Biology HL P2

2006 November

School Level 12th IB Diploma Programme

Board Exam

International Baccalaureate (IB Board)

Solved

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

N06/4/BIOLO/HP2/ENG/TZ0/XX

88066002

BIOLOGY
HIGHER LEVEL
PAPER 2

Thursday 16 November 2006 (afternoon)

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. Plants native to warm climates sometimes suffer injuries when exposed to relatively low temperatures. For example, temperatures in the range of 10°C to 15°C can cause "chilling injuries" to some sub-tropical plants that normally grow between 20°C and 25°C. These "chilling injuries" may affect gene expression and reduce the rates of photosynthesis and protein synthesis. Some plants are more resistant to "chilling injuries" than others.

These injuries could be due to damaged membranes. Membrane lipids consist of a mixture of saturated fatty acids (no double bonds) and unsaturated fatty acids (one or more double bonds). Saturated fatty acids have a higher melting point than unsaturated fatty acids.

The table below shows the main fatty acid composition (as a percentage of the total fatty acid content) of mitochondrial membranes in various plants and the ratio of unsaturated/saturated fatty acids.

		Fatty acid composition / %					
		Chill-resistant plants			Chill-sensitive plants		
Fatty acid	Number of double bonds	Cauliflower	Turnip	Pea	Bean	Sweet potato	Maize
Palmitic	0	21.3	19.0	12.8	24.0	24.9	28.3
Stearic	0	1.9	1.1	2.9	2.2	2.6	1.6
Oleic	1	7.0	12.2	3.1	3.8	0.6	4.6
Linoleic	2	16.4	20.6	61.9	43.6	50.8	54.6
Linolenic	3	49.4	44.9	13.2	24.3	10.6	6.8
Ratio of unsaturated to saturated fatty acids		3.2 : 1	3.9 : 1	3.8 : 1	2.8 : 1	1.7 : 1	2.1 : 1

[Source: A C Terry *et al*, *Plant physiology 2000*, **124**, pages 183–190,
© American Society of Plant Biologists reprinted with permission.]

(a) Identify,

(i) the plant with the lowest ratio of unsaturated fatty acids to saturated fatty acids. *[1]*

. . . . . .

(ii) which saturated fatty acid has the highest percentage composition. *[1]*

. . . . . .

(This question continues on the following page)

(Question 1 continued)

(b) Deduce which data in the table determines whether a plant is **either** chill resistant **or** chill sensitive. *[2]*

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(c) Suggest which physical property of mitochondrial membranes allows some plants to be chill resistant. *[1]*

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(d) Predict how the function of the mitochondria will be affected when chill sensitive plants are cooled. *[1]*

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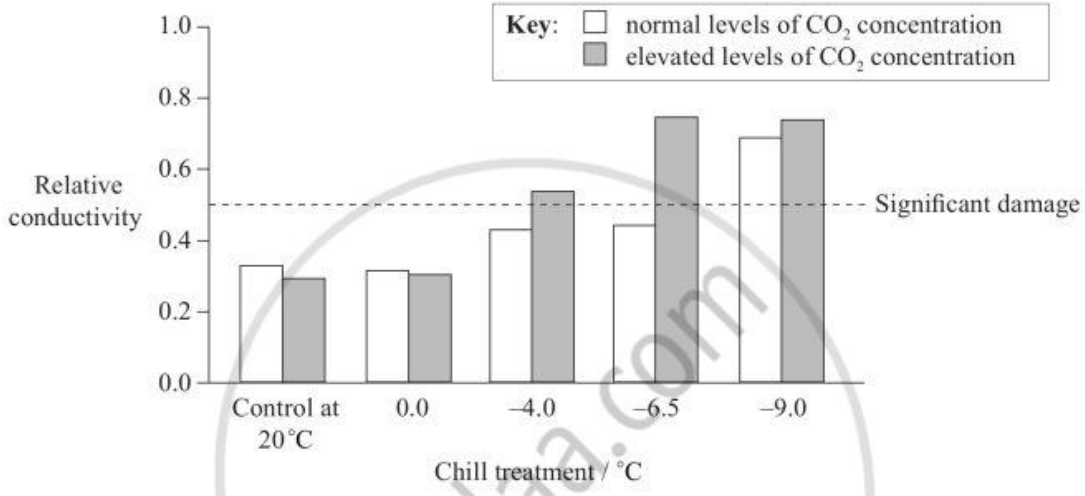
(Question 1 continued)

Researchers have carried out long-term studies into the relationship between the exposure of plants to elevated levels of CO_2 concentration and their tolerance to freezing. The chart below shows the amount of membrane damage caused when plants are grown at different temperatures in normal or elevated levels of CO_2 concentration. The membrane damage was indicated by the amount of membrane leakage and this was measured in terms of relative conductivity (high conductivity indicates membrane leakage).



[Source: A C Terry *et al*, *Plant physiology 2000*, **124**, pages 183–190,
© American Society of Plant Biologists reprinted with permission.]

(e) Identify the relationship between chill treatment and membrane leakage at normal levels of CO_2 concentration. *[1]*

. . . . . .

. . . . . .

(f) Identify the temperature at which significant membrane damage begins to occur in plants treated with elevated levels of CO_2 concentration. *[1]*

. . . . . .

. . . . . .

(g) Evaluate the effect of elevated levels of CO_2 concentration on the freezing tolerance of plants. *[1]*

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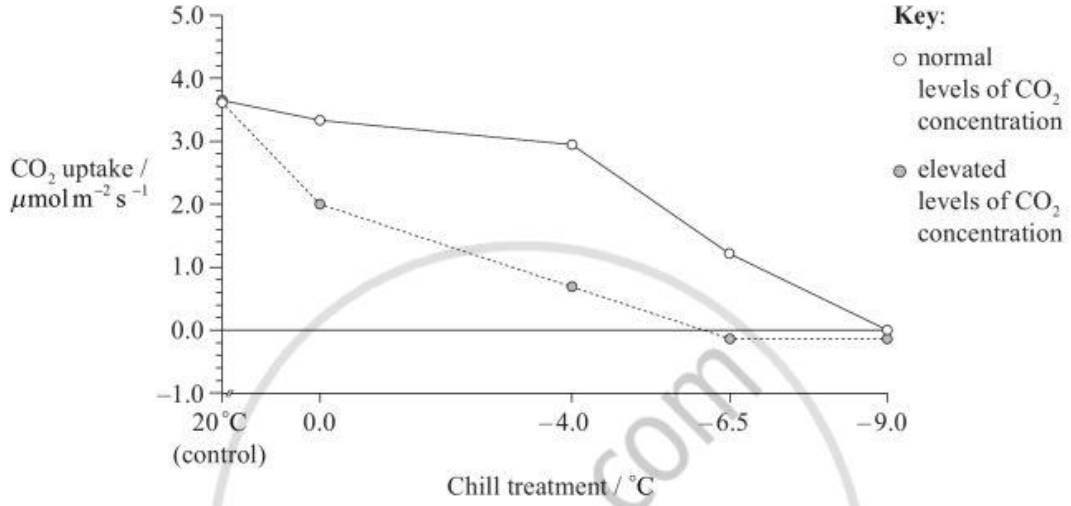
. . . . . .

(This question continues on the following page)

(Question 1 continued)

Researchers wanted to evaluate the effect of chilling treatment on the rate of photosynthesis, measured by CO_2 uptake. This was carried out at normal levels and elevated levels of CO_2 concentration. The photosynthetic rate was measured three weeks after chilling treatment began.



[Source: A C Terry *et al*, *Plant physiology 2000*, **124**, pages 183–190]

(h) Calculate the change in CO_2 uptake from 0.0 °C to −4.0 °C in plants grown in elevated levels of CO_2 concentration. *[1]*

. . . . . .

. . . . . .

(i) Outline the effect of chilling treatment on rate of photosynthesis of plants grown at different levels of CO_2 concentration. *[2]*

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. . . . . .

(j) Suggest what factor other than membrane damage causes a drop in the rate of photosynthesis as the temperature decreases. *[1]*

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(This question continues on the following page)

(Question 1 continued)

(k) Analyse the long-term consequences of the greenhouse effect on the freezing tolerance and chilling tolerance of plants. *[2]*

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2. (a) Define the term *pathogen*. *[1]*

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(b) State the difference between *active immunity* and *passive immunity*. *[2]*

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(c) Explain the process of antibody production. *[3]*

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3. Students investigated a community of trees by sampling a total area of 20 000 m^2.

Species	Number of plants
Douglas fir (*Pseudostuga menziesii)*	30
Big Leaf Maple *(Acer macrophyllum)*	60
Grand Fir (*Abies grandis)*	240

[Source: Unpublished data from April 2003, Western Oregon University]

(a) Calculate the plant density for the Grand Fir. *[1]*

. . . . . .

(b) Describe the method used to collect this data. *[3]*

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(c) Explain why populations show a sigmoidal growth curve. *[3]*

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4. (a) Determine the mRNA sequence that is coded by the following strand of DNA. *[1]*

Sense:	A	T	G	C	T	A	G	A	C
	T	A	C	G	A	T	C	T	G

mRNA: .....

(b) Outline how the lac operon controls gene expression. *[2]*

.....

.....

.....

.....

(c) Outline the structure of nucleosomes. *[1]*

.....

.....

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.*

5. (a) Define the term *homeostasis* and list **four** variables under homeostatic control in humans (excluding water balance). *[5]*

(b) Draw and label a diagram of the structure of the human kidney. *[4]*

(c) Explain the role of the nephron in maintaining the water balance of the blood in the human body. *[9]*

6. (a) Outline the **four** phases of mitosis. *[4]*

(b) Explain the relationship of Mendel's law of segregation and independent assortment with meiosis. *[8]*

(c) Using a table, compare spermatogenesis with oogenesis. *[6]*

7. (a) Outline the structure of part of a double stranded DNA molecule, using a simplified diagram. *[5]*

(b) Discuss the advantages **and** disadvantages of genetic screening. *[9]*

(c) Outline the technique that would be used to transfer a human gene to *E. coli*, starting with mature mRNA. *[4]*

8. (a) Outline factors that result in a high transpiration rate in a mesophytic plant. *[5]*

(b) List **four** adaptations of xerophytic plants. *[4]*

(c) Define the term *evolution* and, using **two** examples, explain the process of evolution in response to environmental change. *[9]*

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N06/4/BIOLO/HP2/ENG/TZ0/XX/M+

MARKSCHEME

November 2006

BIOLOGY

Higher Level

Paper 2

10 pages

General Marking Instructions

Subject Details: Biology HL Paper 2 Markscheme

Mark Allocation

Candidates are required to answer **ALL** questions in Section A total ***[32 marks]*** **and any TWO** questions in Section B ***[20 marks]*** each. Maximum total = ***[72 marks]***.

General

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

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

- Each marking point has a separate line and the end is signified by means of a semicolon (;).
- An alternative answer or wording is indicated in the markscheme by a "/"; either wording can be accepted.
- Words in (…) in the markscheme are not necessary to gain the mark.
- Words that are underlined are essential for the mark.
- The order of points does not have to be as written (unless stated otherwise).
- If the candidate's answer has the same "meaning" or can be clearly interpreted as being the same as that in the markscheme then award the mark.
- Mark positively. Give candidates credit for what they have achieved, and for what they have got correct, rather than penalising them for what they have not achieved or what they have got wrong.
- Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded.
- Units should always be given where appropriate. Omission of units should only be penalized once. Ignore this, if marks for units are already specified in the markscheme.
- Do not penalize candidates for errors in significant figures, unless it is specifically referred to in the markscheme.

Section B

Extended response questions - quality of construction

- Extended response questions for HL P2 carry a mark total of ***[20]***. Of these marks, ***[18]*** are awarded for content and ***[2]*** for the quality of construction of the answer.

- Two aspects are considered:
  expression of relevant ideas with clarity
  structure of the answers.

- ***[1]*** quality mark is to be awarded when the candidate satisfies **EACH** of the following criteria. Thus ***[2]*** quality marks are awarded when a candidate satisfies **BOTH** criteria.

Clarity of expression:

The candidate has made a serious and full attempt to answer all parts of the question and the answers are expressed clearly enough to be understood with little or no re-reading.

Structure of answer:

The candidate has linked relevant ideas to form a logical sequence within at least two parts [(a), (b), etc.] of the question.

- It is important to judge this on the overall answer, taking into account the answers to all parts of the question. Although, the part with the largest number of marks is likely to provide the most evidence.

- Candidates that score very highly on the content marks need not necessarily automatically gain ***[2]*** marks for the quality of construction (and *vice versa*).

SECTION A

1. (a) (i) sweet potato *[1]*

(ii) palmitic acid *[1]*

(b) levels of palmitic acid;
higher level of palmitic acid (above 21.3) in chill sensitive plants / lower level of palmitic acid (below 21.3) in chill resistant plants;
ratio of unsaturated to saturated fatty acids;
lower ratio of unsaturated to saturated fatty acids in chill sensitive plants / higher ratio of unsaturated to saturated fatty acids in chill resistant plants; *[2 max]*

(c) membranes of chill resistant plants are more fluid at lower temperatures / have a lower melting point / low saturated fatty acid composition / *OWTTE* *[1]*

(d) respiration/chemiosmosis/ATP production/electron transport will decrease *[1]*

(e) increased membrane leakage with greater chill treatment/lower temperature *[1]*

(f) $-4.0\,^{\circ}C$ *(unit required)* *[1]*

(g) elevated levels of CO_2 make plants less tolerant to freezing (below $4.0\,^{\circ}C$) / effect is most pronounced at $-6.5\,^{\circ}C$ *[1]*

(h) $1.3\,(\pm 0.1)\,\mu mol\,m^{-2}\,s^{-1}$ *(unit required)* *[1]*

(i) at normal levels of CO_2 concentration, photosynthesis decreases slightly until $-4.0\,^{\circ}C$ then drops significantly after $-4.0\,^{\circ}C$;
at elevated levels of CO_2 concentration, photosynthesis decreases more sharply (until it reaches zero) at $-6.5\,^{\circ}C$;
plants grown in elevated levels of CO_2 concentration have lower photosynthetic rates during frosting treatment; *[2 max]*

(j) decrease in enzyme activity / freezing water / lower rates of diffusion of CO_2 / decreased molecular motion / other reasonable answer *[1]*
Do not accept lower light levels.

(k) plants may suffer frost/freezing damage at higher/warmer temperatures;
elevated levels of CO_2 may make plants more susceptible to chilling injuries;
climate may be warmer so plants may suffer fewer chilling periods;
(natural selection/evolution) may lead to change in fatty acid composition / plants will evolve adaptations to new climate / no change; *[2 max]*

2. (a) a pathogen is an organism (or virus) that causes a disease ***[1]***

(b) *active immunity*: immunity due to production of antibodies by organism itself;
passive immunity: due to acquisition of antibodies produced from another organism; ***[2]***

(c) antigen presentation by macrophages;
activation of T-helper cells;
activation of B cells;
B cells divide to plasma cells and memory cells;
plasma cells secrete antibodies; ***[3 max]***

3. (a) 0.012 plants m^{-2} *(units required)* ***[1]***

(b) use the (random) quadrat method;
throw quadrat / use a random number table to place quadrats / quadrats done on a transect;
plant species in each quadrat are counted and totalled;
mean plants per quadrat × number of quadrats / use formula to arrive at population; ***[3 max]***

(c) lag phase = slow population growth / small change in population size;
exponential phase = population growing/expanding quickly / natality greater than mortality / no effect of limiting factors / resources plentiful;
transitional phase = mortality rate increasing / limiting factors begin to influence growth;
plateau phase = natality is equal to mortality / carrying capacity is reached; ***[3 max]***

4. (a) AUGCUAGAC ***[1]***

(b) regulator gene produces a protein/repressor molecule;
repressor binds to operator;
prevents RNA polymerase from binding to promoter;
gene is not transcribed;
inducer (molecule) deactivates repressor; ***[2 max]***

(c) DNA wrapped around eight histone proteins ***[1]***

SECTION B

Remember, up to TWO "quality of construction" marks per essay.

5. (a) *Responses must define homeostasis to receive full marks, if not award **[4 max]**.*
homeostasis:
maintains the internal environment at a constant level / between narrow limits;
blood pH;
carbon dioxide;
blood glucose;
body temperature; ***[5 max]***

(b) *Award **[1]** for each of the following structures of the kidney clearly drawn and correctly labelled.*
cortex shown at the edge of kidney;
medulla shown inside the cortex with pyramids;
pelvis shown on the concave side of the kidney;
ureter shown connected to the pelvis on the concave side;
renal artery and vein shown originating from the concave side;
calyx/papilla; ***[4 max]***

(c) ultrafiltration / high pressure in the glomerulus;
glomerular filtrate produced in Bowman's capsule;
flows to proximal convoluted tubule;
80% of water reabsorbed;
filtrate enters descending limb / loop of Henle;
descending limb permeable to water / water drawn out by osmosis;
ascending limb pumps sodium into tissues;
ascending limb impermeable to water;
decrease in filtrate concentration (in ascending portion);
concentration in distal convoluted tubule equals concentration in proximal convoluted tubule;
high solute concentration ADH released /ADH controls water balance;
ADH makes collecting duct water permeable to water;
so water can move to tissues / so the urine is more concentrated; ***[9 max]***
Details of how ADH is controlled hormonally should not be credited.
Accept any of the above if clearly explained in a labelled diagram.

*(Plus up to **[2]** for quality)*

6. (a) named phases: prophase, metaphase, anaphase and telophase;
prophase nuclear membrane disappears / chromosomes condense (become visible) / spindle microtubules appear;
metaphase chromosomes (composed of sister chromatids) line-up at equatorial plane;
anaphase (sister) chromatids/chromosomes separate/move to (opposite) poles;
telophase nucleus begins to reform / cytokinesis starts and chromosomes decondense (become invisible); ***[4 max]***
Accept any of the above if clearly explained in a labelled diagram.

(b) (law of segregation) states that for a pair of alleles, each gamete receives only one of the alleles;
meiosis has two divisions;
cells go from diploid to haploid;
(law of independent assortment) states that the segregation of alleles of one gene is independent of the segregation of the alleles of another gene;
alleles of a gene are carried on homologous chromosomes;
homologues line-up at metaphase I;
homologues of one chromosome line-up independently of homologues of other chromosomes at metaphase I;
homologues separate at anaphase I ;
homologues of different chromosomes separate randomly at anaphase I ;
haploid cells have a random assortment of homologues;
only unlinked genes (or genes that are far apart on the chromosome) assort independently; ***[8 max]***

(c) *Award **[1]** for each row, up to **[6 max]**.*

Spermatogenesis	**oogenesis**
both are a process of meiosis;	
both start with cells produced by mitosis;	
millions produced every day	one produced every 28 days;
sperm production start at puberty	egg production starts in fetus;
sperm production continuous through life	egg production stops at menopause;
four sperm produced by meiosis	one egg and polar bodies produced;
occurs in testes	occurs in ovaries;
not much growth phase	significant growth phase;
equal divisions of cytoplasm	unequal divisions of cytoplasm;

[6 max]

*(Plus up to **[2]** for quality)*

7. (a) two strands of DNA;
anti-parallel;
3′ to 5′ linkages;
purine / pyrimidine;
A-T / G-C base pairing;
hydrogen bonds;
sugar-phosphate backbone; ***[5 max]***
*Award **[3 max]** if answer does not include a diagram.*

(b) genetic screening: testing an individual for the presence/absence of a gene;

advantages: ***[4 max]***
individuals can see if they are carriers of a gene before they have children;
fewer children with genetic disease;
lower long-term health costs;
frequency of harmful alleles reduced;
allows early diagnosis of disease;
treatment can start for disease;
prepare parents emotionally/financially for affected children;
plant/animal breeders can screen plants/animals for desired traits;

disadvantages: ***[4 max]***
risk of false negative/false positive;
increase in abortion;
against religious beliefs;
cost to administer;
can discriminate against people / selection of genetic traits;
deny health insurance;
if diagnosed with genetic disease can lead to emotional problems; ***[9 max]***

(c) use reverse transcriptase on mature mRNA to make DNA;
cut plasmid with restriction enzymes;
sticky ends added to donor DNA;
place plasmid and DNA together;
use DNA ligase to splice them together;
place plasmids within *E. Coli*;
test uptake with antibiotics;
culture *E. Coli* with recombinant plasmids; ***[4 max]***

*(Plus up to **[2]** for quality)*

8. (a) high levels of light;
low humidity;
windy conditions;
(relatively) high temperatures;
high number of leaves / (open) stomata;
an actively growing/photosynthesizing plant;
low air pressure / low levels of carbon dioxide; ***[5 max]***

(b) CAM/C4 physiology;
reduced leaves;
rolled leaves;
sunken stomata;
thick cuticle;
hairs;
water storage tissue;
wide-spreading network of shallow roots;
vertical stems to avoid mid-day sun; ***[4 max]***

(c) *definition*: ***[3 max]***
evolution is the process of cumulative change over time;
some variation has to be inherited;
increased reproduction of individuals with favourable characters over time;
thus, species adapt to the environment;

Award ***[3 max]*** *for each example.*
named example;
environmental change;
evolutionary response;

e.g. antibiotic resistance of bacteria;
exposure of bacteria to antibiotics;
survival and reproduction of bacteria with resistant gene;

e.g. heavy metal tolerance in plants / melanism in ladybugs / pepper moths; ***[9 max]***

(Plus up to ***[2]*** *for quality)*