Biology HL P3 TZ2

2008 May

School Level 12th IB Diploma

Programme

Board Exam

International Baccalaureate (IB

Board)

Solved

M08/4/BIOLO/HP3/ENG/TZ2/XX+

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BIOLOGY
HIGHER LEVEL
PAPER 3

Thursday 15 May 2008 (morning)

1 hour 15 minutes

Candidate session number

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INSTRUCTIONS TO CANDIDATES

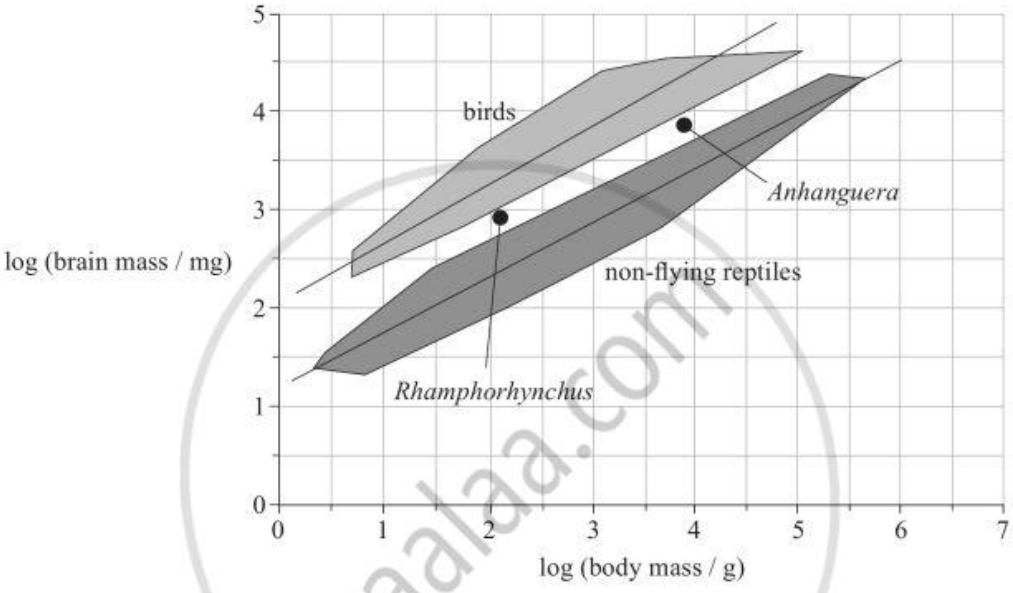
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue your answers on answer sheets. Write your session number on each answer sheet, and attach them 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.

0120

Option D — Evolution

D1. As the ability to fly needs control by the nervous system, it is to be expected that the evolution of flight should have been accompanied by changes in the nervous system. Casts were made of the skulls from two extinct flying reptiles, *Rhamphorhynchus* and *Anhanguera*.

The graph below shows the brain mass and body mass of these two individuals. It also shows the range of brain mass and body mass for living birds and living non-flying reptiles.



[Source: Reprinted by permission from Macmillan Publishers Ltd: L W Witmer *et al.*, 'Neuroanatomy of flying reptiles and implications for flight, posture and behaviour', *Nature,* **425**, (October 2003), page 950-3, © 2003]

(a) Compare the brain mass of birds and non-flying reptiles. *[3]*

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(This question continues on the following page)

(Question D1 continued)

(b) Suggest **one** reason, based on the data, for the extinction of *Rhamphorhynchus* and *Anhanguera*. *[1]*

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(c) Using the data in the graph, evaluate the claim that larger brains evolved to support the demands of flight. *[2]*

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D2. (a) State the conclusion drawn from the Miller-Urey experiment. *[1]*

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(b) Discuss a possible origin of membranes. *[2]*

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(c) In the Hardy-Weinberg equation $(p^2 + 2pq + q^2 = 1)$, state what 2pq represents. *[1]*

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D3. (a) Outline the evolutionary trends seen in fossils from *Homo habilis* to *Homo sapiens*. *[4]*

(b) Discuss the process of speciation. *[6]*

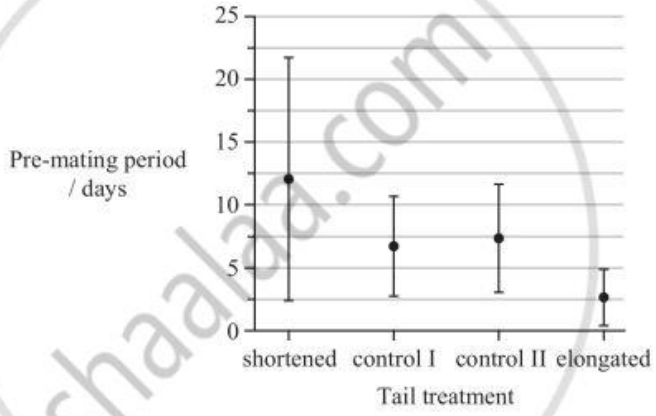
Option E — Neurobiology and Behaviour

E1. The barn swallow *(Hirundo rustica)* usually has one mate. A study was conducted to examine mate selection in barn swallows.

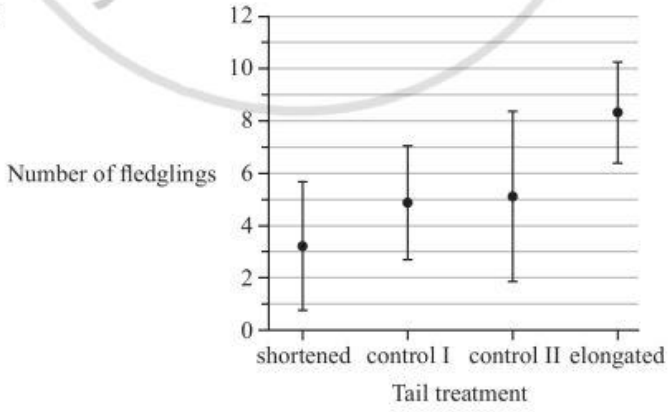
The hypothesis was that females prefer to mate with males displaying longer tail feathers. Four groups of male birds were captured for study. The first group had its tail feathers shortened. The second group (control I) had its tail feathers shortened and the pieces reattached. The third group (control II) was unaltered. The fourth group had its tail feathers elongated by attaching the pieces removed from the shortened group.

Graph A below shows the mean length of time required by each group to attract a mate (pre-mating period). Graph B shows the reproductive success of each group of male birds *i.e.* the number of chicks that reached full development and were ready to fly (fledglings) by the end of the reproductive season. The vertical lines on both graphs indicate the variability of the data.

Graph A



Graph B



[Source: adapted from Moller reported in *Evolutionary Analysis*, by J C Herron (2001), Prentice Hall, New Jersey]

(This question continues on the following page)

(Question E1 continued)

(a) Determine the difference in the mean pre-mating period for the elongated versus the shortened treatment groups. *[1]*

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(b) State the relationship between tail length and the number of fledglings. *[1]*

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(c) Suggest reasons for the difference in reproductive success of the shortened and elongated tail treatment groups. *[2]*

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(d) Explain the conclusions that can be drawn from the data for control I and control II. *[3]*

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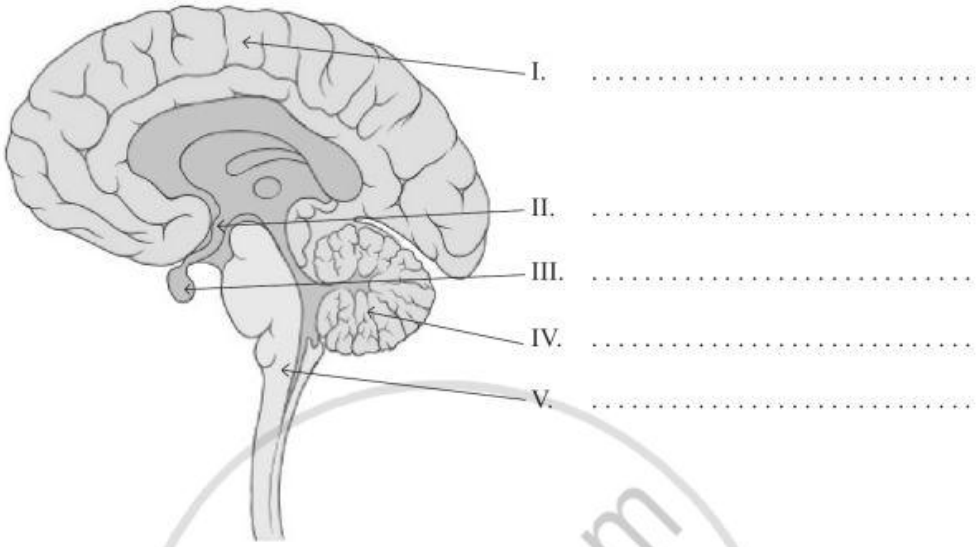
E2. (a) In the diagram of the brain below identify the name of the structures labelled I to V. *[2]*



[Source: Patrick J. Lynch, medical illustrator, Creative Commons Attribution 2.5 License 2006]

(b) Explain how a presynaptic neuron can inhibit a postsynaptic neuron. *[2]*

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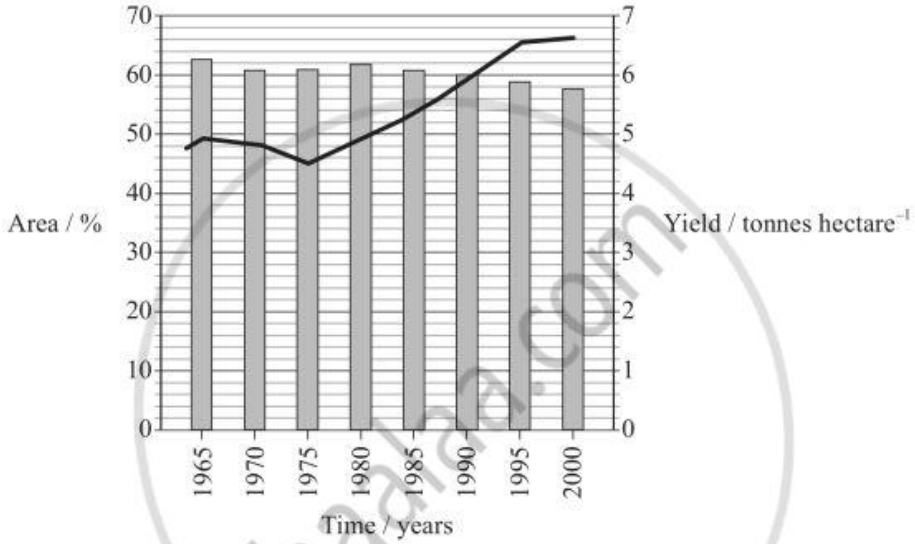
E3. (a) Outline **two** examples of how the conscious part of the brain controls autonomic reflexes. *[3]*

(b) With reference to **two** examples, discuss altruistic behaviour in social organizations. *[6]*

Option F — Applied Plant and Animal Science

F1. Since the mid 1980s, the use of pesticides and commercial fertilizers has declined in Denmark. Reduced application of these chemicals in agriculture has decreased environmental impacts, including pollution of groundwater with pesticides and decreased discharges of nutrients into watercourses, lakes and the sea. At the same time, the total amount of land available for growing crops such as barley has been reduced.

The graph below shows the agricultural area as a percentage of the total area of Denmark, and the yield per hectare of barley in Denmark.



Key: agriculture area — tonnes of barley per hectare (1 tonne = 1000 kg)

[Source: Statistics Denmark and the National Forest and Nature Agency, www.mst.dk. Reproduced with the permission of Frontlinien - The Danish Ministry of the Environment's Centre for Information.]

(a) Determine the change in percentage area under cultivation in Denmark between 1980 and 2000. *[1]*

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(b) Calculate the percentage change in barley yield per hectare from 1980 to the year 2000. *[2]*

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(This question continues on the following page)

(Question F1 continued)

(c) Suggest **two** methods that might have been used to increase barley yields without the use of chemicals. *[2]*

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(d) Discuss whether current trends in barley yields are sustainable. *[2]*

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F2. (a) List **two** veterinary techniques that have been used to improve the fecundity of animals. *[1]*

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2. . . . . .

(b) Describe how plant growth regulators can be used to produce fruit without seeds. *[2]*

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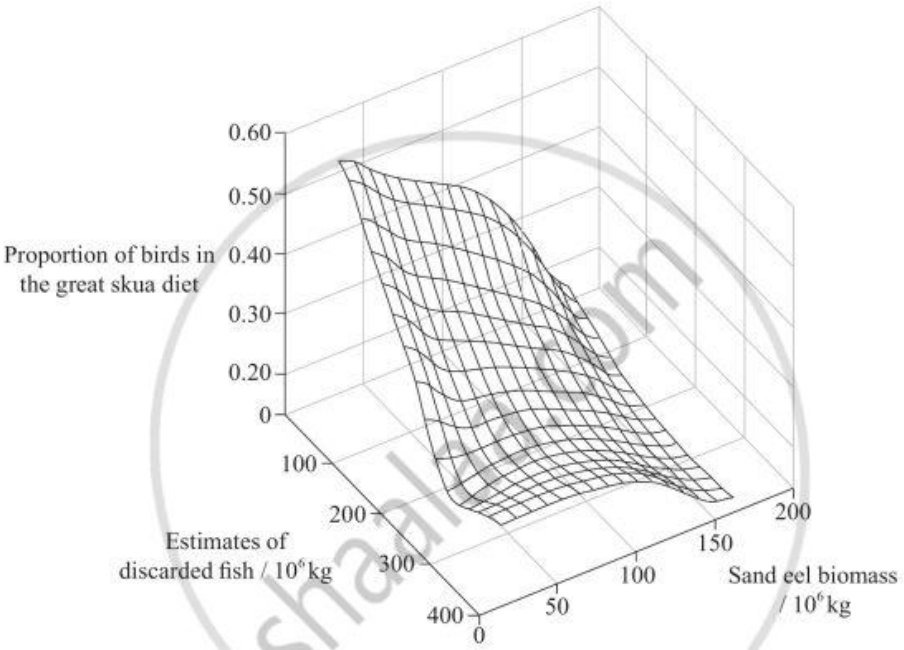
F3. (a) Outline the techniques involved in the production of Flavr-Savr™ tomatoes. *[4]*

(b) Explain how flowering is controlled in long-day plants and short-day plants. *[6]*

Option G — Ecology and Conservation

G1. Fishing activities in marine ecosystems often result in catching unwanted species in addition to the target species. Together with undersize fish, this unwanted catch is often discarded. Discarded fish are a key food resource for many seabird species. The great skua *(Stercorarius skua)* is a scavenger which feeds on other birds, sand eels and discarded fish.

The graph below shows the effect of the size of the sand eel population and the estimated amount of discarded fish on the proportion of birds in the great skua diet.



[Source: Reprinted by permission from Macmillan Publishers Ltd: adapted from S C Votier *et al.*, 'Changes in fisheries discard rates and seabird communities', *Nature*, (19 February 2004), **427** (6976), page 727, © 2004]

(a) State the relationship between the amount of discarded fish and the proportion of birds in the great skua diet when sand eel biomass is low. *[1]*

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(This question continues on the following page)

(Question G1 continued)

(b) Outline the relationship between sand eel biomass and the proportion of birds in the great skua diet when the estimated amount of discarded fish is high. *[2]*

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(c) Suggest **one** reason why the amount of discarded fish may decrease in the future. *[1]*

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(d) Predict **two** possible consequences on the ecological community structure if the amount of discarded fish decreases. *[2]*

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G2. (a) Outline **one** example of mutualism. *[2]*

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(b) Explain why plowing soils might prevent the denitrification of soils. *[2]*

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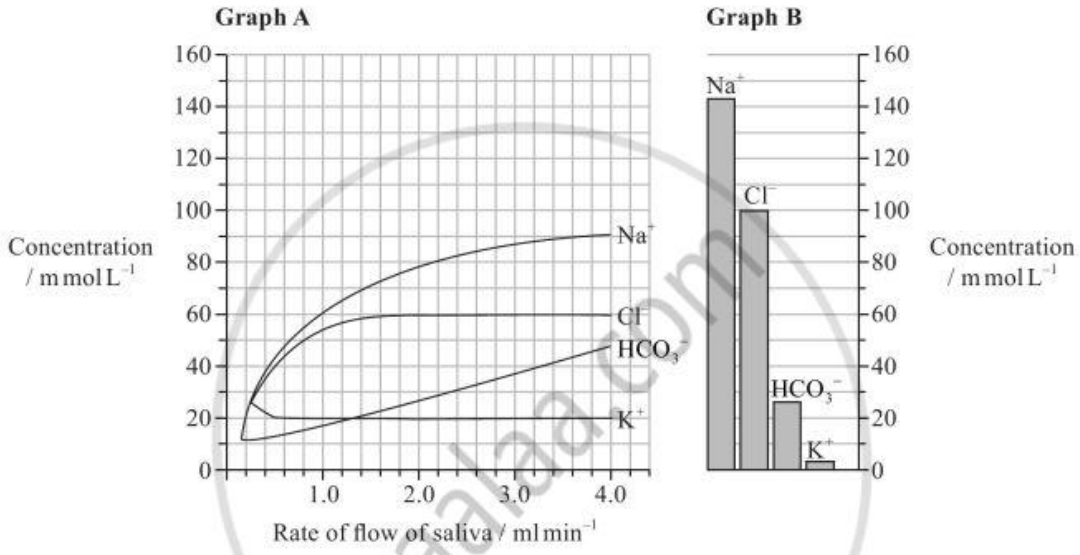
G3. (a) Outline the use of a biotic index in identifying environmental change. *[4]*

(b) Discuss the relationship between CFCs and the hole in the ozone layer. *[6]*

Option H — Further Human Physiology

H1. In the production of saliva, the acinar cells actively transport ions from the blood plasma into the ducts of the salivary gland resulting in water being drawn into the ducts. As this saliva moves down the duct, some ions are re-absorbed but the amount that can be re-absorbed depends on the rate of flow of saliva.

Graph A below shows how the composition of saliva varies depending on the rate of flow of saliva. Graph B shows the composition of blood plasma.



[Source: Jørn Hess Thaysen and Niels A. Thorn, Excretion of Urea, Sodium, Potassium and Chloride in Human Tears, American Journal of Physiology, 178: 160-164, 1954. American Physiological Society.]

(a) Using the data provided compare the concentration of ions in saliva produced at 4.0 ml min^{-1} with the concentration of those ions in the blood plasma. *[2]*

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(This question continues on the following page)

(Question H1 continued)

(b) Outline the relationship between the concentration of Na^+ in saliva and the rate of flow of saliva. *[2]*

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(c) As the saliva moves down the ducts, Na^+ is re-absorbed into the blood plasma. Deduce, with a reason, the type of transport used to bring Na^+ back into the blood plasma. *[1]*

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(d) Suggest why the concentration of Na^+ varies with rate of flow. *[2]*

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H2. (a) State **one** role of osmoreceptors in the hypothalamus. *[1]*

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(b) Explain the role of chemoreceptors in the regulation of ventilation rate. *[2]*

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H3. (a) Outline the circulation of blood through the liver. *[4]*

(b) Explain the problem of gas exchange at high altitudes and the way the body acclimatizes. *[6]*

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MARKSCHEME

May 2008

BIOLOGY

Higher Level

Paper 3

14 pages

Subject Details: Biology HL Paper 3 Markscheme

Mark Allocation

Candidates are required to answer questions from **TWO** of the Options **[2 × 20 marks]**.
Maximum total = **[40 marks]**

1. A markscheme often has more marking points than the total allows. This is intentional. Do **not** award more than the maximum marks allowed for part of a question.

2. Each marking point has a separate line and the end is signified by means of a semicolon (;).

3. An alternative answer or wording is indicated in the markscheme by a slash (/) – either wording can be accepted.

4. Words in brackets ( ) in the markscheme are not necessary to gain the mark.

5. Words that are underlined are essential for the mark.

6. The order of marking points does not have to be as in the markscheme, unless stated otherwise.

7. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by writing ***OWTTE*** (or words to that effect).

8. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

9. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. Indicate this with **ECF** (error carried forward).

10. Only consider units at the end of a calculation. Unless directed otherwise in the markscheme, unit errors should only be penalized once in the paper. Indicate this by writing **–1(U)** at the first point it occurs and **U** on the cover sheet.

Option D — Evolution

D1. (a) trend lines have same slopes / similar pattern;
when comparing same body mass bird brains tend to be bigger;
for both, brain mass increases with body mass;
for both, each body mass has a range of brain masses / range in brain mass larger for flightless reptiles / *vice versa*;
both have similar maximum brain mass; ***[3 max]***
Accept equivalent statements using the specific values.

(b) insufficient brain mass per body mass to support flight / lack complexity for more advanced flight / could not compete with birds with larger brains / brain complexity capable of more advanced flight / not as adapted as birds for flight ***[1]***

(c) birds have larger/heavier brains per body mass than flying/flightless reptiles;
larger brains per body mass (may be) necessary for control of complexities of flight;
both flying reptiles had smaller brain mass per body mass than birds and are extinct / bird best adapted for flight / flying reptiles poorly adapted;
could be correlation rather than cause and effect / could be result of other adaptations than for flight;
only two skulls for flying reptiles / limited data; ***[2 max]***

D2. (a) simple organic compounds could have been formed from inorganic compounds (in conditions similar to pre-biotic Earth) / spontaneous generation of organic matter/molecules/compounds from inorganic / *OWTTE* ***[1]***

(b) polar lipids/phospholipids spontaneously associate into bi-layers;
form micelles when dispersed in water;
creates compartmentalization;
difficult to falsify/prove; ***[2 max]***

(c) the frequency/probability of the heterozygous phenotype / 2×the frequency/ probability of the two alleles of a gene ***[1]***
Do not accept references to <u>number</u> of heterozygous.

D3. (a) *From Homo habilis to Homo sapiens, the following fossil trends are seen*:
intermediates were *H. erectus* and *H. neanderthalensis*;
increased cranial capacity / more brain size related to body size;
bipedalism / changes in articulations/trunk/pelvis/femur;
smaller jaws / smaller jaw angle;
smaller molars / dentition to support more varied diet;
skull of *H. erectus* suggested ability to talk;
fossils increasingly accompanied by more sophisticated tools / evidence of cultural evolution;
higher forehead / reduction in brow ridges / flatter face; ***[4 max]***

(b) speciation is the formation of new species / splitting of existing species;
involves the separation of a population from another population;
so that gene pools are isolated;
different mutations occur in separate groups;
differences in allele frequency develop / different action of natural selection on allele frequency in different groups;
new species cannot interbreed (to produce fertile offspring) with the species it evolved from;
allopatric / geographic isolation;
ecological isolation / non-geographic barriers to reproduction;
reproductive / behavioural isolation occurs;
sympatric speciation / polyploidy in plants;
can occur through migration;
Galapagos finches / other examples; ***[6 max]***

Option E — Neurobiology and Behaviour

E1. (a) ***Marking point for English, French and German papers only.***
9.5 (±0.5) days ***[1]***

Marking points for Spanish paper only.
9.5 (±0.5) days;
range of shortened tails approximately 19 days, range of elongated tails 5 days / shortened with greater range of about 14 (±1) days; ***[1 max]***

(b) the longer the tail the more fledglings ***[1]***

(c) the elongated tailed birds take less time to attract a mate / more attractive to females;
more time to mate / less energy required in mate search;
allows more time to rear multiple batches of chicks / for chicks to develop;
longer tailed males attract fitter females / better providers / protectors / stronger / fitter; ***[2 max]***

(d) control I was designed to determine the effect of trimming tail feathers on reproduction;
trimming has no effect/slightly positive effect in mating time;
both control groups/trimmed and non-trimmed have similar reproductive success / means about the same;
control II supports that length has (small) effect / wider range/variability of reproductive success; ***[3 max]***

E2. (a) *Award **[1]** for every two correct labels.*
I. cerebrum / cerebral hemisphere
II. hypothalamus
III. pituitary
IV. cerebellum
V. spinal cord / medulla oblongata ***[2 max]***

(b) presynaptic neuron releases neurotransmitter / neurotransmitter binds to the postsynaptic membrane;
causing hyperpolarization (of postsynaptic membrane) / negatively charged chloride ions to move in / potassium (K^+) ions out;
making it more difficult to cause depolarization (of postsynaptic neuron)/nerve impulse transmission/action potential; ***[2 max]***

E3. (a) (most) autonomic reflexes under unconscious control / controlling autonomic reflexes can be learned;
e.g. bladder / anal sphincter muscles are under autonomic control;
(young children learn) feces/urine can be released under conscious control;
e.g. partial control of heart rate might be achieved;
through meditation/yoga; ***[3 max]***
*Award **[2 max]** if only one example given.*

(b) altruistic behaviour involves a benefit to another;
at the expense of the individual displaying the behaviour;
example of behaviour in a named species;
statement of how it harms individuals and helps another;
another example of behaviour in a different named species;
statement of how it harms individuals and helps another;

e.g. Vervet monkeys give alarm calls;
alarm calls attract attention of predator and others have more time to escape;
closer the genetic relationship the less altruism involved;
(others argue) benefits increase over time through survival of genes shared with recipient;
behaviour might lead to an advantage for the individual displaying behaviour in the future; ***[6 max]***
*Award **[5 max]** if an example of behaviour is given in only one named species.*

Option F — Applied Plant and Animal Science

F1. (a) $4.1(\pm 0.5)\%$ ***[1]***

(b) $6.6 - 4.9 = 1.7(\pm 0.5)$ tonnes; *(unit not required)*
increase of $35(\pm 3)\%$; *(unit required)* ***[2]***

(c) genetic engineering / genetically engineered crops;
selectively bred higher yield varieties / better barley strains;
biological pest control;
manure / humus / organic matter; ***[2 max]***
Award any other reasonable suggestion.

(d) *arguments against sustainability*:
continued loss of farmland under production may put greater pressure to achieve higher yields per hectare;
will be difficult without the return to pesticides / fertilizers / agrochemicals;
from graph improvements in yield are slowing;

arguments for sustainability:
from graph improvements in yield have been sustained with less land;
avoiding the use of pesticides / fertilizers aids sustainability in other areas;
loss of 4 % of arable land has been matched by a 32 % growth in yield;
yield improvements/better technology can make up for loss of land (in short-term); ***[2 max]***

F2. (a) artificial insemination / vaccination / nutrient supplementation / any other reasonable suggestion ***[1]***
*Award **[1]** for any two correct answers.*

(b) spray (unpollinated) flowers with growth regulator;
e.g. auxin in the case of tomatoes / gibberellin in the case of grapes;
stimulates fruit development without pollination; ***[2 max]***

F3. (a) Flavr-Savr™ tomatoes have delayed ripening;
polygalacturonase promotes ripening;
anti-sense DNA sequence/gene has the same orientation as the functional mRNA / reverse orientation to the sense/normal gene (coding for polygalacturonase);
artificially sequenced;
anti-sense gene transferred to tomatoes;
both anti-sense and sense gene expressed;
two kinds of mRNAs are complementary/bind to one another;
polygalacturonase not produced; ***[4 max]***

(b) photoperiod/flowering controlled by relative length of light and dark;
adaptation for flowering at different times of year;
short day plants need a critical night length/minimum night length;
long day plants cannot exceed a certain night length;
length of dark period is most important in determining flowering;
phytochrome helps plants to determine photoperiod conditions;
phytochrome exists in active and inactive forms;
active (Pfr) form degraded to inactive (Pr) form in darkness / is slow;
inactive (Pr) form converted to active (Pfr) form in the light / is fast; ***[6 max]***

Option G — Ecology and Conservation

G1. (a) higher the discard the lower the proportion of birds in the great skua diet *[1]*

(b) the more sand eel available/eaten, the less birds are eaten by the great skua;
proportion of birds (in diet) stable between 50 and approximately 125 sand eel biomass, drops drastically after 125, stabilizes around 150; *[2]*

(c) ***Marking point for English, French and German papers only.***
changes to fishing practice / markets for discarded fish / decreasing quantities of fish available / over-fishing / better technology filters out fish size more efficiently *[1]*

Marking point for Spanish paper only.
stricter control/international legislation over fishing/legal fish size / fishing methods more efficient/sophisticated / any other reasonable suggestion *[1]*

(d) increase in predation by great skua on other birds/other food sources / decrease in population of other birds/other food sources;
increase in predation on sand eel / decrease in population of sand eels;
decrease in the number of great skua (because of competition for food);
decreased quantities of detritus (from discarded fish) / decrease in other detritus feeders in the community; *[2 max]*

G2. (a) mutualism is a close association between two organisms/species where both benefit;
names of two organisms/species involved; *(common names acceptable)*
description of the manner in which both species/organisms benefit;
e.g. microorganisms in gut of ruminants;
e.g. microorganisms gets nutrients / habitat and host gets assistance with digestion; *[2 max]*
To award full marks an example is needed.

(b) plowing soils aerates the soil / provides oxygen;
bacterial denitrification is an anaerobic process, decreased in aerobic conditions;
leading *Pseudomonas* to use oxygen as a substrate / will not use nitrates as substrate;
plowing increase drainage decreasing denitrification; *[2 max]*

G3. (a) use of living organisms that are sensitive to specific conditions to detect environmental change;
name of indicator species; *(common name accepted)*
description of what it monitors;
consists of index of indicator species;
their relative numbers;
and the variety of indicator species found;
allows for quantitative comparison / measure of environmental change; ***[4 max]***

(b) CFCs/chlorofluorocarbons enjoy wide industrial application / manufactured by humans / used as solvents / propellants / refrigerants / gas blown plastics / other example;
carried by weather patterns to polar/Antarctic regions;
ozone is produced in the upper atmosphere;
ozone absorbs (solar) ultraviolet radiation;
UV causes CFCs to dissociate, releasing Cl atoms/radicals;
Cl atom/radical reacts (repeatedly) with ozone to form O_2;
chemical reaction between CFCs and ozone lead to ozone destruction;
allowing UV light to penetrate the upper atmosphere;
and cause damage within ecosystems / to biological molecules / cancer;
$O_3 + Cl \rightarrow O_2 + ClO$ ***or*** $ClO + O \rightarrow O_2 + Cl$ ***or*** $ClO + O_3 \rightarrow 2O_2 + Cl$; ***[6 max]***

Option H — Further Human Physiology

H1. (a) Na^+ concentration is lower in saliva;
Cl^- concentration is lower in saliva;
HCO_3^- concentration is higher in saliva;
K^+ concentration is higher in saliva; ***[2 max]***
Accept any correct numerical comparisons.
*Award **[2]** if all correct and **[1 max]** if two or three are correct.*

(b) as the flow rate of saliva increases the amount of Na^+ in saliva increases;
the increase is largest initially but then levels off as flow rates increase; ***[2]***

(c) Na^+ concentration (always) higher in blood plasma / moves against concentration gradient so active transport must be used ***[1]***

(d) higher flow rate means Na^+ flows past without being re-absorbed / more difficult to be absorbed / less time of contact with cells;
pumping activity/transport of Na^+ can only occur at a fixed rate;
numbers of pumps limiting / reach saturation level; ***[2 max]***

H2. (a) monitor concentration of blood plasma / regulate water levels in blood/osmotic conditions/solutes / send signal to release ADH if blood plasma too concentrated / homeostasis of blood plasma solutes ***[1]***

(b) pH/CO_2 concentration in blood plasma monitored by chemoreceptors;
found in the aorta / carotid artery/body / walls of arteries;
chemoreceptors send signal to breathing centre in brain/medulla oblongata;
to modify/increase/decrease breathing rate; ***[2 max]***
Do not accept chemorecptors send signal to diaphragm or intercostal muscles.

H3. (a) (oxygenated) blood from heart to liver via hepatic artery;
(nutrient laden) blood carried from intestines through hepatic portal vein;
artery/hepatic portal vein divide (eventually) into sinusoids;
sinusoids drain into (branches of) hepatic vein;
blood leaving the liver departs through the hepatic vein; ***[4 max]***
Accept a clearly drawn correctly annotated diagram.

(b) at high altitudes partial pressure of oxygen is lower;
as air is exchanged in lungs hemoglobin does not become fully saturated;
oxygen deprivation of tissues / Monge disease;
mountain sickness may develop;
ventilation rate/depth increases;
extra red blood cells are produced / more hemoglobin in red blood cells;
extra myoglobin produced by muscles / more capillaries develop in muscles;
hemoglobin with a decreased affinity for oxygen / releases oxygen more readily;
behavioural accommodations including reduced activity / climbing slowly; ***[6 max]***