

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(This question continues on the following page)

(Question D1 continued)

(b) Mitochondrial DNA from the spiders was analyzed to produce the cladogram. Outline the method of analyzing the DNA to produce evidence for cladograms. *[3]*

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(c) Explain the evidence in the diagram for *[3]*

(i) convergent evolution

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(ii) adaptive radiation

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D2. (a) Outline properties of RNA that may have played a role in the development of life on this planet. *[2]*

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(b) State **two** types of molecules used in the experiments of Miller and Urey to simulate the atmosphere of pre-biotic earth. *[1]*

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(c) Outline the endosymbiotic theory. *[4]*

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D3. Discuss the correlation between change in the diet and increase in brain size in early hominid evolution. *[5]*

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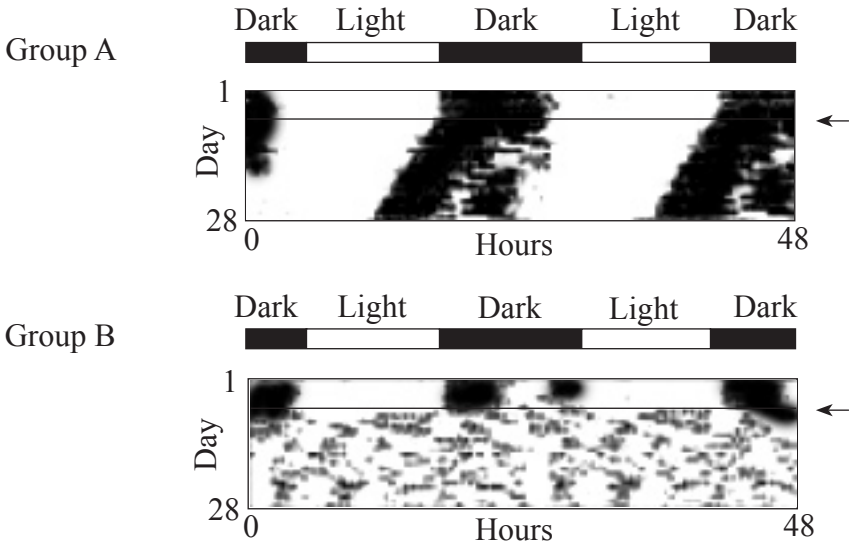
Option E — Neurobiology and behaviour

E1. Circadian rhythms are daily cycles in physiology and behaviours. Cryptochromes are proteins that are thought to be involved in circadian rhythm in mammals.

Two groups of mice were identified. Group A could produce cryptochrome, Group B could not. The behaviour of the mice was assessed by monitoring wheel running activity over a 28 day period. For the first seven days the animals were given alternating 12 hour periods of light and dark. Between day 8 and day 28 they were kept in continuous darkness.

The rotation of the running wheel is plotted as a dark area within the boxes, the time of day is plotted on the x-axis. The band on top indicates the dark and light periods in the first 7 days.



[Source: Aziz Sancar (August 2004), *The journal of Biological Chemistry*, **279**, (33), pages 34079–34082]

(a) (i) State the light conditions when mice were most active during the first 7 days. *[1]*

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(ii) Suggest **one** reason for mice showing this behaviour. *[1]*

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(b) Compare the effect of constant darkness on groups A and B. *[3]*

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(This question continues on the following page)

(Question E1 continued)

(c) Evalute the hypothesis that cryptochromes are necessary for establishing circadian rhythms. *[2]*

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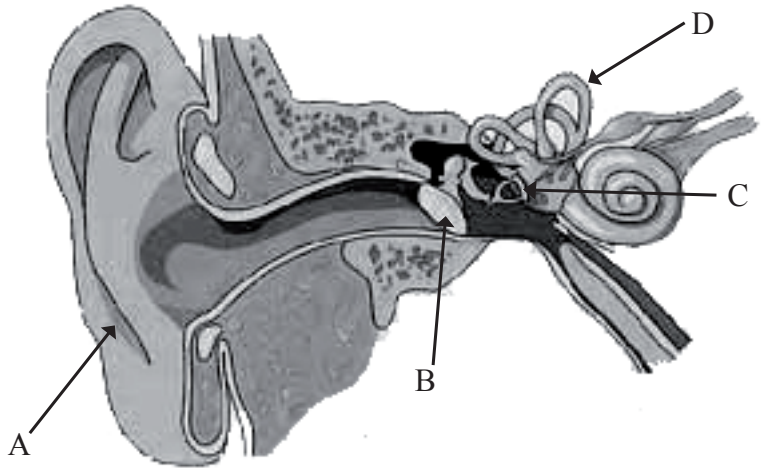
E2. (a) Label the diagram of the human ear shown below. *[2]*



[Source: www.msjensen.gen.umn.edu/webanatomy_archive/wa_nervous/wa_ear_1.html]

A: . . . . . .

B: . . . . . .

C: . . . . . .

D: . . . . . .

(b) Define the term *stimulus*. *[1]*

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(c) Outline the sympathetic and parasympathetic control of the heart rate. *[4]*

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E3. Discuss the evolution of altruistic behaviour in a non-human species. *[6]*

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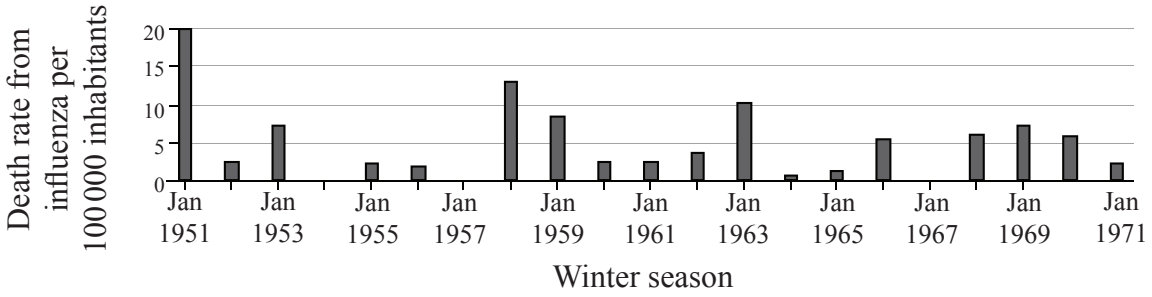
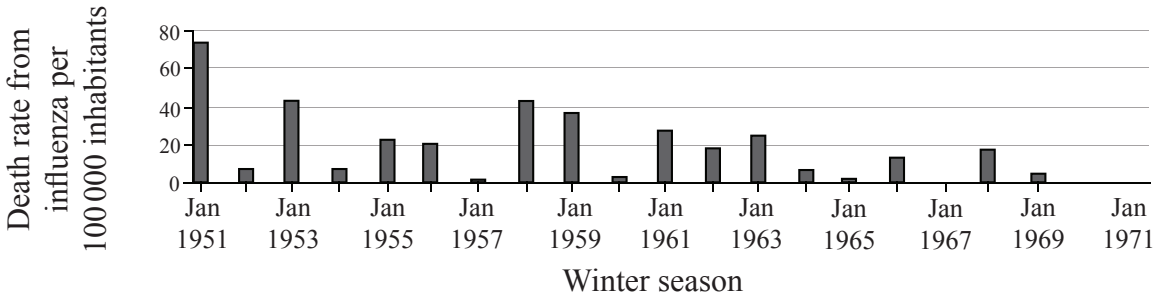
Option F — Microbes and biotechnology

F1. The diagrams show the death rate in January from influenza in Canada and the United Kingdom (U.K.). Canada is a very large, sparsely populated country. The United Kingdom is a densely populated island.

Canada



United Kingdom



[Source: G Vihoud, *et al*., (2006), *Emerging Infectious Diseases*, **12**, (4), pages 661–668]

(a) (i) Identify the year in which there were no observed deaths from influenza in **either** country. *[1]*

. . . . . .

(ii) Calculate the total number of deaths from influenza in 1968 in Canada assuming the population size was 19.8 million. *[1]*

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(b) Compare the death rates between Canada and the United Kingdom between 1953 and 1963. *[3]*

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(This question continues on the following page)

(Question F1 continued)

(c) Suggest **two** reasons for the differences in observed death rates in 1951 between Canada and the United Kingdom. *[2]*

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F2. (a) State **one** example of a microbial photoautotroph and a microbial chemoautotroph. *[1]*

Photoautotroph: . . . . . .

Chemoautotroph: . . . . . .

(b) Draw and label the nitrogen cycle. *[5]*

F3. (a) Describe the transmission of malaria. *[2]*

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(b) Discuss the prion hypothesis. *[5]*

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Option G — Ecology and conservation

G1. The timing of breeding in tree swallows (*Tachycineta bicolor*) was studied in the United States and Canada from 1959 to 1991. Figure A represents the mean egg laying date for each year. The date is indicated as number of days after January 1st. Figure B shows the correlation between mean May temperature (°C) and mean laying date over the same period.

Figure A

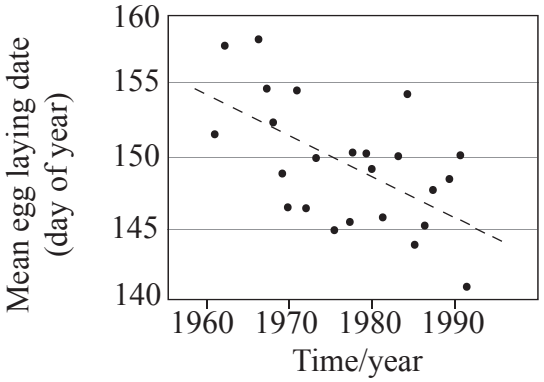
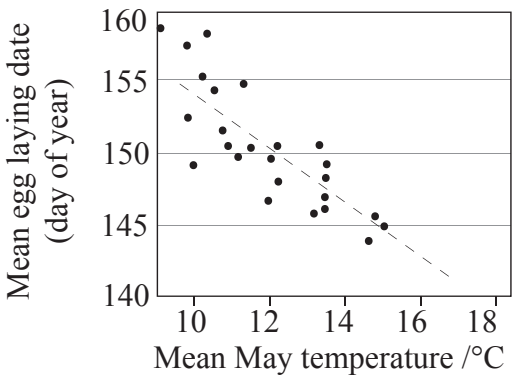


Figure B



[Source: www.pewclimate.org/docUploads/final%5FObsImpact%2Epdf]

(a) Identify the year with the earliest mean egg laying date. *[1]*

. . . . . .

(b) Outline the relationship between mean laying date and mean May temperature. *[1]*

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(c) Evaluate the evidence for global warming using figures A and B. *[2]*

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(This question continues on the following page)

(Question G1 continued)

(d) A change in mean laying date may increase competition with another species.

(i) State the competitive exclusion principle. *[1]*

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(ii) Apply the competitive exclusion principle to a change in mean laying date for the tree swallow. *[2]*

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G2. (a) Define *gross production*. *[1]*

. . . . . .

(b) Outline the characteristics of a desert biome. *[3]*

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G3. (a) Outline the factors that affect the distribution of animal species. *[5]*

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(b) Discuss the environmental conditions that favour r-strategies. *[4]*

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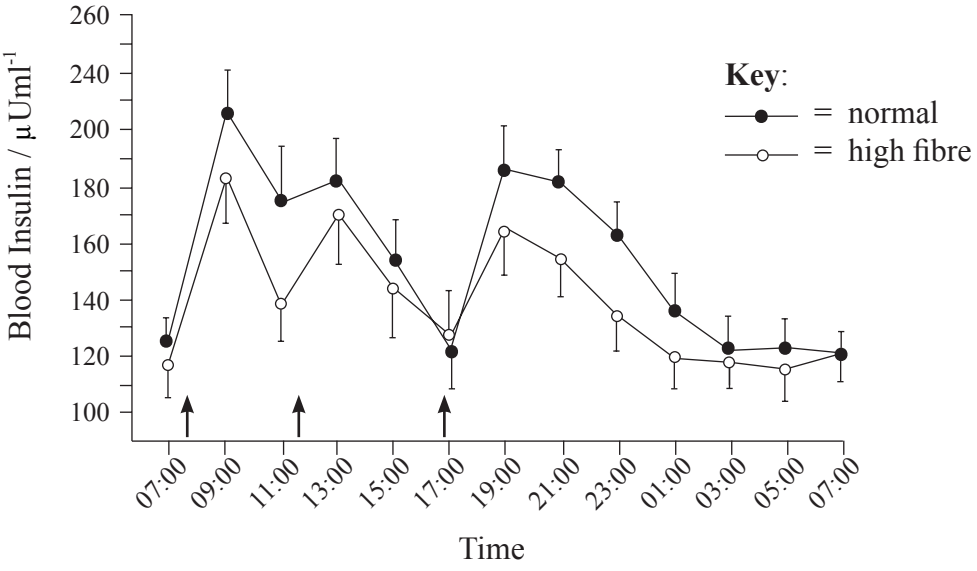
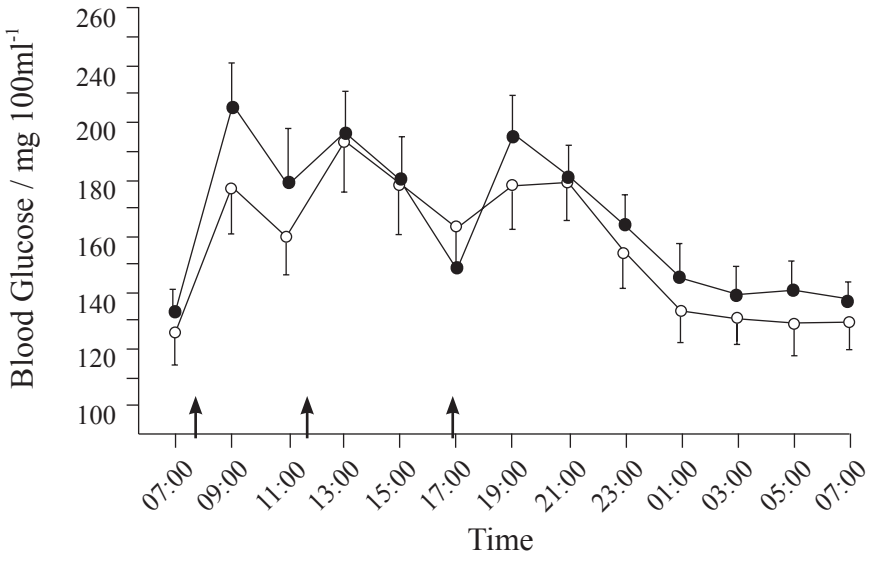
Option H — Further human physiology

H1. In North America normal diets are traditionally low in fibre. Scientists have proposed the hypothesis that people with diabetes benefit from a high fibre diet. The diagrams show the effect on blood glucose and blood insulin concentrations of a group of diabetic patients fed on a high fibre diet compared to a group of diabetic patients fed on a normal diet. The bars indicate standard error.





[Source: M Chandalia, *et al*., *The New England Journal of Medicine*, (2000), **342**, pages 1392–1398]

(This question continues on the following page)

(Question H1 continued)

(a) (i) Deduce, with a reason, what occurred at the times indicated by the arrows. *[1]*

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(ii) State the lowest blood glucose concentration in the normal diet. *[1]*

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(b) Compare the variation, over a 24 hour period, in both the blood glucose and insulin concentrations in the high fibre group. *[2]*

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(c) Evaluate the effect of the high fibre diet on lowering blood glucose and insulin levels in the two groups. *[3]*

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H2. (a) List **three** of the materials that are egested. *[1]*

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(b) Describe the process of erythrocyte and hemoglobin breakdown in the liver. *[4]*

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H3. (a) Distinguish between the mode of action of steroid and protein hormones. *[2]*

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(b) Explain the events of the cardiac cycle including systole, diastole and heart sounds. *[6]*

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SPEC/4/BIOLO/HP3/ENG/TZ0/XX/M

MARKSCHEME

SPECIMEN PAPER

BIOLOGY

Higher Level

Paper 3

11 pages

Option D — Evolution

D1. (a) on Maui *T.stelarobusta* and *T. eurychasma* are closely related based on the cladogram (but they produce different webs);
distantly related spiders, *e.g. T. hawaiensis* and *T. stelarobusta* produce similar webs but are on different islands;
suggesting island is better indicator for relatedness than webs;
data inconclusive / more studies needed; ***[2 max]***

(b) (mt) DNA is isolated from organism/species;
(mt) DNA is sequenced/order of bases determined;
(mt) DNA sequence is compared between organisms/species;
more similarities between sequences signify more closely related/ recent divergence;
fewer similarities between sequences signify less relatedness/more distant divergence;
cladograms are calculated by software that depicts the cladogram with the fewest number of branches;
for rooting the cladogram an outgroup/distantly related species is used; ***[3 max]***

(c) (i) *Award **[2]** max*
Definition of convergent evolution: independent evolution of similar traits in response to similar environments;
Evidence for: T. stelarobusta (Maui) and *T. hawaiensis* (Hawai'i) produce the same type of web;
T.filiciphilia (Maui) and "eurylike" (O'ahu) also produce similar webs;

(ii) *Definition of adaptive evolution:* rapid speciation to fill ecological niches;
Evidence for: on Maui, all three T. species present produce three different kinds of webs; ***[3 max]***

D2. (a) autocatalytic/can function as an enzyme;
can function as genetic material;
can (self)replicate; ***[2 max]***

(b) *Award **[1]** for any two of the following:*
CH_4 / H_2 / NH_3 / H_2O ***[1 max]***
Accept symbol chemical formulae or words.

(c) describes the origin of eukaryotic cells;
endosymbionts live within larger host cells;
eukaryotic cells contain mitochondria and/or chloroplasts;
mitochondria and chloroplasts have evolved from independent free living organisms (bacteria);
these organisms were taken into a larger heterotrophic cell by endocytosis;
not digested but cells were kept alive and continued to carry out aerobic respiration and photosynthesis; ***[4 max]***

D3. (a) tool making first associated with *H. habilis*;
requires larger brain;
brain requires vast amounts of energy / consumes 40% of energy intake;
so larger brain size had an effect on diet requirements / created a demand for changes in diet;
food scarcity may lead to decrease in brain size;
change to higher calorific diet may allow increase in brain size;
more complex tool making/human society/language development required larger brain size;
larger brain/better cognitive skills allowed for better hunting and gathering;
led to greater calorific intake;
about 2.5 MYBP (million years before present) animal foods began to occupy an increasingly prominent place in diet;
animal tissues can provide the necessary structural lipid for human brain expansion;
changes in the dental fossil record are indirect evidence for such a change in diet; ***[5 max]***

Option E — Neurobiology and behaviour

E1. (a) (i) dark ***[1]***

(ii) because they are nocturnal / to avoid predation by being active at night ***[1]***

(b) group A is able to maintain a rhythm while group B is not;
group B is active more frequently than group A;
group B is active for a shorter period than group A; ***[3]***

(c) (before constant darkness) group B had a rhythm suggesting cytochromes are not necessary;
(after constant darkness) group B were unable to re-establish a rhythm suggesting cytochromes are necessary;
cytochromes involved along with other variables; ***[2 max]***

E2. (a) A: pinna;
B: eardrum;
C: stapes/bones of the middle ear;
D: semicircular canals; ***[2 max]***
*Award **[2]** for 4 correct answers, **[1]** for three correct answers, **[0]** for two or one correct answer(s)*

(b) (a stimulus is) a change in the environment (internal or external) that is detected by a receptor and elicits a response ***[1]***

(c) the sympathetic and parasympathetic systems are part of the ANS;
the sympathetic and parasympathetic systems are antagonistic;
the sympathetic system accelerates the heart rate and stimulates glucose release (from the liver);
more blood is pumped to the muscles and the intestines;
the sympathetic system (mostly) uses norepinephrine (noradrenaline);
the parasympathetic system slows down heart rate and stimulates the stomach and the intestines;
body relaxes and blood flow slows down;
the parasympathetic system (mostly) uses acetylcholine; ***[4 max]***

E3. altruistic behaviour may be harmful to the animal itself but beneficial to other animals;
occurs in social animals;
usually occur in the same species;
need not happen between genetically related animals from one population;
altruistic behaviour often occurs in animals which are genetically closely related;
altruistic behaviour may increase the survival rate of the group and thus the species;
helping close relatives or siblings increases the chances of passing on genes to the next generation;
due to natural selection;
this is called inclusive fitness;
enhancing reproductive success of relatives is called kin selection;
if altruism was a negative trait it would/may have disappeared;
altruistic species do just as well as non altruistic species belonging to the same order; ***[6 max]***

Option F — Microbes and biotechnology

F1. (a) (i) 1967 ***[1]***

(ii) (death rate = 5 per 100,000 / yr, total number of deaths would be 5 times 198) = 990 deaths ***[1]***

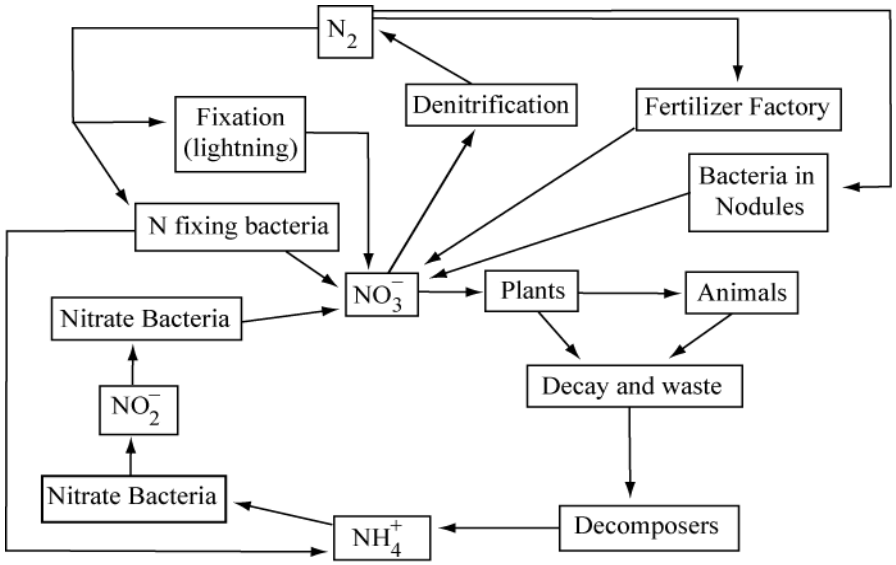
(b) death rate in Canada is always lower than United Kingdom;
highest death rate in United Kingdom approx 40 per 100,000 whereas in Canada never above 15;
no death from influenza recorded in Canada in 1957 but some in the United Kingdom;
highest death rate for United Kingdom recorded in 1953 but in Canada in 1958;
both countries have very low/zero death rate in 1954 and 1957;
between 1953 to 1963 patterns are very similar; ***[3 max]***

(c) higher population density in United Kingdom facilitated spread;
may not have been the same viral strain that caused the epidemic / viral strain may have mutated;
UK population had more elderly people than Canadian population;
winters more severe in Canada so people are inside more and thus less contact;
winter clothes prevent spread of virus;
winter in the U.K. may have been particularly harsh;
differences in the (genetically) susceptibility; ***[2 max]***

F2. (a) *Award **[1]** if both correct answers given* ***[1 max]***

Photoautotroph	*Cyanobacteria*; classes: *Chroobacteria* / *Hormogoneae* / *Gloeobacteria*; orders: *Chroococcales / Gloeobacterales / Nostocales / Oscillatoriales / Pleurocapsales* / *Stigonematales*; families: *Prochloraceae* / *Prochlorotrichaceae;* genera: *Halospirulina / Planktothricoides / Prochlorococcus / Prochloron / Prochlorothrix*;
Chemoautotroph	*Methanobacteria* / *Methanococci* / *Methanopyri* / *Halobacteriaceae* / Sulfur-reducing bacteria / thermoacidophile;

(b)



[5 max]

*Award **[1]** for any **two** correctly labeled and connected boxes*

F3. (a) protozoan parasite, *Plasmodium falciparum*, has insect host Anopheles mosquito;
a mosquito bites infected human/human suffering from malaria and ingests (gametocytes) parasite;
parasite has a (sexual) life cycle in mosquito / produces sporocytes;
when mosquito bites another human it injects parasite into bloodstream;
human falls ill with malaria and produces parasites in bloodstream; ***[2 max]***

(b) prions are infectious proteins/proteinaceous particles;
transmission can be by eating contaminated food;
prions cause a number of degenerative brain diseases;
Creutzfeld – Jakob disease in humans / scrapie in sheep / mad cow disease (BSE, bovine spongiform encephalopathy) in cattle;
prions are formed from naturally occurring proteins found in brain cells;
can occur in two forms / PrP^{sc} and PrP^{c};
PrP^{sc} is the misfolded form/different conformation, and PrP^{c} is the normal form/wild type;
PrP^{sc} can act as a mould and cause PrP^{c} to misfold;
PrP^{sc} is the cause of the degenerative brain diseases;
PrP^{c} is a protein occurring naturally in brain cell membranes;
function of PrP^{c} is unknown;
PrP^{sc} is resistant to proteases/high temperatures; ***[5 max]***

Option G — Ecology and conservation

G1. (a) 1991 ***[1]***

(b) as mean temperature goes up, earlier mean laying date ***[1]***

(c) trend for egg laying being earlier over study period (in figure A);
higher temperatures lead to earlier egg laying;
egg laying correlated with warmer temperature;
data highly variable / evidence is indirect; ***[2 max]***

(d) (i) only one species can occupy a niche within an ecosystem / niches in an ecosystem will not overlap in the long term ***[1]***

(ii) earlier egg laying date means that parents may compete for food/nesting materials/nesting sites with other species or any example of how change may cause niche to overlap;
tree swallow may expand range northward to hatch on the same day/tree;
tree swallow may cause a decline in population of species that now overlaps niche / tree swallow may decline in population because of overlapping niche or any example which shows the consequence of overlapping niche; ***[2 max]***

G2. (a) (gross production =) net production + respiration;
(gross production is) the total amount of organic matter produced by plants in an ecosystem; ***[1 max]***

(b) temperature is high during daytime and low during night time;
solar radiation during day is high / heat loss during night is high;
moisture is less than 500 mm rainfall per annum;
vegetation is sparse;
fauna is specialized; ***[3 max[***

G3. (a) distribution is the range of places that an animal inhabits;
is closely linked to the levels of the abiotic and biotic factors of that environment;
main abiotic factors are water, temperature;
other factors include breeding sites, food supply and territory;
temperature, extremes of temperatures require special adaptations;
water, some animals are aquatic and some live in deserts;
breeding sites, special sites are needed to ascertain survival of offspring;
food supply, availability of special foods limits range of habitation;
territory, has an effect on the distribution of a species clumped rather than dispersed; ***[5 max]***

(b) r- strategists are usually small organisms that are found in an unstable environment;
little advantage in adaptations that permit successful competition as the environment is likely to change quickly;
are density independent;
environment should have ample supply of energy;
many offspring are produced so habitat should be able to support that;
early maturity so climate should favour this, *e.g.* short spring season in the artic regions;
short life expectancy so offspring also has a chance of survival; ***[4 max]***

Option H — Further human physiology

H1. (a) (i) patients were fed / plasma glucose/blood insulin levels start to rise after intake of food ***[1 max]***

(ii) 147 (±1) mg $100ml^{-1}$ (*units required*) ***[1]***

(b) both glucose and insulin rise after a meal/at specific times during the day;
both have a trough at 11:00 and 17:00 and end concentrations almost the same; ***[2]***

(c) blood insulin and glucose seem to have been lowered by the high fibre diet;
more pronounced decrease of concentration after morning meal/8 am than after dinner/5 pm;
less fluctuation in insulin and glucose levels in the high fibre diet;
effect of high fibre seems to persist even when no food is consumed/after 1 am;
standard error for most data points is such that no valid conclusion can be drawn; ***[3 max]***

H2. (a) *Award **[1]** for **three** of the following*
cellulose / lignin / bile pigments / bacteria / intestinal cells ***[1]***

(b) erythrocytes rupture when they reach the end of their life span/after 120 days;
absorbed by phagocytosis/Kupffer cells in liver from blood;
hemoglobin split into globin and heme groups;
iron removed from heme leaving bile pigment/bilirubin;
bilirubin released into alimentary canal;
digestion of globin to produce amino acids; ***[4 max]***

H3. (a)

protein hormones	*steroid hormones*
do not enter cells/do not pass through plasma membrane	pass through plasma membrane;
bind to receptors on the outside of the cell	form complex with cytoplasmic receptors;
causes release of a secondary messenger inside the cell	can act as transcriptional regulators;

[2 max]

H3. (b) SA (sino atrial) node/pacemaker receives signal to fire;
when ventricle 70 %/almost full;
AV (atrio ventricular) valve opens and blood fills ventricle (to maximum)/ atrial systole;
pressure increase in ventricle closes AV valve/ventricular systole;
AV node fires;
Purkinje fibres carry impulses to all areas of ventricles for simultaneous firing;
pressure increase causes semilunar valve to open;
blood pumped from ventricle to aorta / systole sound / ventricular diastole;
pressure lowers in ventricle closing semilunar valve / diastole sound;
pressure in ventricle lower than atria so AV valve opens;
increases blood ventricular volume;
both atria and ventricles are relaxed/diastole;
atria receive blood from veins;
cycle repeats; ***[6 max]***

IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

BIOLOGY
STANDARD LEVEL
PAPER 1

SPECIMEN PAPER

45 minutes

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.

1. What do error bars on graphs show?

A. If the data is correct or not.

B. How variable the data is.

C. Which result is closest to the true result.

D. What statistical technique was used to eliminate incorrect results.

2. What is the correct order of increasing size for the following biological structures?

I. The width of a virus
II. The width of a bacterium
III. The thickness of a cell surface membrane
IV. The diameter of a eukaryotic cell

A. I → III → II → IV

B. I → III → IV → II

C. III → I → II → IV

D. III → II → I → IV

3. Which of the following structures are present in **both** plant and animal cells?

I. Cell wall
II. Chloroplast
III. Mitochondrion

A. I only

B. I and II only

C. I and III only

D. III only

4. In viewing an electron micrograph of a cell, ribosomes, pili and a single circular chromosome are observed. What other structure is likely to be present?

A. The rough endoplasmic reticulum (rER)

B. Mitochondria

C. A nuclear membrane

D. A plasmid

5. The DNA of a particular cell is damaged, so that the cell continues to divide uncontrollably. What is the possible result?

A. Coronary heart disease

B. AIDS

C. Tumour formation

D. Down syndrome

6. What is produced as a result of mitosis?

A. Two cells, each containing half the number of chromosomes of the original cell

B. Two cells, each containing the same number of chromosomes as the original cell

C. Four cells, each containing the same number of chromosomes as the original cell

D. Four cells, each containing half the number of chromosomes of the original cell

7. Carbon, hydrogen, nitrogen and sulphur are elements found in living cells. Which is the least common?

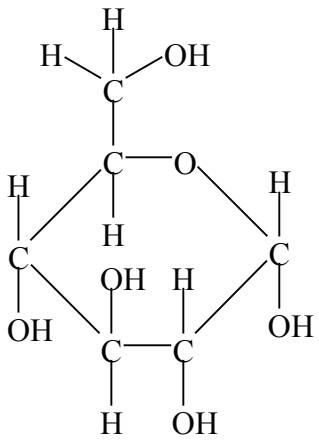
A. Carbon

B. Hydrogen

C. Nitrogen

D. Sulphur

8. Which of the following terms correctly describe the molecule below?



I. Monosaccharide

II. Ribose

III. Carbohydrate

A. I only

B. I and III only

C. II and III only

D. I, II and III

9. A certain gene in a bacterium codes for a polypeptide that is 120 amino acids long. How many nucleotides are needed in the mRNA to code for this polypeptide?

A. 30

B. 40

C. 360

D. 480

10. What enzyme is used in transcription but **not** in translation?

A. DNA polymerase

B. Helicase

C. Protease

D. RNA polymerase

11. Humans can respire aerobically and anaerobically. Which are products of **both** aerobic cell respiration and anaerobic cell respiration **in humans**?

A. Pyruvate and ATP

B. Pyruvate and lactate

C. ATP and carbon dioxide

D. Lactate and carbon dioxide

12. Which two colours of light does chlorophyll absorb most?

A. Red and yellow

B. Green and blue

C. Red and green

D. Red and blue

13. How are plasmids used in biotechnology?

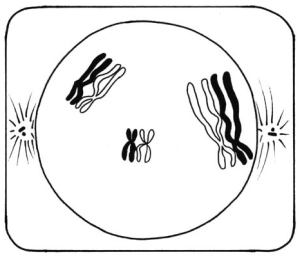
A. For respiration in prokaryotes

B. For photosynthesis in eukaryotes

C. For protein synthesis in prokaryotes and eukaryotes

D. For gene transfer

14. The diagram below shows the cell of an organism going through the first division of meiosis.



How many different combinations are possible for these chromosomes in the haploid cells formed by meiosis?

A. 2

B. 6

C. 8

D. 9

15. If the amount of DNA in a haploid gamete is represented by ×. What is the quantity of DNA in a cell from the same organism at the start of meiosis?

A. 0.5 ×

B. ×

C. 2 ×

D. 4 ×

16. A parent organism of unknown genotype is mated in a test cross. Half of the offspring have the same phenotype as the parent. What can be concluded from this result?

A. The parent is homozygous dominant for the trait.

B. The trait being inherited is polygenic.

C. The parent is heterozygous for the trait.

D. The parent is homozygous recessive for the trait.

17. If a man has blood group O and a woman has blood group AB, what is the probability that their child will be blood group O?

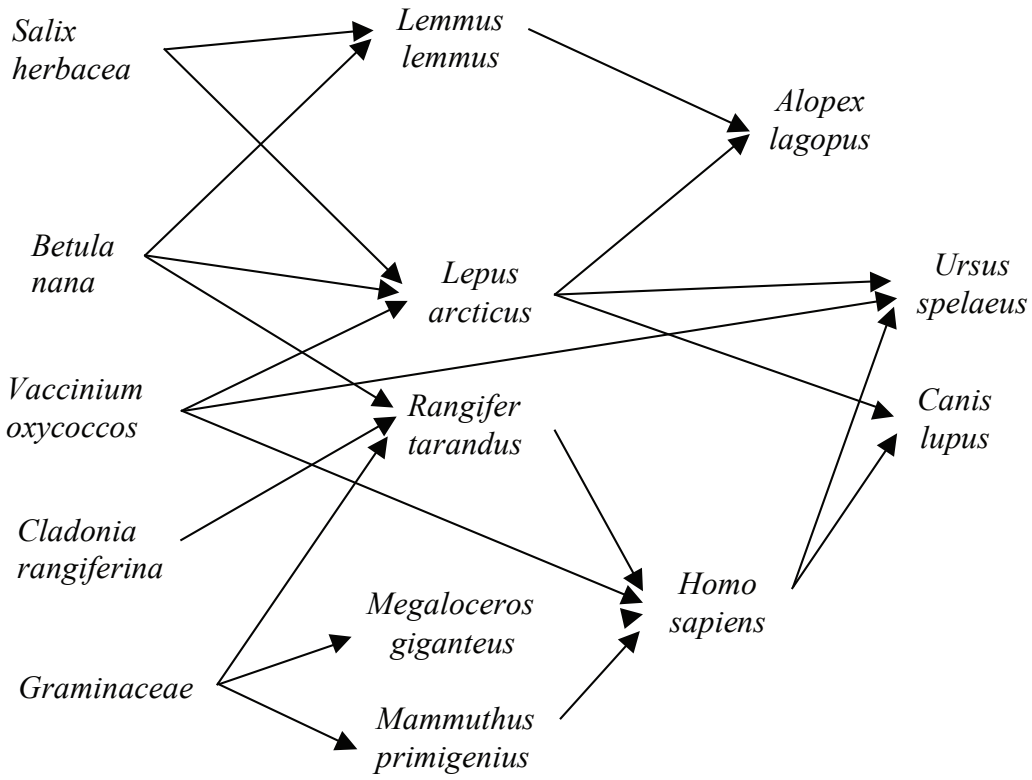
A. 0%

B. 25%

C. 50%

D. 100%

18. The food web below shows a community in central France 24 000 years ago.



Which statement is a correct description of *Ursus spelaeus*?

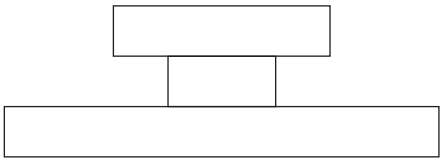
A. It is an omnivore which feeds on *Lemmus lemmus*.

B. It is a producer preyed upon by *Vaccinium oxycoccos*.

C. It is a top carnivore and a primary consumer.

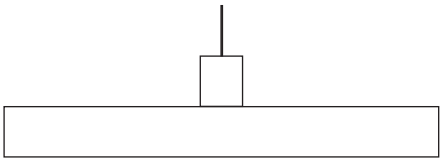
D. It is a decomposer and it competes with *Rangifer tarandus*.

19. Which diagram shows the flow of energy through a community with three trophic levels?

A. 

B. 

C. 

D. 

20. According to the precautionary principle, what should happen if there are fears that eating a food might cause a health problem?

A. People should be warned about the possible health problem.

B. The company producing the food should be warned about the possible health problem.

C. People who have fears about the food should test it to see if it causes a real health problem.

D. The company producing the food should test the food to prove that it does not cause a health problem.

21. If natality is slightly larger than mortality, and immigration is much larger than emigration, what will happen to the size of a population?

A. It will increase

B. It will decrease

C. It will fluctuate up and down

D. It will remain constant

22. Which process has the greatest effect in determining which members of a population are most likely to survive until reproductive age?

A. Evolution

B. Natural selection

C. Meiosis

D. Hybridization

23. In the hierarchy of taxa, what is in a family?

A. A group of classes

B. A group of genera

C. A group of orders

D. A group of phyla

24. What does the digestion of starch by amylase produce?

A. Lactose

B. Sucrose

C. Galactose

D. Maltose

25. Which vessel carries deoxygenated blood?

A. The coronary artery

B. The pulmonary artery

C. The aorta

D. The pulmonary vein

26. William Harvey discovered that blood flows away from the heart in arteries and back to the heart in veins. What hypothesis could be developed from this discovery?

A. The human body contains both arteries and veins.

B. Blood vessels link up arteries to veins.

C. How blood moves from arteries into veins.

D. Veins are connected to the left side of the heart and arteries to the right side.

27. Which factors related to mucous membranes protect the body against microbes?

I. Production of lysozyme

II. Secretion of alkaline solutions

III. Trapping of microbes

A. I and II only

B. II and III only

C. I and III only

D. I, II and III

28. Capillaries surround the alveoli in the lungs. Which pair of statements correctly describes the concentrations of oxygen and carbon dioxide in the lungs?

	Oxygen	**Carbon dioxide**
A.	Higher in the capillaries	Higher in the alveoli
B.	Lower in the capillaries	Higher in the alveoli
C.	Lower in the alveoli	Higher in the capillaries
D.	Higher in the alveoli	Higher in the capillaries

29. What causes a resting potential to develop in a neuron?

A. Diffusion of sodium and potassium ions

B. Active transport of sodium and potassium ions

C. Active transport of sodium and diffusion of chloride ions

D. Active transport of potassium and diffusion of chloride ions

30. What are the levels of the hormones estrogen, progesterone, LH and FSH during the menstrual cycle at the time of ovulation?

	Estrogen	**Progesterone**	**LH**	**FSH**
A.	High	Low	High	High
B.	High	High	Low	High
C.	Low	High	High	Low
D.	Low	Low	Low	Low

IB DIPLOMA PROGRAMME
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PROGRAMA DEL DIPLOMA DEL BI

SPEC/4/BIOLO/SPM/ENG/TZ0/XX/M

MARKSCHEME

SPECIMEN PAPER

BIOLOGY

Standard Level

Paper 1

2 pages

1.	B	16.	C	31.	–	46.	–
2.	C	17.	A	32.	–	47.	–
3.	D	18.	C	33.	–	48.	–
4.	D	19.	D	34.	–	49.	–
5.	C	20.	D	35.	–	50.	–
6.	B	21.	A	36.	–	51.	–
7.	D	22.	B	37.	–	52.	–
8.	B	23.	B	38.	–	53.	–
9.	C	24.	D	39.	–	54.	–
10.	D	25.	B	40.	–	55.	–
11.	A	26.	B	41.	–	56.	–
12.	D	27.	C	42.	–	57.	–
13.	D	28.	D	43.	–	58.	–
14.	C	29.	B	44.	–	59.	–
15.	D	30.	A	45.	–	60.	–

IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

BIOLOGY
STANDARD LEVEL
PAPER 2

SPECIMEN PAPER

1 hour 15 minutes

Candidate session number

0	0							

INSTRUCTIONS TO CANDIDATES

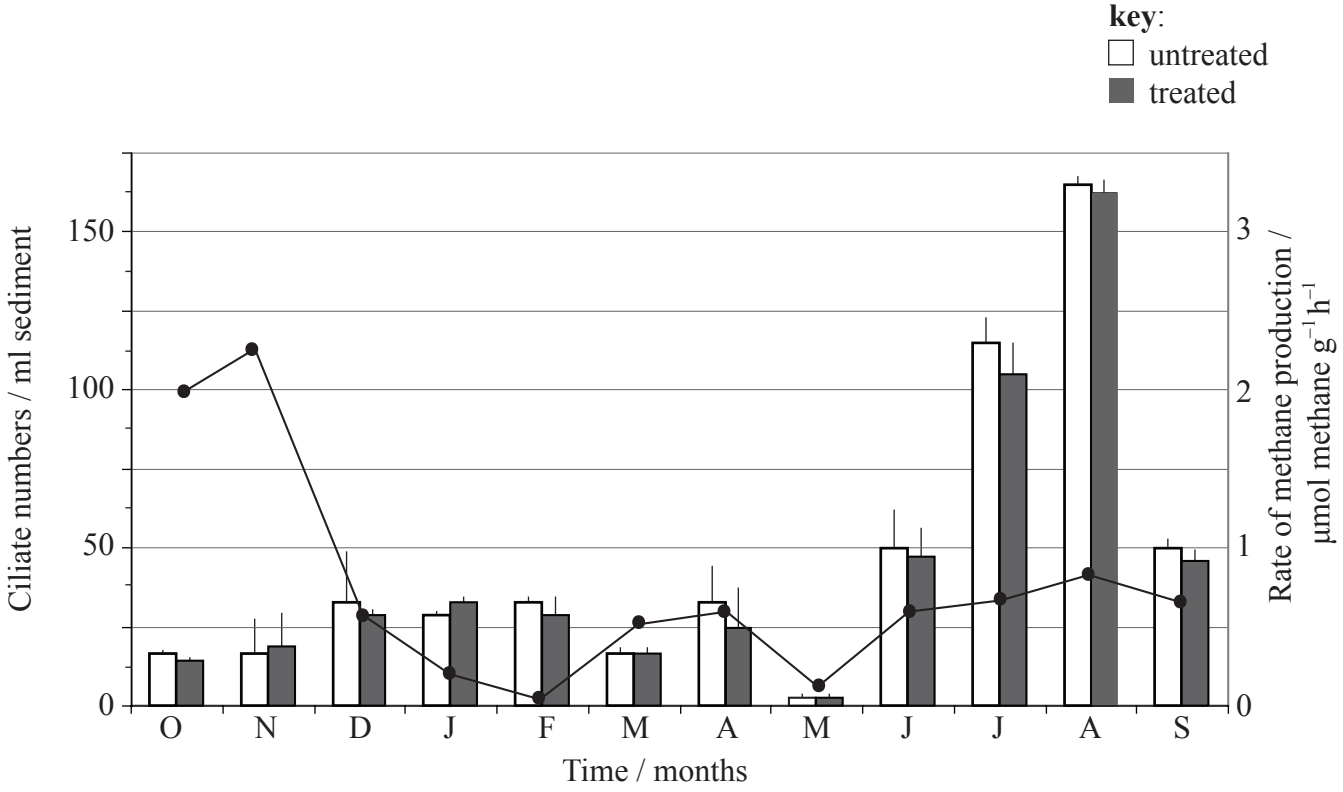
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all of Section A in the spaces provided.
- Section B: answer one question from Section B. Write your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the numbers of the questions answered in the candidate box on your cover sheet and indicate the number of sheets used in the appropriate box on your cover sheet.

SECTION A

*Answer **all** the questions in the spaces provided.*

1. Methane produced by anaerobic bacteria contributes substantially to atmospheric methane concentration. These bacteria are found in a variety of habitats. Some live inside the cytoplasm of larger unicellular organisms and are known as endosymbionts. In marine sediments, endosymbionts living in the cytoplasm of a group of unicellular organisms, known as ciliates, can contribute up to 90% of methane production.

To see if endosymbionts in freshwater sediments had the same effect on methane production a one-year study was carried out in Holland. The graph below shows the rate of methane production by untreated sediment samples and sediment samples treated to kill the ciliates containing endosymbionts. The standard deviations are indicated by bars. The total number of ciliates is also indicated by circles.



[Source: AHAM van Hoek, *et al.*, *Acta Protozoologica*, (2006), **45**, pages 215–224]

(a) State what the standard deviation indicates. *[1]*

. . . . . .

. . . . . .

(b) State the maximum number of ciliates and the month in which the maximum occurs. *[1]*

. . . . . .

(This question continues on the following page)

(Question 1 continued)

(c) Compare the methane production in the untreated and treated samples. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(d) Deduce, with reasons, whether the endosymbionts in the ciliates are responsible for the methane produced by the sediment samples. *[2]*

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(e) Explain how methane and other greenhouse gases cause global warming. *[2]*

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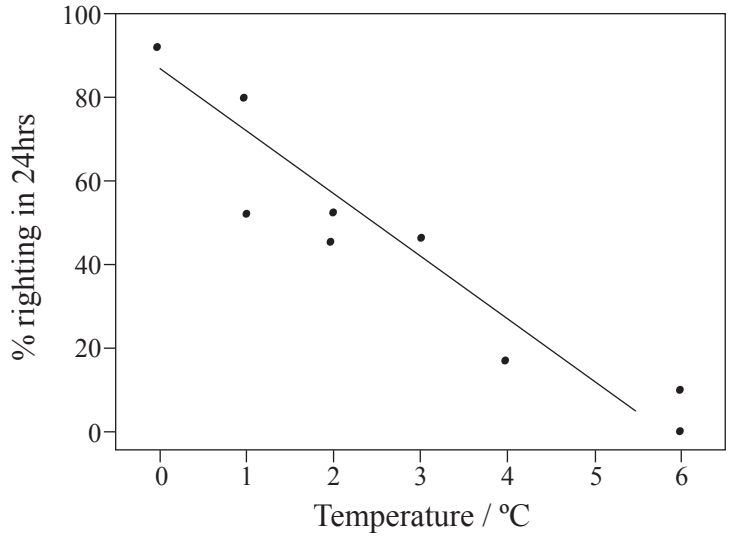
(This question continues on the following page)

(Question 1 continued)

Models predict global warming will cause sea temperatures to rise by approximately 2 °C by 2100. An investigation was carried out to study the effect of slight increases in temperature on the ability of Antarctic marine molluscs to carry out basic activities essential for survival.

The graph below shows the effect of temperature on the percentage of limpets (*Nacella concinna*) able to right themselves after being turned over.



[Source: LS Peck, *Frontiers in Zoology*, (2005), 2:9]

(f) Outline what the two parts of the scientific name *Nacella concinna* refer to. *[1]*

. . . . . .

. . . . . .

(g) State the relationship between temperature and the percentage righting in *N. concinna.* *[1]*

. . . . . .

. . . . . .

(h) Estimate the percentage change of *N. concinna* able to right themselves when the temperature is raised from 0 ºC to 2.5 ºC. *[1]*

. . . . . .

. . . . . .

(This question continues on the following page)

(Question 1 continued)

(i) At present, the maximum summer temperature in the normal Antarctic environment of this organism is 1ºC. Suggest what might be the effect on the survival of this organism if the predicted rise in sea temperature due to global warming occurs. *[2]*

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. . . . . .

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2. (a) Define *osmosis*. *[1]*

. . . . . .

. . . . . .

(b) Outline how transport occurs across membranes by facilitated diffusion. *[2]*

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. . . . . .

(c) Explain how the properties of phospholipids help to maintain the structure of cell membranes. *[3]*

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3. (a) State **two** procedures used for the preparation of a DNA profile. *[1]*

. . . . . .

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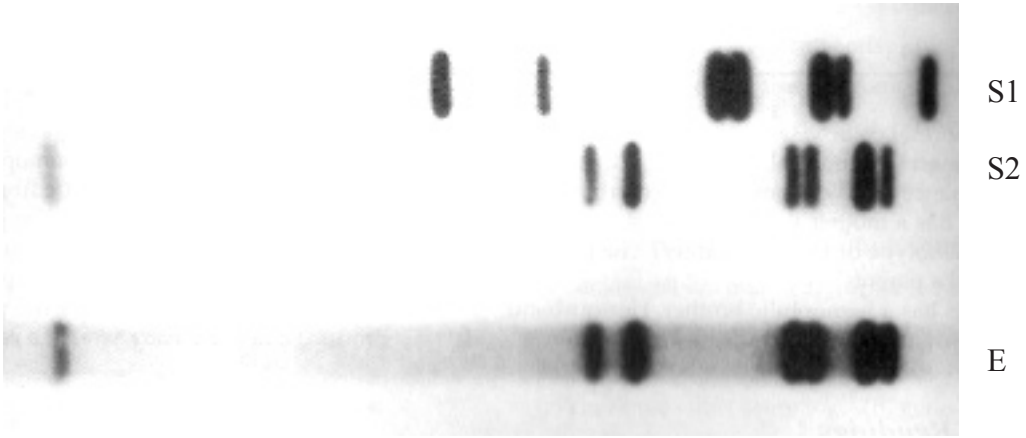
The following part of a DNA profile was used as evidence in a criminal investigation. DNA profiles of two suspects labeled S1 and S2 were compared to the DNA profile taken from the scene of the crime labeled E.



[Source: Solomon and Berg, (1995), *The World of Biology*, Saunders Harcourt Brace College, Publishers Orlando, page 238]

(b) Analyse the profiles to determine which suspect was present at the crime scene. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

4. (a) List **two** roles of testosterone in males. *[1]*

1. . . . . .

2. . . . . .

(b) A boy inherited red-green colour-blindness from one of his grandfathers. Deduce, giving your reasons, which of his two grandfathers was also colour-blind. *[3]*

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5. (a) Outline the effect of light intensity on the rate of photosynthesis. *[2]*

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. . . . . .

. . . . . .

(b) Identify which phyla of plants fit each of the brief descriptions below. *[2]*

(i) Evergreen woody plant; leaves are shaped like needles; seed-producing with reproductive structures in cones.

Phylum: . . . . . .

(ii) Underground stem that bears roots and leaves called fronds; spores develop in spore cases called sporangia located on the underside of fronds.

Phylum: . . . . . .

SECTION B

*Answer **one** question. Up to two additional marks are available for the construction of your answer. Write your answers on the answer sheets provided. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.*

6. (a) Draw and label a diagram of the ultrastructure of a liver cell. *[4]*

(b) Explain how mitosis produces two genetically identical nuclei. *[8]*

(c) Outline **one** therapeutic use of stem cells. *[6]*

7. (a) Draw and label a diagram of the molecular structure of DNA. *[4]*

(b) Explain the consequences of a base substitution mutation in relation to the processes of transcription and translation. *[8]*

(c) Outline the evidence for evolution provided by homologous structures. *[6]*

8. (a) Draw and label a diagram of the digestive system. *[4]*

(b) Discuss factors that affect enzyme activity. *[9]*

(c) Outline **one** industrial use of lactose. *[5]*

IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
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SPEC/4/BIOLO/SP2/ENG/TZ0/XX/M

MARKSCHEME

SPECIMEN PAPER

BIOLOGY

Standard Level

Paper 2

7 pages

SECTION A

1. (a) standard deviation summarizes the spread of values around the mean / 68% of all values fall within one standard deviation of the mean / gives a measure of variability of the data / OWTTE ***[1 max]***

(b) November had 113 (+2) ciliates ml^{-1} sediment (*units required*) ***[1]***

(c) production by treated and untreated samples is almost the same;
production by untreated samples is usually slightly higher than treated samples;
except November, January when the treated samples have a slightly higher methane production; ***[2 max]***

(d) endosymbionts do not seem to be responsible for methane production;
methane production is almost the same whether the ciliates are alive (untreated samples) or killed (treated samples);
no apparent correlation between methane production and number of ciliates;
months when the population of ciliates is highest are not the months when the methane production is highest / ciliate numbers high in November when methane production is low / methane production highest in July and August when ciliate numbers are not high; ***[2 max]***

(e) greenhouses gases collect in atmosphere;
layer of gases allows incoming short-wave radiation (from sun) to pass through to earth's surface where it is converted to longer-wave radiation;
long wave radiation cannot all pass through layer of gases but some reflected back to earth causing earth's surface to become warmer; ***[2 max]***

(f) first name/*Nacella* refers to the genus and the second name/*concinna* refers to the species ***[1]***

(g) negative correlation/inversely proportional/as temperature increases the percentage righting in *N. concinna* decreases ***[1]***

(h) percentage of *N. concinna* able to right themselves decrease by 50% / decreases from 95% to less than 50% / less than half able to right themselves ***[1]***

(i) model suggests two degree rise in temperature which would mean summer temperatures of 3ºC;
at this temperature less than 50% of organisms able to carry out basic behaviour;
decreased survival of species / decreased ability to avoid predation; ***[2 max]***

2. (a) (osmosis is) the passive movement of water/solvent molecules from a more dilute solution/region of lower solute concentration to a more concentrated solution/region of higher solute concentration through a partially permeable membrane ***[1]***

(b) facilitated diffusion is a form of passive transport / molecules move from a region of higher concentration to a region of lower concentration/down a diffusion gradient;
requires specific protein channels in plasma membrane; ***[2]***

(c) phospholipds have hydrophilic and hydrophobic regions;
hydrophilic heads attracted to water and hydrophobic/fatty acid tails repelled by/not attracted to water;
phospholipd bilayer forms with heads in contact with water on both sides of membrane/with environment and cytoplasm;
hydrophobic tails found in centre (of bilayer) away from water;
stability to membrane brought about by attraction between hydrophobic tails/between hydrophilic heads and water; ***[3 max]***

3. (a) polymerase chain reaction <u>and</u> electrophoresis
*Both required for **[1]*** ***[1]***

(b) all bands on the DNA profile of E/evidence match those of S2 / no agreement between DNA fragments and S1;
suspect 2/S2 was present at the crime scene; ***[2]***

4. (a) *Award **[1]** for **two** of the following*
pre-natal development of male genitalia;
development of male secondary sexual characteristics / name of specific characteristic;
maintenance of sex drive; ***[1 max]***

(b) red-green colour-blindness is a sex-linked character/gene located on X-chromosome;
boy inherits X chromosome from mother, only inherits Y chromosome from father;
boy's mother must have been carrying the gene;
he inherited it from mother's father/maternal grandfather; ***[3 max]***

5. (a) as light intensity increases rate of photosynthesis increases up to a point when reaches maximum rate;
as light intensity increases beyond this maximum there is no further effect on rate; ***[2]***
Credit can be given for a clearly annotated graph showing the above points.

(b) (i) coniferophyta ***[1]***

(ii) filicinophyta ***[1]***

SECTION B

6. (a) *Award **[1]** for each structure clearly drawn and correctly labeled.*
nucleus-smaller area than cytoplasm, surrounded by double membrane with pores;
mitochondrion-surrounded by double membrane, inner membrane has infoldings;
rough endoplasmic reticulum-stacked tubules with dots/small circles on outer surfaces;
Golgi apparatus-curved stacked tubules, small vesicles near ends of tubules/sacs;
ribosomes both attached to rER and free ribosomes in cytoplasm drawn and labeled;
lysosome / nucleolus / nuclear envelope / nuclear pore / plasma membrane; ***[4 max]***

Award ***[0]*** if a plant cell is drawn.
Award ***[3 max]*** if a plant cell structure (such as the cell wall) is present.

(b) during interphase DNA replicates/produces two copies of genetic material;
sister chromatids are two identical DNA molecules held together by centromere;
sister chromatids are separated during mitosis to form two genetically identical nuclei;
in prophase chromosomes shorten/thicken/become visible as double-stranded chromosomes/joined sister chromatids;
chromosomes condense by supercoiling;
chromosomes attach to spindle microtubules at centromeres;
chromosomes begin to move towards equator/centre of cell;
during metaphase all chromosomes lined up at equator separately/not in homologous pairs;
at start of anaphase centromeres divide separating sister chromatids;
separated sister chromatids known as (single stranded) chromosomes;
(identical sets of) chromosomes pulled to opposite poles;
move by contraction of microtubules;
nuclear envelope/membrane forms around each set of chromosomes; ***[8 max]***
Many of these points can be shown by correctly annotated diagrams.
Credit may be given for diagrams clearly illustrating these points.

(c) *Award **[4 max]** for any of the following general statements:*
stem cells are cells that retain the capacity to divide and have the ability to differentiate along different paths into all types of cells/are pluripotent/totipotent;
stem cells are derived from blastocysts/human embryos, left over from IVF/placenta/umbilical cord/some adult tissues;
new techniques/technologies rely on replacing diseased/dysfunctional cells with healthy/functioning ones;
need to identify desired type of stem cell and grow in culture/special solutions/controlled conditions;
develop biochemical solution that will cause cells to differentiate into desired cell type;
develop means of implanting/integrating cells into patient's own tissues so that they function with the body's natural cells;
danger of rejection of cells therefore need to suppress immune system;
must make sure new cells do not become overgrown/develop into cancerous tumours;

*Award **[2 max]** for a specific example i.e: **[1]** for type of cells and **[1]** for proposed use:*
e.g. retinal cells;
replace dead cells in retina to cure presently incurable diseases such as glaucoma and macular degeneration;

e.g. graft new skin cells;
to treat serious burn victims;

e.g. nerve tissue;
help repair catastrophic spinal injuries / help victims of paralysis regain movement; ***[6 max]***

7. (a) *Award **[1]** for each of the following clearly drawn and correctly labelled. Simple shapes may be used but must have a key or be clearly labelled.*
two nucleotide strands (note that strands must be drawn antiparallel although it does not need to be labelled as such);
alternating sugar-phosphate backbone;
complementary base pairs shown, A-T and C-G;
hydrogen bonds between base pairs;
covalent bonds between sugar and phosphate groups/between sugar and bases;
nucleotide including sugar, phosphate and base (with parts correctly connected); ***[4 max]***

(b) mutation is a change in the genetic make-up;
base substitution mutation occurs when one (nitrogenous) base in DNA chain is replaced by another;
this is a gene mutation/change in the base sequence of a gene;
effect of mutation ranges from no effect/no change in amino acid sequence to drastic changes;
sickle-cell anaemia involves change in gene for one of polypeptides in hemoglobin/ Hb/ HB^A ;
GAG has mutated to GTG (on DNA);
adenine replaced by thymine in DNA;
transcription of DNA produces the triplet GUG instead of GAG on mRNA;
one codon is different in mRNA;
new codon is for valine rather than glutamic acid;
tRNA brings amino acid to ribosome during translation;
different amino acid placed in polypeptide chain being formed by translation;
the two amino acids differ in solubility/have different properties / valine causes HB^S to be less soluble;
causes red blood cells to become sickle shaped/carry oxygen less efficiently;
HB^S allele causes sickle-cell anaemia but gives resistance to malaria; ***[8 max]***

(c) comparative anatomy of groups of animals or plants shows certain structural features are basically similar;
homologous structures are those that are similar in shape in different types of organisms;
structural similarities imply a common ancestry;
(homologous structures) used in different ways;
example is pentadactyl limb in vertebrates / modification of ovary wall or pericarp to aid seed dispersal / other suitable example;
adapted to different mode of locomotion in particular environment / example of two differences such as bat's wing and human hand;
illustrates adaptive radiation since basic plan adapted to different niches;
the more exclusive the shared homologies the closer two organisms are related;
certain homologous structures in some species with no apparent function such as human appendix (homologous with functional appendix in herbivores); ***[6 max]***

8. (a) *Award **[1]** for each structure correctly drawn and labelled.*
esophagus – attached to both mouth and stomach;
stomach – j-shaped sac attached to esophagus and u-shaped portion of small intestine;
large intestine – wider diameter than small intestine, attached to small intestine;
pancreas – leaf-shaped, in u-shaped region of small intestine with small duct connected to small intestine;
liver – large, triangular, to left of stomach;
gall bladder – small sac drawn on top of liver with tube connected to small intestine at same region as duct from pancreas;
anus – at end of large intestine but narrower in diameter; ***[4 max]***

(b) at low temperatures, rate of reaction increases as temperature increases (or vice versa);
more kinetic energy/faster movement of molecules means more collisions between enzyme/active site and substrate;
optimum temperature is temperature at which rate of enzyme-catalyzed reaction is fastest;
at high temperatures enzymes are denatured and stop working;
denatured means change of structure in enzyme/protein resulting in loss of its biological properties/no longer can carry out its function;
too much kinetic energy/vibrations breaks bonds that give enzyme specific shape;
optimum pH is one at which rate of enzyme-catalyzed reaction is fastest;
rate of reaction reduced as increase or decrease pH (from optimum);
strong acids and alkalis can denature enzymes;
affect (weak, ionic, hydrogen) bonds that hold enzyme in specific shape;
at low substrate concentrations, as increase concentration get increase in rate of reaction;
more chance of collision between substrate and enzyme/active site;
at high substrate concentration, have no change in rate as increase concentration;
all active sites occupied; ***[9 max]***

(c) lactose intolerance high in some human populations/Asian/African/native American and Australian aboriginal populations;
lactase used to produce lactose-free/low-lactose milk;
lactase breaks down lactose to glucose and galactose;
source of lactase is usually yeast / many sources such as bacteria, moulds;
milk passed over immobilized lactase / lactase bound to inert substance;
increase sweetness of milk;
no need to add extra sugar in manufacture of flavoured milk drinks/ frozen desserts;
can add (harmless) bacterium such as *L.acidophilus* which has same effect on lactose as in yoghurt; ***[5 max]***

IB DIPLOMA PROGRAMME
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PROGRAMA DEL DIPLOMA DEL BI

BIOLOGY
STANDARD LEVEL
PAPER 3

SPECIMEN PAPER

1 hour

Candidate session number

0	0							

INSTRUCTIONS TO CANDIDATES

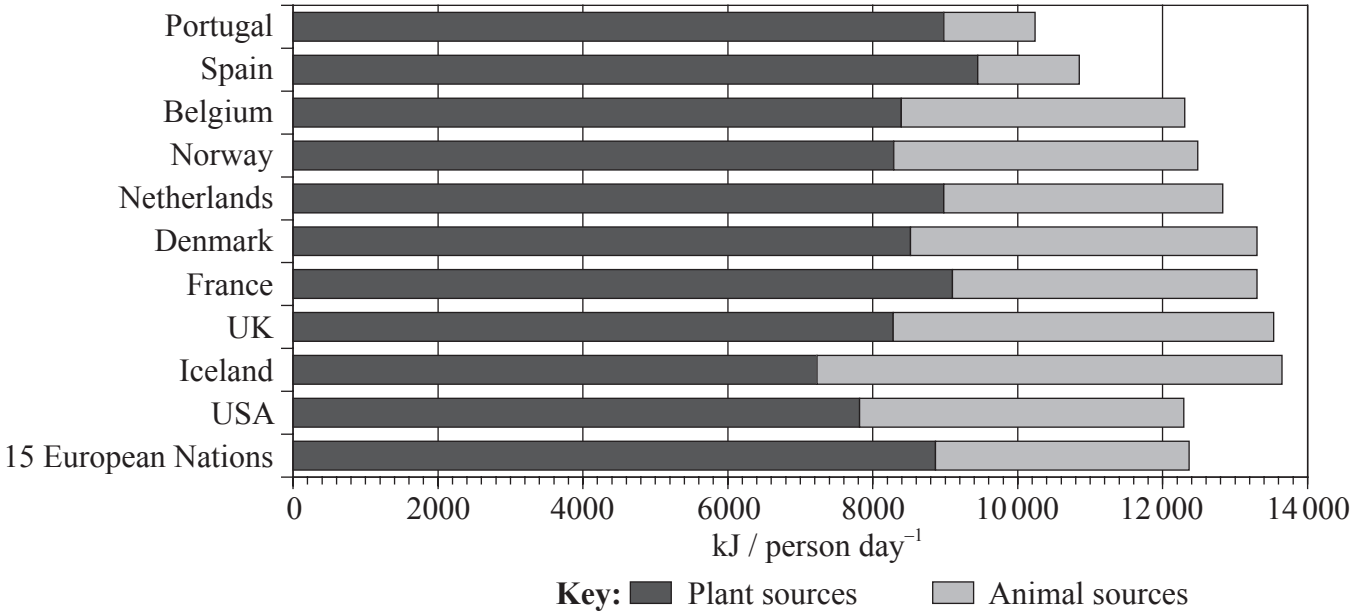
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the candidate box on your cover sheet and indicate the number of answer sheets used in the appropriate box on your cover sheet.

Option A — Human nutrition and health

A1. A study was conducted to investigate dietary changes in European Atlantic coast countries, USA and a broader group of 15 European nations. The graphs below show the dietary intake from plant and animal sources in 1961 and 2000.

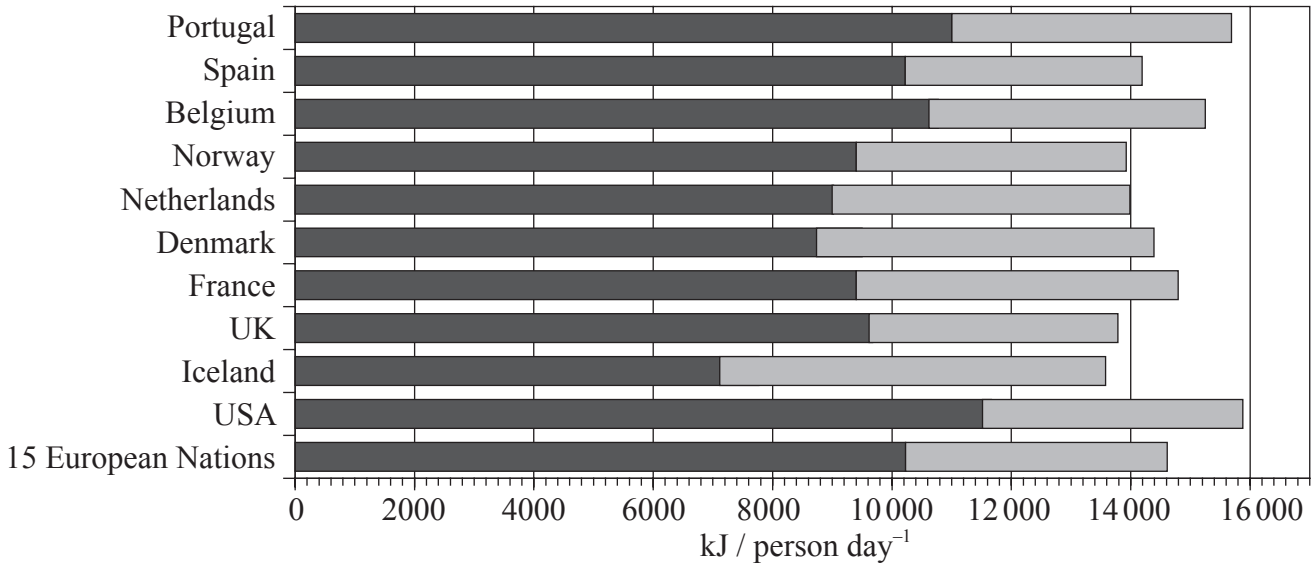
Dietary energy intake from Plant and Animal Origin, Total Availability – Year 1961

Graph 1



Dietary energy intake from Plant and Animal Origin, Total Availability – Year 2000

Graph 2



[Source: FAO, Global Perspectives Studies Group, ESDG, 2003]

(This question continues on the following page)

(Question A1 continued)

(a) A commonly recommended daily intake of energy is 10 500 kJ day^{-1}. Identify **one** country that did not reach this target in 1961. *[1]*

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(b) State the country whose total dietary energy intake changed the least over the study period. *[1]*

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(c) Compare dietary changes in the USA with the dietary changes that occurred in the group of 15 European nations. *[2]*

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(d) Discuss why the incidence of coronary heart disease and obesity may be on the rise in the European Atlantic coast countries. *[3]*

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A2. (a) Distinguish between *minerals* and *vitamins* in terms of their chemical nature. *[2]*

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(b) Explain the benefits of artificial supplementation of iodine in the diet. *[3]*

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A3. (a) Compare the energy content of carbohydrate, protein and fat. *[2]*

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(b) Outline the causes and symptoms of type II diabetes. *[4]*

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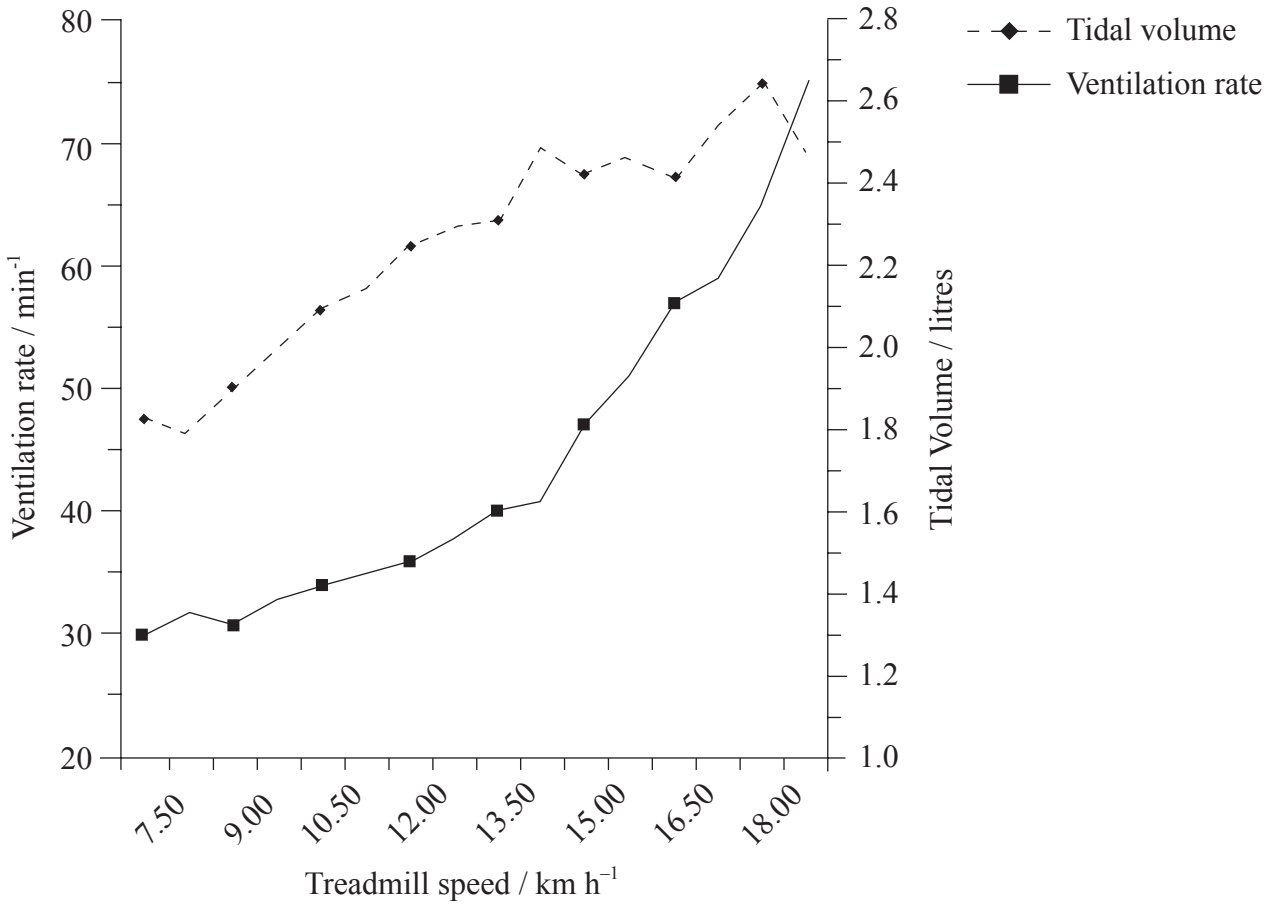
Option B — Physiology of exercise

B1. As intensity of exercise increases, humans respond to the increased need for gas exchange in two ways: varying ventilation rate and varying tidal volume. Experimental data for a runner on a treadmill are shown below.



[Source: www.home.hia.no/~stephens/ventphys.htm]

(a) Outline the relationship between treadmill speed and tidal volume.

(i) up to 14 km h^{-1} *[1]*

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(ii) above 14 km h^{-1} *[1]*

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(b) Compare the trend in ventilation rate with the trend in tidal volume at a high treadmill speed. *[1]*

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(This question continues on the following page)

(Question B1 continued)

(c) Calculate the total volume of air inhaled per minute when the treadmill speed is $15\,km\,h^{-1}$. *[2]*

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(d) Suggest how the ventilation rate and tidal volume might alter if treadmill speed were increased even further. *[2]*

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B2. (a) Outline the functions of the

(i) synovial fluid *[1]*

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(ii) joint capsule *[1]*

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(b) State the name of the structure that links muscle to bone. *[1]*

. . . . . .

(c) Describe the injuries involved in a sprain. *[2]*

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B3. (a) Outline the role of ATP in muscle contraction. *[2]*

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(b) Evaluate the effectiveness of dietary supplements containing creatine phosphate in enchancing performance in sports. *[4]*

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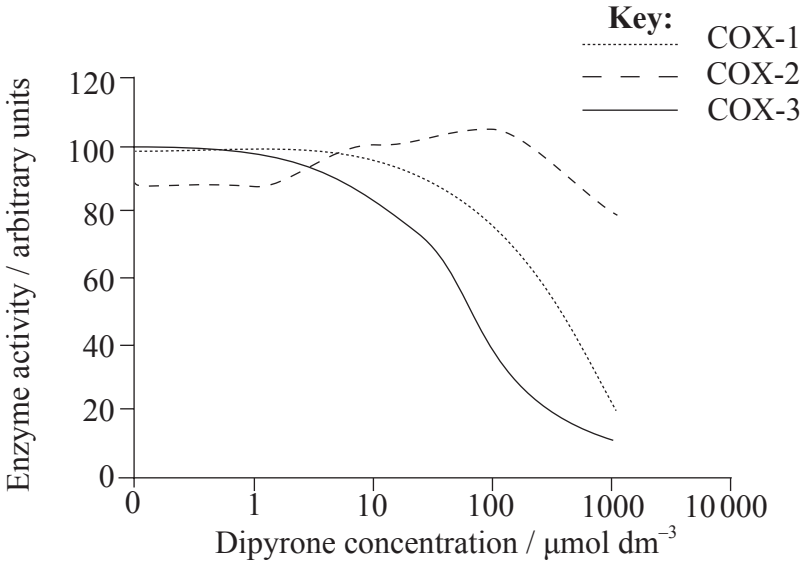
Option C — Cells and energy

C1. Inflammation of human tissues often causes pain. Cyclooxygenases (COX) are a group of enzymes that play a role in causing inflammation. Analgesics are drugs that can reduce pain. The graph below shows how increasing concentrations of the analgesic drug dipyrone, affects the activity of three different cyclooxygenases, COX-1, COX-2 and COX-3.



[Source: Adapted from N V Chandrasekharan, *et al*, (2002), *Proceedings of the National Academy of Sciences,* USA, **99,** (21), pages 13926–13931]

(a) Outline the relationship between dipyrone concentration and COX-3 activity. *[2]*

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(b) Deduce whether dipyrone is an inhibitor of COX-2. *[2]*

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(c) Evaluate the potential of dipyrone as an analgesic using the data in the graph. *[2]*

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C2. (a) List **two** examples of fibrous proteins. *[1]*

1. . . . . .

2. . . . . .

(b) (i) State **one** protein involved in oxidative phosphorylation. *[1]*

. . . . . .

(ii) Outline the role of this protein in oxidative phosphorylation. *[2]*

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C3. (a) Explain why carbon dioxide concentration is a limiting factor of photosynthesis. *[3]*

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(b) Explain the relationship between the structure of the chloroplast and its function. *[3]*

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(c) State **two** products of the light-dependent reactions. *[2]*

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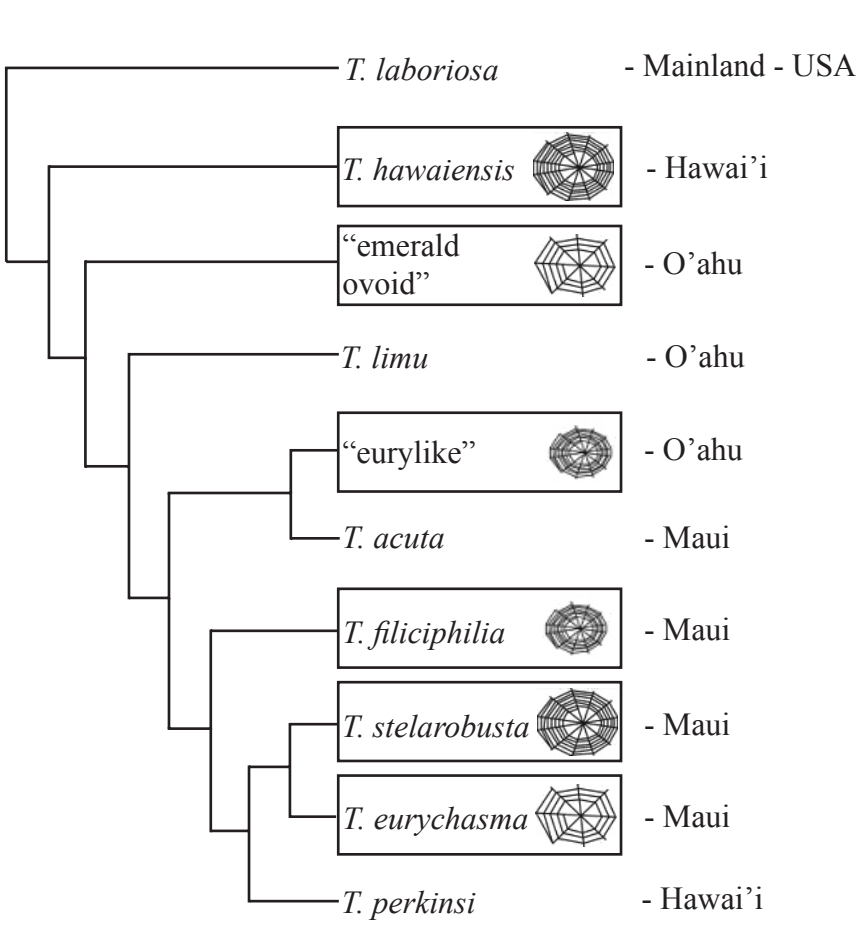
Option D —Evolution

D1. The tree diagram (cladogram) below shows how closely related a group of species of spiders are on the Hawaiian island group. Two of the species have not been given a scientific name. Three pairs of the spiders spin very similar webs. These are shown on the diagram. The island on which the spider lives is also indicated.



[Source: T A Blackledge and R G Gillespie (November 2004), *Proceedings of the National Academy of Sciences*, **101**, (46), pages 16228–16233]

(a) State which species is most distantly related to *T. perkinsi* on the basis of the tree diagram. *[1]*

. . . . . .

(b) Explain the evidence in the diagram for *[3]*

(i) convergent evolution

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. . . . . .

(ii) adaptive radiation

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(This question continues on the following page)

(Question D1 continued)

(c) Deduce whether spiders that spin similar webs or spiders that live on the same island are more closely related. *[2]*

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D2. (a) Define *sympatric speciation.* *[1]*

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(b) Describe **two** examples of barriers between gene pools. *[4]*

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D3. (a) Define *half-life.* *[1]*

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(b) Discuss gradualism and punctuated equilibrium. *[6]*

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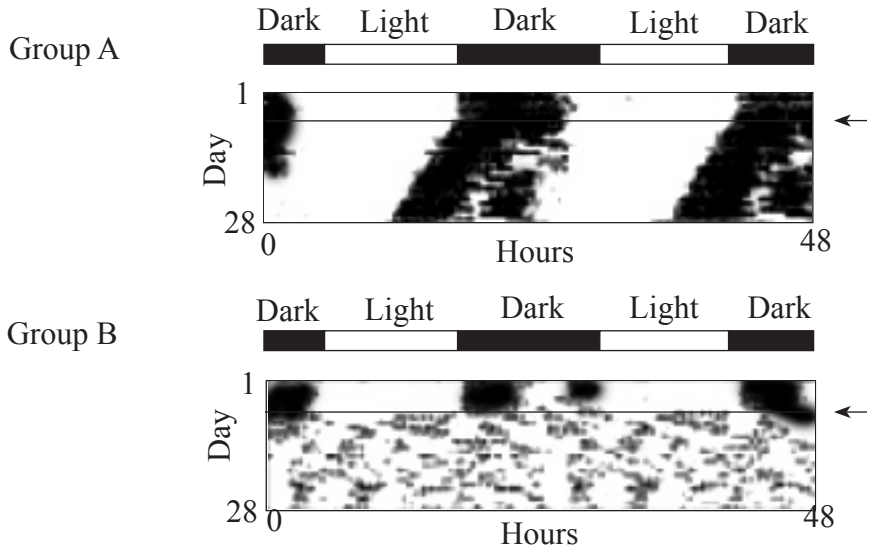
Option E — Neurobiology and behaviour

E1. Circadian rhythms are daily cycles in physiology and behaviours. Cryptochromes are proteins that are thought to be involved in circadian rhythm in mammals.

Two groups of mice were identified. Group A could produce cryptochrome, Group B could not. The behaviour of the mice was assessed by monitoring wheel running activity over a 28-day period. For the first seven days the animals were given alternating 12-hour periods of light and dark. Between days 8 and 28 they were kept in continuous darkness.

The rotation of the running wheel is plotted as a dark area within the boxes, the time of day is plotted on the x-axis. The band on top indicates the dark and light periods in the first seven days.



[Source: Aziz Sancar, (August 2004), *The Journal of Biological Chemistry,* **279**, (33), pages 34079–34082]

(a) (i) State the light conditions when mice were most active during the first 7 days. *[1]*

. . . . . .

(ii) Suggest **one** reason for mice showing this behaviour. *[1]*

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(b) Compare the effect of constant darkness on groups A and B. *[3]*

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(This question continues on the following page)

(Question E1 continued)

(c) Evaluate the hypothesis that cryptochromes are necessary for establishing circadian rhythms. *[2]*

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E2. (a) List **two** types of human sensory receptors. *[1]*

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(b) Define the term *contra lateral processing*. *[1]*

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(c) Outline the role of hair cells in the cochlea in the processing of sound. *[3]*

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E3. (a) (i) List **two** examples of excitatory psychoactive drugs. *[1]*

1. . . . . .

2. . . . . .

(ii) State **one** behavioural effect of THC (Tetrahydrocannabinol). *[1]*

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(b) Discuss the role of genetic predisposition and dopamine secretion in addiction. *[4]*

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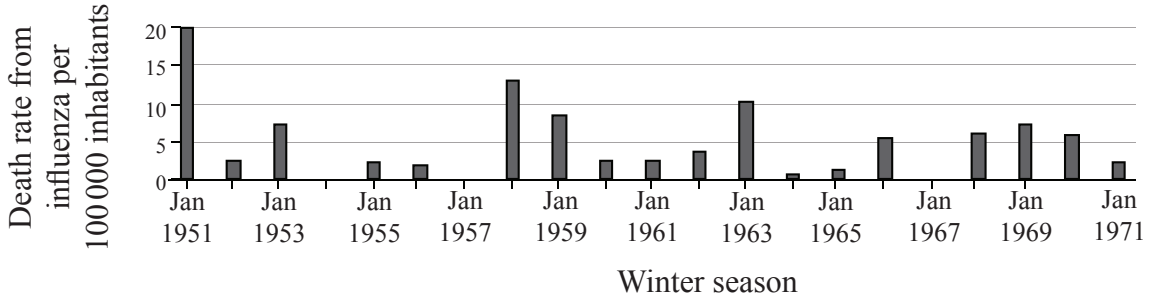
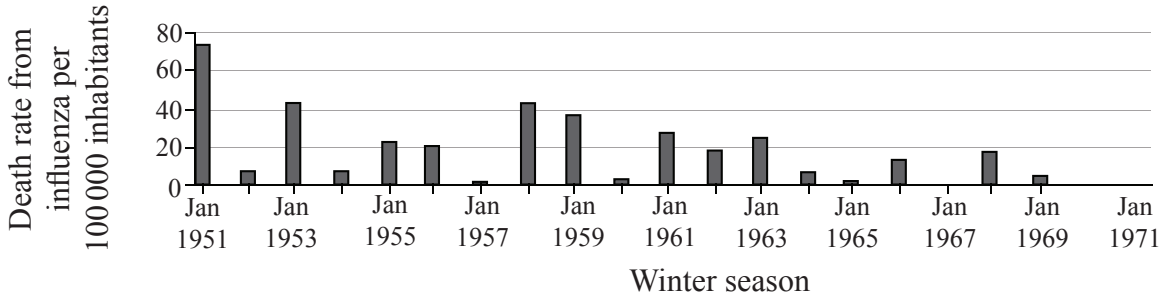
Option F — Microbes and biotechnology

F1. The diagrams show the death rate in January from influenza in Canada and the United Kingdom (U.K.). Canada is a very large, sparsely populated country. The United Kingdom is a densely populated island.

Canada



United Kingdom



[Source: G Vihoud, *et al*., (2006), *Emerging Infectious Diseases*, **12**, (4), pages 661–668]

(a) (i) Identify the year in which there were no observed deaths from influenza in **either** country. *[1]*

. . . . . .

(ii) Calculate the total number of deaths from influenza in 1968 in Canada assuming the population size was 19.8 million. *[1]*

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(b) Compare the death rates between Canada and the United Kingdom between 1953 and 1963. *[3]*

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(This question continues on the following page)

(Question F1 continued)

(c) Influenza is caused by a virus. Outline the diversity of structure in viruses. *[2]*

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F2. (a) Explain **one** use of reverse transcriptase in biotechnology. *[3]*

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(b) List **two** commercial production processes that rely on the activity of *Saccharomyces.* *[2]*

1. . . . . .

2. . . . . .

F3. (a) Explain the consequences of releasing raw sewage into a river. *[4]*

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(b) Outline the habitat of methanogens. *[2]*

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Option G — Ecology and conservation

G1. The timing of breeding in tree swallows (*Tachycineta bicolor*) was studied in the United States and Canada from 1959 to 1991. Figure A represents the mean egg laying date for each year. The date is indicated as number of days after January 1st. Figure B shows the correlation between mean May temperature (°C) and mean laying date over the same period.

Figure A

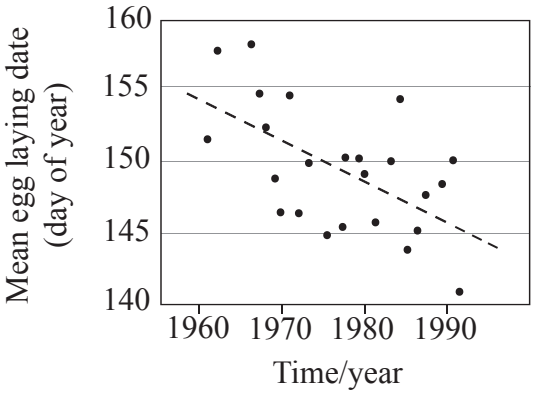
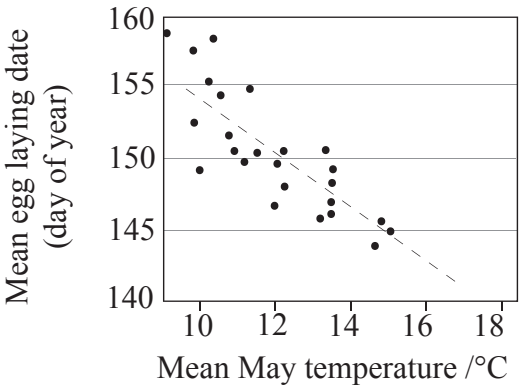


Figure B



[Source: www.pewclimate.org/docUploads/final%5FObsImpact%2Epdf]

(a) Identify the year with the earliest mean egg laying date. *[1]*

. . . . . .

(b) Outline the relationship between mean laying date and mean May temperature. *[1]*

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(c) Evaluate the evidence for global warming using figures A and B. *[2]*

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(This question continues on the following page)

(Question G1 continued)

(d) A change in mean laying date may increase competition with another species.

(i) State the competitive exclusion principle. *[1]*

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(ii) Apply the competitive exclusion principle to a change in mean laying date for the tree swallow. *[2]*

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G2. (a) Define the term *biomagnification.* *[1]*

. . . . . .

(b) Outline **one** example of biomagnification. *[3]*

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G3. (a) Outline the temperature, moisture and vegetation characteristics of any one biome. *[3]*

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(b) Discuss ecological arguments for the preservation of biodiversity. *[4]*

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SPEC/4/BIOLO/SP3/ENG/TZ0/XX/M

MARKSCHEME

SPECIMEN PAPER

BIOLOGY

Standard Level

Paper 3

8 pages

Option A — Human nutrition and health

A1. (a) Portugal ***[1]***

(b) Iceland ***[1]***

(c) both showed an increase in energy consumption;
USA showed a greater relative increase in the proportion of dietary energy from plant origin;
USA overtook the 15 European nations group in daily dietary energy consumption; ***[2 max]***

(d) increase in dietary energy intake / energy intake in all countries exceeds recommended daily intake;
likely consequence is obesity;
animal source of energy linked to intake of saturated fat;
some countries have shown an increased consumption of animal source energy;
pattern for increase in animal source energy is less uniform coupled with decrease in exercise/manual labour; ***[3 max]***

A2. (a) minerals are usually elements whereas vitamins are compounds;
minerals are inorganic while vitamins are organic; ***[2]***

(b) iodine deficiency can lead to goitre/mental retardation;
iodine is necessary for thryoxine production;
dietary supplementation usually through iodized salt;
cost to supplement is minimal but cost of deficiency is high;
few foods rich in iodine / lack of marine food in diet can lead to deficiency; ***[3 max]***

A3. (a) protein and carbohydrate have similar energy content per gram / both have approximately 1700 kJ per 100g;
100 g of fat has more than twice the energy content of 100 g of carbohydrate or 100 g of protein; ***[2]***

(b) *causes **[2 max]**:*
genetic component / high-risk ethnic group (Aboriginal, Asian, Pacific Islander, Hispanic, Pima);
obesity (BMI > 27 kg/m^2) / diets high in fat/sugar;

*symptoms **[2 max]**:*
poor ability to clear glucose from the blood is used to diagnose / high blood glucose;
frequent urination / thirst / tiredness;
glucose detected in urine; ***[4 max]***

Option B — Physiology of exercise

B1. (a) (i) as treadmill speed increases, tidal volume increases ***[1]***

(ii) at high treadmill speeds, tidal volume begins to level off / rate of increase slows ***[1]***

(b) ventilation rate continues to increase while tidal volume decreases/levels off ***[1]***

(c) ventilation rate x tidal volume;
116 L ± 4 L; ***[2]***

(d) ventilation rate would increase (until a physical limit was reached);
tidal volume would level off/decrease / physical limit would be reached; ***[2]***

B2. (a) *synovial fluid*: lubricates joints (to reduce friction);
joint capsule: seals the joint / encloses the synovial fluid; ***[2]***

(b) tendon ***[1]***

(c) a sudden violent movement of joint / extension of joint beyond normal range;
leads to soft tissue damage;
torn or stretched ligament; ***[2 max]***

B3. (a) ATP provides energy for muscle contraction;
(binding of) ATP causes myosin heads to detach / breaks cross-bridges (from their actin binding sites);
(hydrolysis of) ATP causes cocking of myosin heads/change in their angle; ***[2 max]***

(b) taken by body builders as it is reputed to increase muscle mass;
some suggest that mass gains are due to increased water retention;
high intensity anaerobic sports report performance enhancement;
less certain results for swimming and running;
upper limit to amount body can store;
supplementation not recommended for adolescents/people with kidney dysfunction;
supplementation may suppress the body's natural synthesis; ***[4 max]***

Option C — Cells and energy

C1. (a) at low dipyrone concentrations, there is no effect on enzyme function;
as concentration of dipyrone increases, increased inhibition of enzyme activity; ***[2]***

(b) over range of concentrations in the experiment appears to have no effect on enzyme function (of COX-2);
may be inhibited at concentrations higher than those used in the experiment; ***[2]***

(c) it would limit inflammation due to COX-1 and COX-3;
but not COX-2;
effective only at high doses; ***[2]***

C2. (a) *Award **[1]** for any **two** correct examples*
e.g. keratin and collagen ***[1]***

(b) (i) ATPase ***[1]***

(ii) electron transport chain involves proteins in inner mitochondrial membrane;
leads to proton build-up;
that powers ATP synthesis by (the protein) ATPase; ***[2 max]***

C3. (a) photosynthetic rate rises as CO_2 concentration rises;
up to a maximum when rate levels off / labeled graph showing outline of relationship;
at high levels of CO_2 other factors become limiting;
CO_2 levels most important determinant of photosynthetic rate/rate limiting factor;
stomata need to close to prevent water loss, which prevents CO_2 uptake; ***[3 max]***

(b) large surface area for light absorption;
small space inside thylakoids for accumulation of protons;
fluid stroma for the enzymes of the Calvin cycle; ***[3]***

(c) ATP and NADPH + H^+/$NADPH_2$ ***[2]***

Option D — Evolution

D1. (a) *T. laboriosa* ***[1]***

(b) (i) *Award **[2]** max*
Definition of convergent evolution: independent evolution of similar traits in response to similar environments;
Evidence for: T. stelarobusta (Maui) and *T. hawaiensis* (Hawai'i) produce the same type of web;
T.filiciphilia (Maui) and "eurylike" (O'ahu) also produce similar webs;

(ii) *Definition of adaptive evolution:* rapid speciation to fill ecological niches;
Evidence for: on Maui, all three T. species present produce three different kinds of webs; ***[3 max]***

(c) on Maui *T.stelarobusta* and *T. eurychasma* are closely related based on the tree diagram (but they produce different webs);
distantly related spiders, *e.g. T. hawaiensis* and *T. stelarobusta* produce similar webs but are on different islands;
suggesting island is better indicator for relatedness than webs;
data inconclusive / more studies needed; ***[2 max]***

D2. (a) the formation of new species by populations that inhabit the same or overlapping geographic regions ***[1]***

(b) a population colonizes a new habitat that involves unique selection pressures/becomes geographically isolated;
e.g. Darwin's finches;
polyploidy;
e.g. some variants of wheat; ***[4]***

D3. (a) time for radiation material to decay to half its original amount/activity/mass ***[1]***

(b) *gradualism*: slow, continuous change over a long period of time;
gradual accumulation of (neutral) mutations/variations;
punctuated equilibrium: long periods of stability followed by sudden changes;
fossil record supports this;
natural selection can be intense and can cause rapid change/evolution;
rapid evolution due to major environmental changes/volcanic eruptions/ meteor impact/other example;
only advantageous alleles ultimately survive;
some mutations had no morphological effects so not visible in the fossil record;
rate of evolution could have fluctuated over time; ***[6 max]***
*Award **[4 max]** if only one idea is discussed.*

Option E — Neurobiology and behaviour

E1. (a) (i) dark ***[1]***

(ii) because they are nocturnal/avoid predation by being active at night ***[1]***

(b) group A is able to maintain a rhythm while group B is not;
group B is active more frequently than group A;
group B is active for a shorter period than group A; ***[3]***

(c) (before constant darkness) group B had a rhythm suggesting cytochromes are not necessary;
(after constant darkness) group B were unable to re-establish a rhythm suggesting cytochromes are necessary;
cytochromes involved along with other variables; ***[2 max]***

E2. (a) *Award **[1]** for any **two** of the following:*
chemoreceptors / baroreceptors / thermoreceptors / photoreceptors / propioreceptors ***[1]***

(b) processing of stimuli which takes place on the opposite side of where the stimuli was detected / where the right brain processes information from the left visual field ***[1]***

(c) cilia on hair cells vary in length;
each resonates to a different frequency of sound;
complex sounds are resolved into their components;
inner hair cells send message to the brain / outer hair cells receive signals from the brain; ***[3 max]***

E3. (a) (i) *Award **[1]** for any **two** of the following:*
nicotine / cocaine / amphetamines ***[1]***

(ii) increase sense of intensity of perceived sensory data / sense of emotional well-being / concentration reduced / impaired judgment of time and space ***[1]***

(b) addiction is dependence on a substance (such as alcohol or other drugs) or an activity;
stopping is very difficult and causes severe physical/mental reactions/complex behaviour;
predisposition may be determined by polygenic inheritance;
significant role of environmental factors;
dopamine released in response to reward/e.g. food;
some drugs/heroin/cocaine enhance dopamine activity;
abuse drugs hypothesized to lead to down-regulation of dopamine receptors;
requires increasing amounts to achieve same effect; ***[4 max]***

Option F – Microbes and biotechnology

F1. (a) (i) 1967 ***[1]***

(ii) (death rate = 5 per 100,000 /yr, total number of deaths would be 5 times 198 =) 990 deaths ***[1]***

(b) death rate in Canada is always lower than United Kingdom;
highest death rate in United Kingdom approx 40 per 100,000 whereas in Canada never above 15;
no death from influenza recorded in Canada in 1957 but some in the United Kingdom;
highest death rate for United Kingdom recorded in 1953 but in Canada in 1958;
both countries have very low/zero death in 1954 and 1957;
between 1953 to 1963 patterns are very similar; ***[3 max]***

(c) viruses consist of nucleic acid and a protein coat;
DNA double stranded or single stranded;
RNA double stranded or single stranded;
protein coat contains receptors specific for target organism; ***[2 max]***

F2. (a) reverse transcriptase obtained from viruses;
used to convert mRNA to cDNA;
mature mRNA will not contain introns;
bacteria cannot undertake post-transcriptional modification;
cDNA can be inserted into bacterial host;
example of use; ***[3 max]***

(b) production of beer;
wine;
bread; ***[2 max]***

F3. (a) raw sewage contains organic matter;
increase in N or P/eutrophication/algal bloom;
increase in bacteria/microbes (that feed on dead algae);
increased BOD/reduced dissolved oxygen;
oxygen sensitive organisms in river die/emigrate;
pollution sensitive organisms increase / diversity decreases;
increased levels of toxins/hormones/heavy metals; ***[4 max]***

(b) anaerobic habitats;
marshes / guts of mammals / oxygen depleted soils; ***[2]***

Option G – Ecology and conservation

G1. (a) 1991 ***[1]***

(b) as mean temperature goes up, earlier mean laying date ***[1]***

(c) trend for egg laying being earlier over study period (in figure A);
higher temperatures lead to earlier egg laying;
egg laying correlated with warmer temperature;
data highly variable / evidence is indirect; ***[2 max]***

(d) (i) only one species can occupy a niche within an ecosystem / niches in an ecosystem will not overlap in the long term ***[1]***

(ii) earlier egg laying date means that parents may compete for food/nesting materials/nesting sites with other species or any example of how change may cause niche to overlap;
tree swallow may expand range northward to hatch on the same day/tree;
tree swallow may cause a decline in population of species that now overlaps niche / tree swallow may decline in population because of overlapping niche or any example which shows the consequence of overlapping niche; ***[2 max]***

G2. (a) (biomagnification) is a process in which chemical substances become more concentrated at each trophic level ***[1]***

(b) example of chemical that was magnified *e.g.* DDT / mercury;
source/use of chemical substance *e.g.* weed killer/ground water contamination;
example of top heterotroph affected *e.g.* birds of prey / human;
consequence of biomagnification *e.g.* thin egg shells / birth deformities; ***[3 max]***

G3. (a) correctly named biome *e.g.* temperate deciduous forest;
level of precipitation *e.g.* moderate precipitation / 75-150 cm throughout the year;
temperature range *e.g.* 15-18ºC/warm summers and 3-7ºC/cold winters / significant annual temperature variation;
dominant plant *e.g.* dominant plants are broad leaf trees (that lose leaves annually) / ecosystem characteristics *e.g.* significant diversity of understory plants; ***[3 max]***

(b) species within an ecosystem are interdependent;
loss of one species affects a network of other species;
organism that expands to fill unoccupied niche might disrupt balance;
species impact abiotic factors;
example of impact on abiotic factor such as: increased erosion/decrease soil fertility/microclimate changes *etc.*;
human cultures/indigenous populations ability to live sustainably within ecosystem might be affected; ***[4 max]***