RECOGNISING ACHIEVEMENT

ADVANCED GCE

2804

BIOLOGY

Central Concepts

WEDNESDAY 24 JANUARY 2007

Morning

Time: 1 hour 30 minutes

Additional materials: Electronic calculator

Candidate Name

Centre Number

Candidate Number

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre Number and Candidate Number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. ANSWERS WRITTEN ELSEWHERE WILL NOT BE MARKED.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

For Examiner's Use		
Qu.	**Max.**	**Mark**
1	14	
2	8	
3	16	
4	14	
5	13	
6	14	
7	11	
Total	90	

This document consists of **20** printed pages and **4** blank pages.

Answer **all** the questions.

1 In woodlands that are managed, a conflict exists between the economic yield and the maintenance of biodiversity.

Fig. 1.1 is a photograph of an area of coppice and standard woodland.

A photo has been removed due to third party copyright restrictions

Details:

A photo of an area of coppice with woodland behind

Fig. 1.1

(a) (i) Describe the process of coppicing and explain how it is used in the sustainable management of a woodland.

....

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....

.... [3]

(ii) State two ways in which managing woodland as a mix of standard and coppiced trees can be of economic benefit to the owner.

1 ....

....

2 ....

....[2]

Fig. 1.2 shows some deadwood that has been colonised by fungi.

A photo has been removed due to third party copyright restrictions

Details:

A photo of a piece of deadwood that has been colonised by fungi

© Offwell Woodland & Wildlife Trust

Fig. 1.2

(b) (i) List three features of organisms belonging to the Kingdom Fungi.

1 ....

2 ....

3 ....[3]

[Turn over

(ii) State **two** features that fungi have in common with plants.

1 ....

....

2 ....

....[2]

(iii) Explain how the fungal decomposition of deadwood is of benefit to the living trees within the woodland.

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....[4]

[Total: 14]

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2 Reproduction in seahorses, *Hippocampus*, is unusual as it is the male rather than the female that becomes pregnant. The male has a brood pouch located on its tail. The larger the male the larger the pouch. The female transfers unfertilised eggs into the pouch. The larger the female the more eggs are produced that can be transferred to the brood pouch. The male releases sperm onto the eggs and they are fertilised. The male carries the developing brood for a period of several weeks until he finally gives birth.

Research into seahorse populations has revealed the following.

- They are monogamous. A male and female remain together for the whole mating season.
- Within a population, mates are selected by size. Large females mate with large males and small females mate with small males.
- Few intermediate sized individuals are produced and they have a low survival rate.

Two different species of seahorse are found in the coastal regions shown in Fig. 2.1. The ranges of these two seahorse species overlap in many areas of these waters.

A map has been removed due to third party copyright restrictions

Details:

A map showing the locations of 2 species of sea horse found in the Gulf of Mexico and the Caribbean

Fig. 2.1

(a) **(i)** Name the type of speciation that occurs when there is no geographical barrier to gene flow.

....[1]

(ii) Explain how Fig. 2.1 supports the hypothesis that the type of speciation named in **(i)** has occurred in seahorses.

....

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....[2]

The type of natural selection that can produce the type of speciation that has occurred in seahorses is known as disruptive selection. This is where the extreme phenotypes are more likely to survive and reproduce than the intermediate phenotypes.

(b) Explain how disruptive selection occurs in seahorse populations.

....

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....[3]

(c) In terms of reproductive potential, explain why it is beneficial for large females to mate with large, rather than small, males.

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....[2]

[Total: 8]

3 **(a)** Fig. 3.1 shows the absorption spectra for three different photosynthetic pigments.

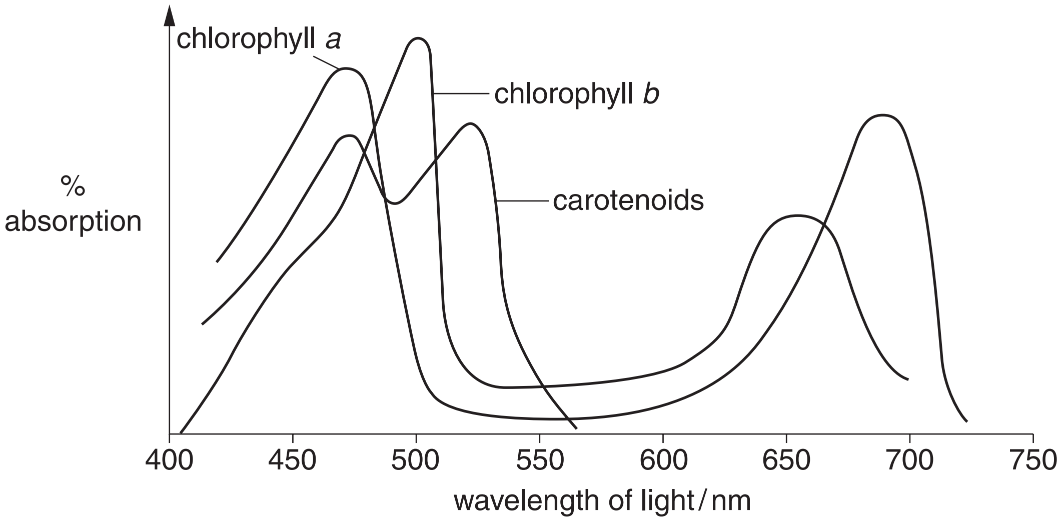

Fig. 3.1

(i) Explain what is meant by the term *photosynthetic pigment*.

....

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....

....[3]

(ii) Using Fig. 3.1, describe the pattern shown by chlorophyll *a*.

....

....

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....[2]

(b) Photosynthetic pigments fall into two categories: primary pigments and accessory pigments.

Explain the difference between primary and accessory pigments.

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....[2]

(c) In this question, one mark is available for the quality of the use and organisation of scientific terms.

Photosynthetic pigments are arranged in light-harvesting clusters called photosystems.

Describe how the light energy absorbed by these photosystems is converted into chemical energy in the **light dependent stage** of photosynthesis.

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....[8]

Quality of Written Communication [1]

[Total: 16]

4 **(a)** During interphase preceding meiosis, each chromosome replicates itself and becomes two chromatids joined at the centromere. These identical chromatids are known as sister chromatids. During the first division of meiosis, pairing of homologous chromosomes takes place. The structure formed is called a bivalent. When paired in this way non-sister chromatids from the two chromosomes exchange segments of genetic material by breaking and rejoining.

(i) State the name given to the exchange of segments of chromatids by breaking and rejoining.

....[1]

(ii) Name the stage of the first division of meiosis when this exchange of segments occurs.

....[1]

(iii) Describe the genetic difference between sister and non-sister chromatids.

....

....[1]

(b) Fig. 4.1 represents a pair of homologous chromosomes at the beginning of the first division of meiosis. The loci of two genes are shown, and both genes have two alleles.

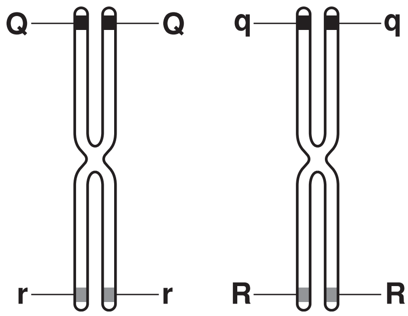
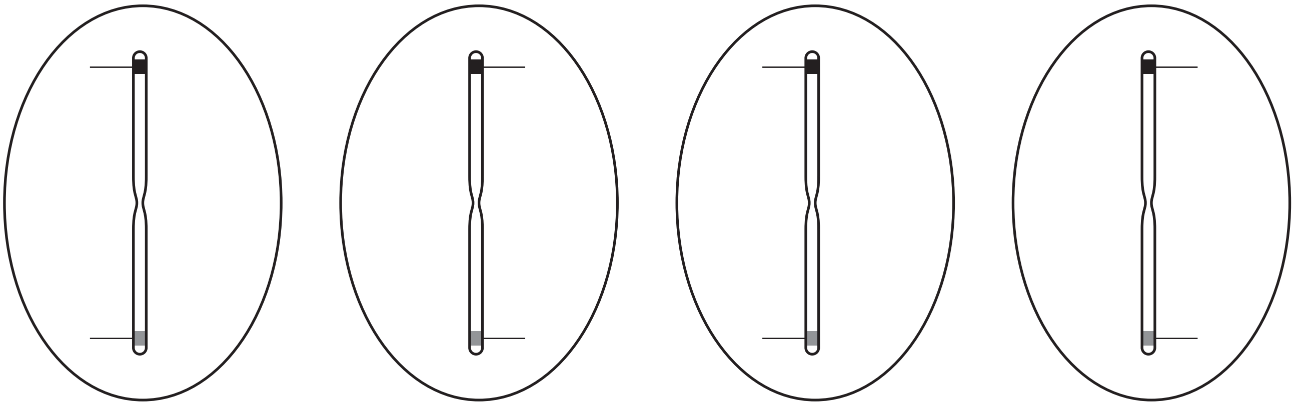


Fig. 4.1

Complete the diagram below to show the four possible gametes formed at the end of meiosis. Use the same letters as in Fig. 4.1.



[2]

(c) A student carried out a genetic investigation with fruit flies, *Drosophila melanogaster*. Two characteristics were observed, body colour and wing shape. The student had the following information:

- the characteristics were controlled by separate genes carried on separate chromosomes
- grey body colour was dominant to black body colour
- normal wing shape was dominant to bent wing shape.

The student carried out a cross between a fly **heterozygous** for both grey body colour and normal wing shape and a fly with a black body and bent wing. The numbers and phenotypes of the offspring were as follows:

grey body and normal wing	83
black body and normal wing	85
grey body and bent wing	78
black body and bent wing	74

(i) Complete the genetic diagram to explain this cross. Use the following symbols to represent the alleles:

A = grey body colour, a = black body colour
B = normal wing shape, b = bent wing shape

Parental phenotypes: grey body / normal wing x black body / bent wing

Parental genotypes: ....

Gametes: ....

Offspring genotypes: ....

Offspring phenotypes: ....

....

Phenotypic ratio: ....[5]

The student concluded that the results showed that independent assortment had taken place.

To determine whether this conclusion is justified a chi-squared test (χ^2) can be carried out on the experimental data.

(ii) Complete Table 4.1 by calculating the expected numbers.

Table 4.1

offspring	observed numbers	expected numbers
grey body / normal wing	83	
black body / normal wing	85	
grey body / bent wing	78	
black body / bent wing	74	
total	320	320

[1]

(iii) The χ^2 value is calculated in the following way:

$$\chi^2 = \sum \frac{(\text{observed} - \text{expected})^2}{\text{expected}} \qquad \text{where } \sum = \text{‘ sum of …’}$$

Calculate the χ^2 value for the above data. Show your working.

χ^2 value = ... [2]

(iv) The critical value of χ^2 for this type of investigation with three degrees of freedom is 7.82.

Explain whether your answer to **(c) (iii)** supports the student's conclusion.

....

....[1]

[Total: 14]

5 Fig. 5.1 is an outline diagram of the Krebs cycle. A two carbon acetyl group enters the cycle by combining with a molecule of oxaloacetate. A molecule of citrate is formed which is decarboxylated and dehydrogenated to regenerate the oxaloacetate.

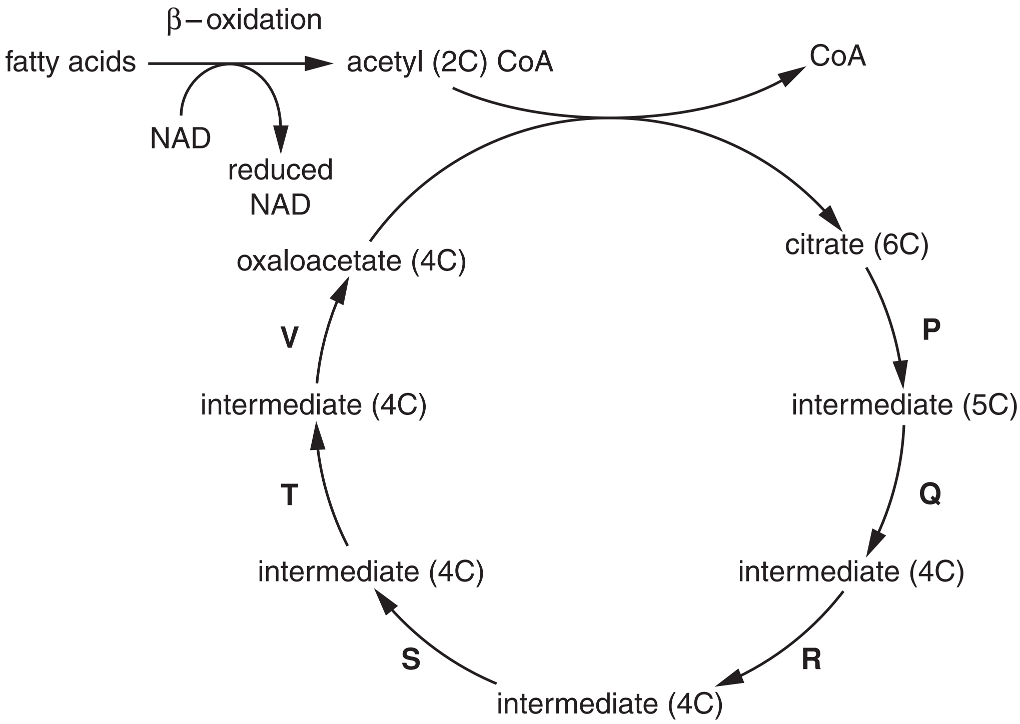


Fig. 5.1

(a) **(i)** Explain the following terms:

decarboxylation ....

dehydrogenation ....[2]

(ii) State the **letters** of the individual steps in the cycle where decarboxylation is taking place.

....[1]

(b) ATP is made directly by substrate level phosphorylation in the Krebs cycle.

State the number of ATP molecules that are made directly **per 'turn'** of the cycle.

....[1]

(c) Fig. 5.1 also shows that fatty acids can be converted into acetyl CoA units by a process known as β-oxidation. Both this process and the Krebs cycle require NAD. The Krebs cycle also requires FAD. The hydrogen atoms released in β-oxidation and the breakdown of acetyl CoA in the Krebs cycle reduce the NAD and FAD molecules.

(i) State the number of reduced NAD and reduced FAD molecules that are formed in the Krebs cycle from **one** molecule of acetyl CoA.

reduced NAD ....

reduced FAD .... [2]

(ii) State where the reduced NAD and reduced FAD molecules are reoxidised **and** describe what happens to the hydrogen atoms.

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....[4]

(d) The liver is responsible for producing enzymes which detoxify alcohol by breaking it down into smaller units. This breakdown by enzymes uses NAD. This means that other reactions that use NAD are less likely to take place. The build up of fats in the liver is one of the first signs of liver damage due to excessive alcohol intake.

Using the information in Fig. 5.1, explain why the build up of fats occurs in the liver of an individual who consumes large amounts of alcohol.

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....[3]

[Total: 13]

6 Fig. 6.1 represents **some** of the changes that occur across the membrane of the axon. Three protein complexes are shown to be present in the membrane:

- sodium channels
- potassium channels
- sodium-potassium pumps.

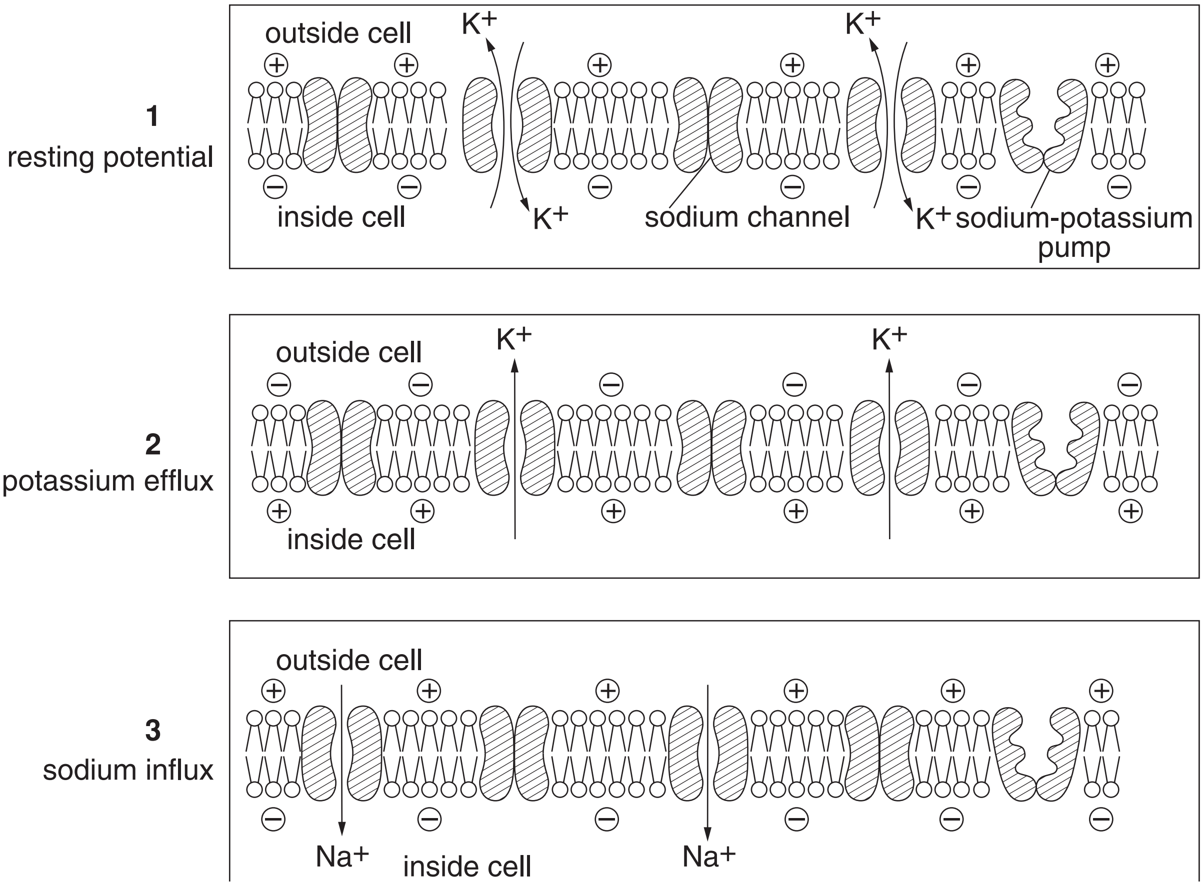

Fig. 6.1

Fig. 6.2 shows the change of membrane potential associated with an action potential.

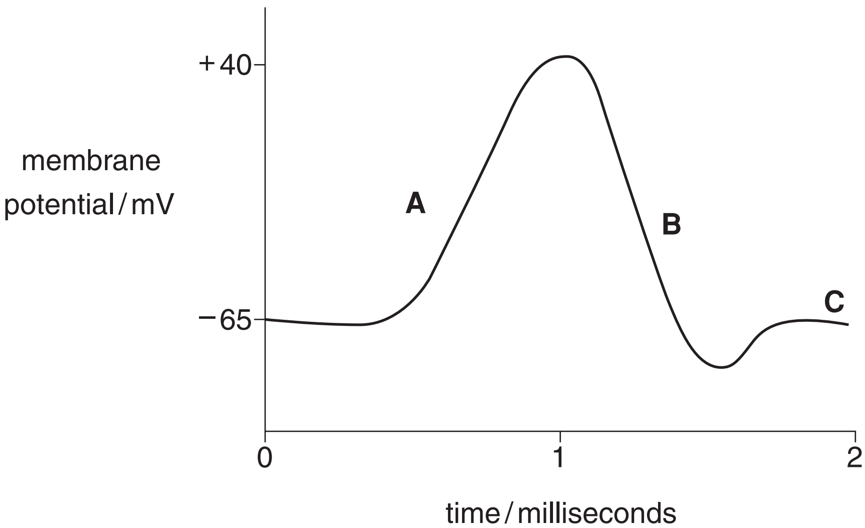

Fig. 6.2

(a) **(i)** State which of the three diagrams of the axon membrane in Fig. 6.1 match up to the phases labelled in Fig. 6.2. Write your answers in the table below.

phase	number
A	
B	
C	

[1]

(ii) With reference to Fig. 6.1, explain the changes in membrane potential in Fig. 6.2.

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....[5]

(b) In this question, one mark is available for the quality of spelling, punctuation and grammar.

In order to transfer information from one point to another in the nervous system, it is necessary that action potentials be transmitted along axons. In humans, the rate of transmission is $0.5\,m\,s^{-1}$ in a nonmyelinated neurone, increasing to $100\,m\,s^{-1}$ in a myelinated neurone.

Explain how action potentials are transmitted along a nonmyelinated neurone **and** describe which parts of this process are different in myelinated neurones.

No credit will be given for reference to events at the synapse.

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....[7]

Quality of Written Communication [1]

[Total: 14]

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7 An experiment was carried out to investigate the effect of gibberellins on stem elongation in both wild type and dwarf varieties of *Brassica campestris*. Plants from both varieties were germinated and grown under controlled laboratory conditions. Stem measurements were taken on day 12 after planting, and then on five more occasions, as indicated in Table 7.1. Stems were measured from the point at which they join the seed to the apical meristem. The plants were divided into four groups as follows:

- wild type variety treated with a gibberellin solution
- dwarf variety treated with gibberellin solution
- wild type variety treated with water (control)
- dwarf variety treated with water (control).

The stem lengths were measured and the mean values are shown in Table 7.1.

Table 7.1

A table has been removed due to third party copyright restrictions

Details:

A table of data showing the average length of stems of plants varying in age

(a) (i) Suggest how the dwarf variety may have arisen.

....

....

.... [2]

(ii) State two environmental factors that would need to be controlled during this experiment.

1 ....

2 .... [2]

(b) With reference to Table 7.1, describe the effect of the gibberellin solution on stem elongation in both the wild type and dwarf varieties.

wild type

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dwarf

....

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....[5]

(c) Explain the different effects of the gibberellin solution on stem elongation in these two varieties.

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....[2]

[Total: 11]

END OF QUESTION PAPER

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Q1 Fig. 1.1 © Barrie Galpin, Leicestershire and Rutland Wildlife Trust, http://www.rutlandwater.org.uk/
Q1 Fig. 1.2 Image copyright Offwell Woodland & Wildlife Trust, www.offwell.info
Q2 Fig. 2.1 © A G Jones, *Male pregnancy and the formation of seahorse species* © *Institute of Biology*, 2004
Q7 Table 7.1 From Russell and Sunday www.sfu.ca/-msr/Papers/BISC/brassica.html