

Please place one
of your Candidate Identification labels
in this box

CANDIDATE'S NUMBER:

In figures

In words

TIME ALLOWED FOR THIS PAPER:

Reading time before commencing: Ten minutes.
For working paper: Three hours.

MATERIAL TO BE PROVIDED FOR THIS PAPER:

Question paper comprising 40 pages and 47 questions.
One piece of blank paper for rough work.

INSTRUCTIONS TO CANDIDATES: See page 2 of this question paper.

FOR EXAMINER'S USE ONLY							
Section	Question Number	First Mark	Second Mark	Section	Question Number	First Mark	Second Mark
A	1 ~ 40			C	46 a		
	41				46 b		
	42				46 c		
B	43				47 a		
	44				47 b		
	45				47 c		
	Sub-total B				Sub-total C		

	First Mark	Second Mark
Final Total		

INSTRUCTIONS TO CANDIDATES:

Marks will be allocated as follows: SECTION A - 40 marks
SECTION B - 36 marks
SECTION C - 24 marks

Write your number on the front of this question paper.

The answer sheet for Section A is on page 40 which is folded into the back of this paper.

Write your number in the box at the top of page 40 before answering Section A. Attempt ALL questions in this section. Marks are NOT deducted for wrong answers.

When you have completed the Section A answer sheet, fold it back inside the question book. DO NOT tear out this sheet.

Answer Sections B and C in the places provided in the question paper.

You are provided with a piece of blank paper for rough work.

You MUST NOT take this question paper away from the examination room.

SEE PAGE 3

SECTION A

Suggested time: 60 minutes (40 marks)

Record each answer for questions 1-40 by marking your choice of alternatives on the answer sheet (page 40). For example, if your choice is 3, show it as follows:

1	2			5
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An error in recording your choice may be cancelled by completely blocking out the error as shown in 4 above.

Give ONE answer to each of questions 1-40. Marks will not be subtracted for wrong answers.

- Each group of organisms in a community derives energy from the group preceding it in the food chain, and energy is

- concentrated
- decreased
- in equilibrium
- recycled

- Members of a species that are found in a particular community are known as

- a population
- a niche
- an ecosystem
- a family

- The action of an enzyme in a biological system is primarily to

- produce energy
- lower energy production
- catalyze a specific reaction
- produce metabolic water

SEE PAGE 4

Questions 4, 5 and 6 are based on the following table. First fill in the blank spaces in the table.

	Organism			
	1	2	3	4
Phylum	Arthropoda			
Class	Insecta			
Order	Coleoptera	Coleoptera		
Family	Buprestidae	Scarabaeidae		
Genus	<i>Melobasis</i>	<i>Heteronychus</i>	<i>Melobasis</i>	Buprestidae
Species	<i>metallica</i>	<i>sanctae-helenae</i>	<i>serplagiata</i>	<i>stigmatera</i>

4. Which two organisms are the most similar?

- 1 and 2
- 1 and 3
- 1 and 4
- 2 and 3

5. Which organism is the most distantly related to organism 4?

- 1
- 2
- 3
- All are equally related

6. Which organisms belong to the same family?

- 1 and 4 only
- 2 and 4 only
- 1, 3 and 4 only
- 1, 2, 3 and 4

7. Genes affecting the same trait which are located at the same position on homologous chromosomes are called

- alleles
- dominants
- recessives
- genotypes
- phenotypes

SEE PAGE 5

8. If the generation time of a certain species of bacteria is 20 minutes, how many bacteria will be present after two hours if we start with one bacterium?

- 12
- 32
- 40
- 64
- 128

9. Both sea squirts and lampreys have a notochord at some stage of development, and a ventral heart. This similarity of two different kinds of animals is explained by postulating

- similar adaptations to the same predators
- a likeness of dietary habit
- the same environmental pressures
- the same type of development of the fertilized egg
- a common ancestry

10. Which of the following is the best example of an evolutionary change in a species?

- Change of colour of a canary's feathers due to feeding the bird pepper
- Yellowing of bean seedlings grown in the dark
- Alteration of molecular structure of DNA by radiation
- Development of thicker fur on a rabbit in winter

11. "A tentative statement, or supposition adopted provisionally as a working tool to explain certain facts and to guide investigations of the problem" describes a

- law
- conclusion
- hypothesis
- purpose
- principle

SEE PAGE 6

12. Robert Brown announced the presence of the nucleus in cells about ten years before Schleiden and Schwann put forward a "cell theory". Which of the following best explains why this occurred?

1. The nucleus is more important than the cytoplasm
2. The English had better microscopes than the Germans
3. Nuclei take a darker stain than other parts of cells
4. The nucleus is an observable structure while the "cell theory" is a generalisation
5. In cell division, the behaviour of chromosomes is the most conspicuous phenomenon

13. Transpiration rate in a maple tree is controlled by

1. mitochondria
2. stomata
3. xylem vessels
4. cambium

14. After being removed from the blood, the fluid collected in the Bowman's capsules passes through the kidney tubules, where much of it is reabsorbed. Of the following substances, which one is completely reabsorbed under normal conditions?

1. Uric acid
2. Salts
3. Water
4. Urea
5. Glucose

15. Using a 50X objective, the area of the field of view is 0.07 mm^2 and one sees, on the average, 8 stomates in this field of view. What is the density of stomates per mm^2 ?

1. 11.40
2. 0.56
3. 114.29
4. 5.60

SEE PAGE 7

Questions 16 17 are based on the following information about three new species of animals which fit into our existing classification system.

	Species		
	A	B	C
Habitat	terrestrial	marine	terrestrial
Embryo develops in	water	mother	egg
Mates	in water	in water	on land
Skeleton is	internal	internal	internal
Epidermis covered with	slime or mucus	hair	scales

16. Which specimen(s) probably has (have) internal fertilization?

1. A only
2. B only
3. C only
4. A and B only
5. B and C only

17. Which of the following would be the most likely sequence based on number of eggs released at one time (least to most)?

1. A, B, C
2. A, C, B
3. B, C, A
4. B, A, C
5. C, B, A

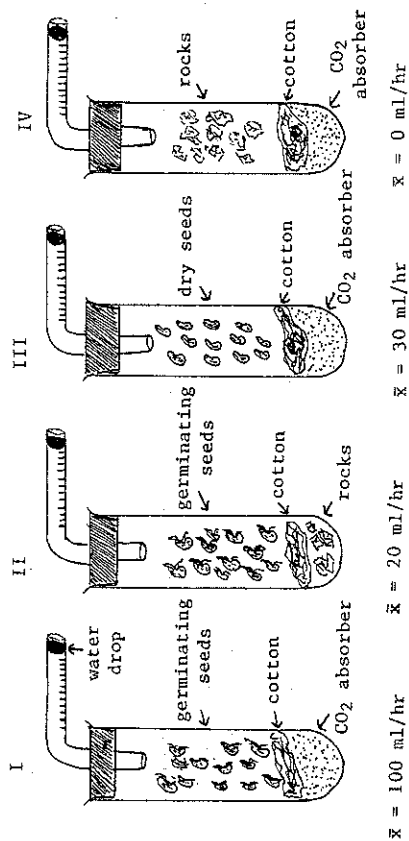
18. Two student observers simultaneously took the radial artery pulse of one patient, using both of his arms. Frequently the pulse rate counts varied slightly between the two observers. These differences in counts were probably the result of

1. individual differences between the two observers
2. a different contraction rate between the left and right ventricles
3. a possible constriction in one of the radial arteries
4. a difference in muscular contraction between the two arms

SEE PAGE 8

Questions 19-21 are based on the following information.

Using respirometers, an experiment was performed to determine the respiration rate of germinating pea seeds. A respirometer measures gas volume. The average value (\bar{x}) for 10 repetitions for each of four respirometers is shown below. Note that a decrease in gas volume causes the water drop to move to the left.



19. What is the purpose of respirometer IV?

1. to measure temperature and atmospheric pressure changes
2. to equalise temperature and atmospheric pressure
3. to show that rocks do not respire
4. to compare respiration in living and dead things
5. it has no purpose since the water droplet did not move

20. What is the best general interpretation of these data?

1. dry pea seeds have a higher respiration rate than germinating seeds
2. germinating pea seeds have a higher respiration rate than dry seeds
3. dry and germinating pea seeds use O_2 at about the same rate
4. dry seeds do not use very much O_2
5. rocks absorb CO_2

SEE PAGE 9

21. Comparing tubes I and II, what can be said about the amount of CO_2 produced and the amount of O_2 used in tube I?

1. CO_2 output is greater than O_2 input
2. CO_2 output is less than O_2 input
3. CO_2 output equals O_2 input
4. CO_2 output varies

22. Brine shrimps repeatedly exposed to light over short time intervals respond positively to this stimulus for a while and then no longer react. One possible explanation of this is that the light stimulus is associated with their food, algae. This explanation is best called

1. a fact
2. a hypothesis
3. a conclusion
4. an observation

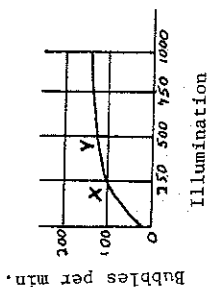
23. Rather than respond to light energy, the brine shrimp may respond to a temperature change produced by the light. Which of the following would probably resolve this?

1. Expose one side of the darkened container to a source of heat and the other side to a source of light
2. Expose the darkened container to a light which is first passed through a heat filter
3. Measure the water temperature before and during exposure to light
4. Expose one culture to heat-filtered light and another culture to unfiltered light

SEE PAGE 10

Questions 24 and 25 are based on the following information.

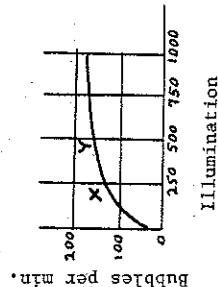
Elodea shoots were placed upside down in water and illuminated. Bubbles of constant size which were emitted from the leaves and stem were counted. Intensity of illumination was varied by moving the light source. Results are shown in the following figure.



24. What is the best interpretation of these data alone?

1. heat is the limiting factor
2. light is limiting up to X and then some other factor becomes limiting
3. CO_2 is the limiting factor
4. light is limiting up to X but darkness limits beyond Y
5. temperature increases the rate of bubble emission

The above experiment was repeated except that a strong bicarbonate solution was added to provide an excess of CO_2 . Results are shown in the following figure.



SEE PAGE 11

25. What does experiment 2 tell us about experiment 1?

1. CO_2 is the limiting factor at X in experiment 1
2. light can be made to be limiting by decreasing other factors
3. temperature is limiting at Y in experiment 2
4. CO_2 is limiting at X in experiment 2
5. light is limiting at X in experiment 2

26. The principle of division of labour in multicellular organisms involves

1. production of cells, each of which can carry out many functions
2. reduction of interdependence of cells
3. differentiation of cells into tissues having different functions
4. growth of more cells to do the work required

27. Active transport occurs when substances move across membranes

1. from lower to higher concentrations
2. from higher to lower concentrations
3. by osmosis
4. by simple diffusion

28. The term digestion refers to

1. burning food for energy
2. building up proteins from amino acids
3. changing organic molecules
4. breaking large molecules into smaller ones

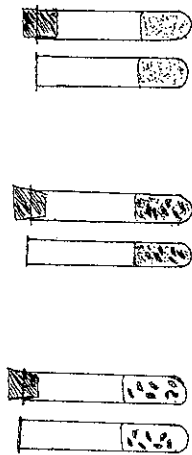
29. The small intestine is adapted for efficient absorption because it

1. has a good nerve supply
2. is of short length
3. has muscular walls to move the food along
4. has folds and villi

SEE PAGE 12

Questions 30-32 are based on the following experimental design. All the tubes were exposed to normal 24-hour-day condition.

I II III IV V VI



Paramecium
in pond water

Paramecium
and green algae
in pond water

Green algae
in pond water

30. In which tube would CO₂ increase most rapidly?

1. I
2. II
3. III
4. IV

31. In which tube would the *Paramecium* population have the best chance of surviving over several months?

1. I
2. II
3. III
4. IV

32. If all of the tubes were placed in the dark for several days, which tube would have produced the same results in the dark as it did in the light?

1. I
2. III
3. V
4. VI

33. In some areas houseflies are not killed by DDT because they

1. have a superior sense of smell
2. produce more ATP than other flies
3. are survivors of ancestors that were resistant to DDT
4. have developed resistance to DDT in order to survive

SEE PAGE 13

34. If a chemical that prevents meiosis was applied to each of the following animals, which one would probably still be able to reproduce?

1. rat
2. fish
3. frog
4. *Paramecium*

35. What is the main disadvantage of a spherical cell doubling its diameter without dividing?

1. the effectiveness of diffusion is reduced
2. the nucleus loses control of half the cytoplasm
3. there is increased volume for stored food
4. the amount of food diffusing into the cell is reduced

36. Which is most important in determining the direction of evolution of an animal species?

1. high mutation rate for certain traits
2. independent assortment and recombination of certain traits
3. selection of certain traits by environmental conditions
4. the gradual change of certain traits by environmental conditions
5. an inner desire to survive in the face of change

37. Blood which leaves the liver and moves to the heart has a higher than usual concentration of which of the following?

1. Urea
2. Bile
3. Oxygen
4. Red blood cells
5. White blood cells

SEE PAGE 14

Questions 38-40 are based on the following information.

Bacterium X was grown in a liquid medium which was then diluted and pipetted on the surface of 5 plates. To 4 of these was added an antibiotic, neomycin. The cultures were exposed either to the dark or to different intensities of ultraviolet (UV) light as shown in the table below. Colony counts after incubation were as follows:

	I dark	II low UV	III medium UV	IV high UV	V dark
Colonies per culture	5	10	25	50	10,000
Neomycin in medium	yes +	yes +	yes +	yes +	no -

38. What is the naturally occurring rate of mutation for the neomycin resistance trait in bacterium X? Assume that no neomycin-resistant bacteria were in the original population.

1. 0.05%
2. 0.10%
3. 0.25%
4. 0.50%

39. How much does high intensity ultraviolet change the naturally occurring mutation rate for neomycin resistance in bacterium X?

1. it doubles the rate
2. it increases it 5 times
3. it increases it 10 times
4. it increases it 50 times
5. it does not change the ratio

40. Which plate served as the control for intensity of ultraviolet light exposure?

1. I
2. V
3. I and V
4. II and III
5. there was no control

SEE PAGE 15

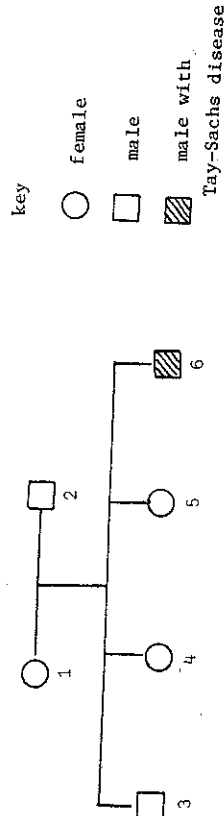
SECTION B

Suggested time: 75 minutes (36 marks)

Attempt all questions in this section. Write your answers in the spaces provided.

41. (9 marks)

In man, the disease Tay-Sachs results in complete mental degeneration, blindness and death usually before the age of 3 or 4 years. The allele for Tay-Sachs is inherited as a recessive autosomal lethal. From the information given in the pedigree, answer the questions listed below.



(a) What proportion of the gametes of male 2 carry the Tay-Sachs allele?

(b) What is the probability of any additional female offspring from the mating of 1 and 2 being a carrier of the Tay-Sachs allele?

(c) If a carrier female mates with male 3, what is the probability of their first child suffering from Tay-Sachs disease? Show in detail how you obtained your answer.

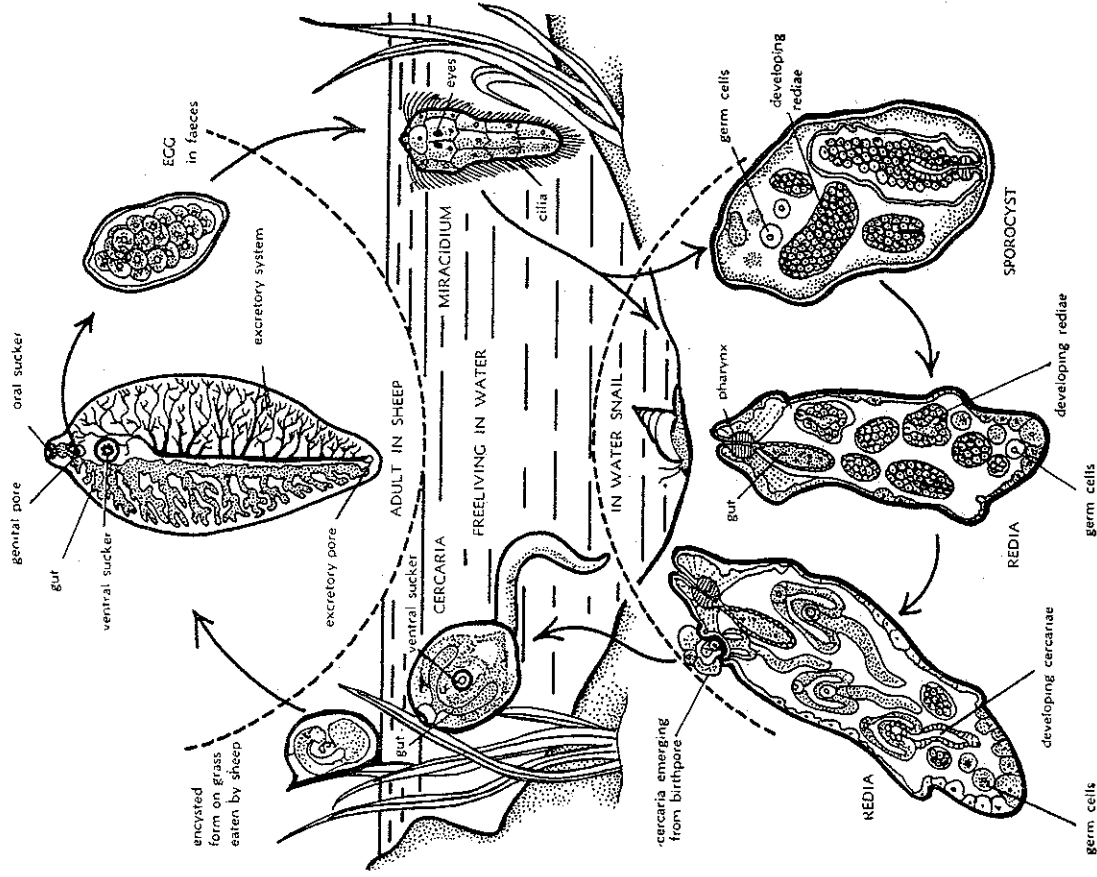
(d) In the case of (c) above, what is the probability of their third child suffering from Tay-Sachs disease?

(e) In general, given that numerous offspring are produced in the mating of 1 and 2 in the above pedigree, what proportion of female infants would you expect to show Tay-Sachs disease? Explain your answer.

SEE PAGE 16

42. (7 marks)

FASCIOLA HEPATICA: LIFE HISTORY



SEE PAGE 17

42. (continue...)

In the life cycle of the liver fluke, the adult parasite in the duct of the sheep produces millions of eggs that are passed in the host's faeces. Some of the eggs are washed into ponds and rise to miracidia which bore into a certain species of snail. In this host, the development continues and eventually myriads of cercariae are released which swim to the vegetation at the edge of the pond. They encyst and may be ingested by a sheep and the cycle begins again.

(a) Explain why the adult fluke produces so many eggs.

(b) Give two possible ways in which the spread of the liver fluke may be controlled.

(c) What is the role of the snail in this life cycle?

(d) Give two structural adaptations for parasitism seen in this life cycle.

(e) Give one behavioural adaptation shown by the free-living stages.

SEE PAGE 18

43. (8 marks)

A scientist, who was studying germination in plants, placed some seeds in the light and others in the dark. At intervals of two days, she determined the amount of weight gain or loss of dry matter in the seeds (or seedlings). In both of the containers, plants bearing leaves appeared on day 12. Below are her results:

Number of days from start of experiment	Percentage gain or loss in weight	
	In light	In dark
2	-2.5	-2.5
4	-5.0	-6.0
6	-8.0	-9.0
8	-10.0	-10.5
10	-12.0	-12.5
12	-15.0	-16.0
14	-17.0	-17.5
16	-18.5	-20.0
18	-16.0	-22.0
20	-13.0	-25.0
22	-7.0	-27.0
24	+1.0	-30.0
26	+9.5	-32.0
28	+19.0	-33.0
30	+27.0	-35.0

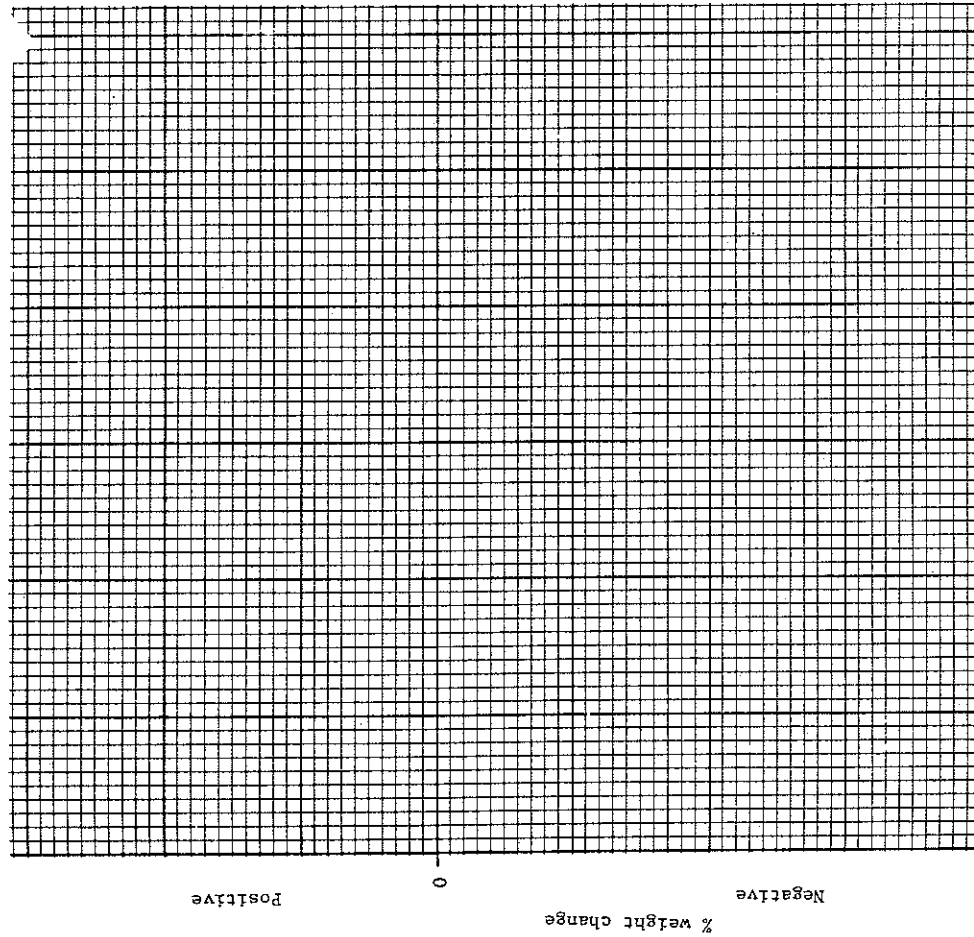
(a) Graph these data on the graph paper provided. You may use the spare graph paper on page 39 if you need to do so.

(b) What is the name of the initial process by which plants reproduce organic materials?

(c) Explain the reason for the difference between the graphs for the two seed groups.

SEE PAGE 19

43. (continua



Number of days from start of experiment

SEE PAGE 20

44. (5 marks)

An investigation was conducted into the amount of amylase present in the saliva of three groups of people living in Africa. These groups were:

- (i) the Tswana whose diet consisted mainly of carbohydrates (sorghum and maize) with only very small amounts of meat and vegetables when these were available,
- (ii) the Europeans who ate a mixed diet,
- (iii) the Bushmen who ate mainly lizards, snakes and birds.

The results are tabulated below:

Group	Number of people	Mean activity of amylase in units per ml of saliva
Tswana	92	248
Europeans	32	101
Bushmen	10	22

- (a) Give one hypothesis which was probably under test in this investigation.

SEE PAGE 21

44. (contii. d)

- (b) Do the results support your hypothesis? Explain your answer.

- (c) Five Bushmen lived in a city environment for six months and consumed the same foods as Europeans. At the end of this period their saliva was tested and found to contain 95 units of amylase. What possible conclusion could be drawn from this information?

- (d) Suggest two improvements to the experimental design used in (c).

SEE PAGE 22

45. (7 marks)

The following table shows the number of mice caught in 10 traps randomly placed in a 100 hectare field over a period of 12 months:

Month	Number caught	Month	Number caught
Jan	50	July	2
Feb	45	Aug	14
Mar	40	Sept	11
Apr	30	Oct	20
May	25	Nov	31
Jun	5	Dec	40

- (a) For the mice in this field, determine between which two successive months there was the greatest rate of change in the population size. Show your reasoning.

- (b) Calculate the change in density of mice between March and April. Show your working.

SEE PAGE 23

45. (continued)

- (c) Give any two assumptions we would have to make about the sampling method in order to be confident in our answers to (a) and (b).

- (d) If the rate of population growth in these mice at a certain time was 200/1000/year, the immigration rate was 40/1000/year, death rate was 10/1000/year and birth rate was 180/1000/year, what would have been the emigration rate? Show your working.

SEE PAGE 24

SECTION C

Suggested time: 45 minutes

There are three alternatives to each question. Choose ONE alternative from each question.

Each question is worth 12 marks. Answer both questions in essay form.

Write your answers on the sheets provided at the end of this section.

Where possible, support your answers with labelled diagrams.

46. EITHER

(a) Pesticides have been implicated in severe environmental disturbance. Because of this, scientists throughout the world have been seeking other means of maintaining high agricultural production of crops and livestock.

(i) Explain three ways, other than use of pesticides, of maintaining agricultural productivity in the face of threats by pests. Give named examples.

(ii) Explain why these ways are more desirable than use of pesticides.

OR

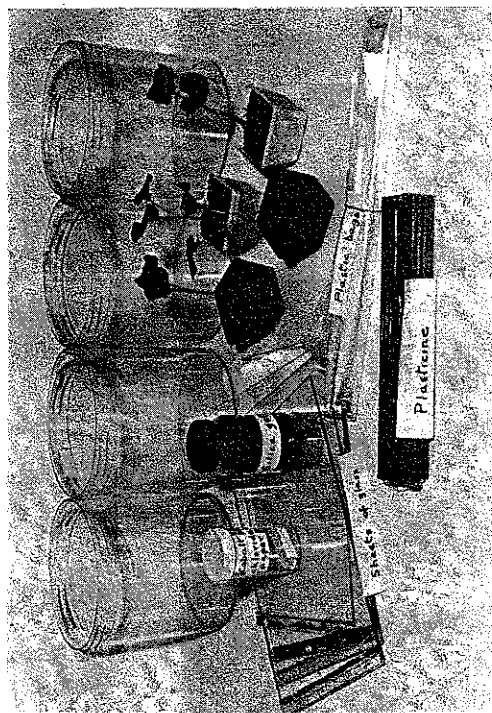
(b) Explain the hormonal control of ONE body process, paying particular attention to the means whereby the rate of hormonal production is varied to suit the differing conditions within the body.

SEE PAGE 25

46. (continued)

OR

(c)



Design an experiment to test the hypothesis that plants transpire. Select the equipment that you would need from that shown above and note that not all of these items may be found necessary.

You may find the following information useful:

- cobalt chloride paper is blue in dry air and pink in humid air
- silica gel crystals absorb water vapour
- plasticine can give an airtight seal.

(i) Draw a diagram of your design and explain why you chose it.

(ii) What results would support the above hypothesis? Give explanations for these results.

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47. EITHER
(a)

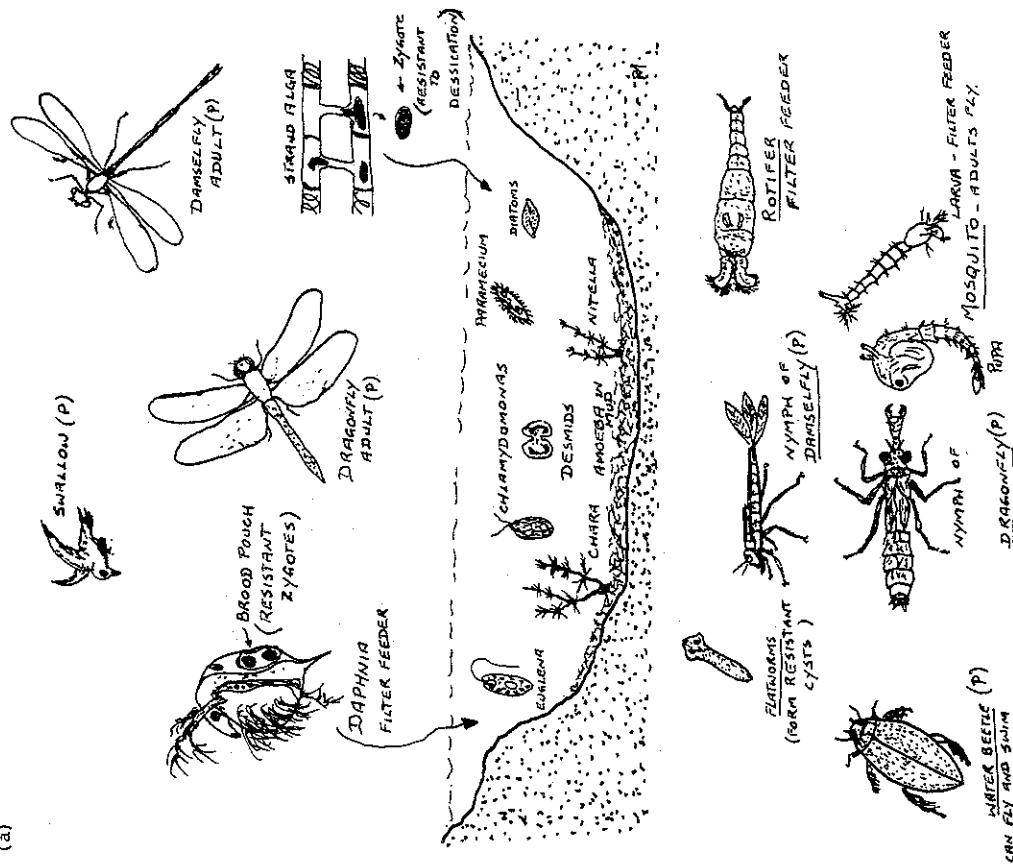
47. (a) (continued)

In the arid zones of Australia the summers are dry and extremely hot. In these areas can be found large sheets and domes of granite in which there are saucer-shaped depressions lined with a layer of dried mud. On the occasions when rain does fall, the depressions fill with water and within a few days living organisms can be found in the pools. As long as water remains, the diversity and numbers of the organisms increases until a state of equilibrium is reached. Eventually the pools disappear and the depressions may remain dry for many years. However, life always returns when they refill with water.

- (i) Give three possible explanations for the reappearance of living organisms in the pool.
- (ii) Explain how energy enters and flows through this ecosystem. How is the amount of biomass at each feeding level related to the flow of energy through the food web? (You should not draw a food web).

[Question 47(b) is on page 28]

SEE PAGE 28



ALL THE ABOVE CAN BE FOUND IN THE WATER

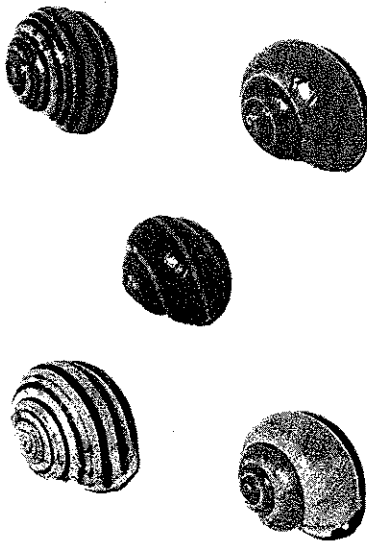
CHARA } GREEN PLANTS
NITELLA } FORM RESISTANT ZYGOTES

DESMIDS } SINGLE CELL
DIATOMS } ALGAE
CHLAMYDOMONAS }

(P) = PREDATOR

SEE PAGE 27

47. OR
(b)



Wide variation in the body colour and degree of development of body banding is to be found in many animals which inhabit a range of environments. For instance, a study of one species of sea snake showed that those individuals with darkly-banded bodies were difficult to detect against a background of dark sea grasses. However the pale, non-banded snakes were invisible against a sandy ocean floor.

In England, Cain and Shepherd discovered a similar diversity in body colour and pattern in the snail, *Cepea nemoralis*, living in the woodlands and meadows of Oxfordshire. They found that the snail's predator, the Song Thrush, made a different choice of food in shady woodlands from that made in green, grassy meadows. The thrush, having broken each shell on an anvil stone, discards it after eating the contained soft tissues. An examination of these shells showed that in woodlands the birds selected snails with pale backgrounds and light banding. However, in open meadows the darker and heavily-banded snails were used as food.

SEE PAGE 29

47. (b) (continued)

The following table gives the results of the shell counts in the two different environments.

Shady Woodland		Open Meadow	
Dark-banded shells	493	Pale-banded shells	340
Pale-banded shells	2875	Dark-banded shells	2567

Investigation into the inheritance of the shell patterns has shown that the banding is controlled by several pairs of genes. Some eggs from dark-banded snails develop into pale-banded animals and the opposite is also true. Thus, despite predation, no colour pattern is completely eliminated from the different *Cepea* populations.

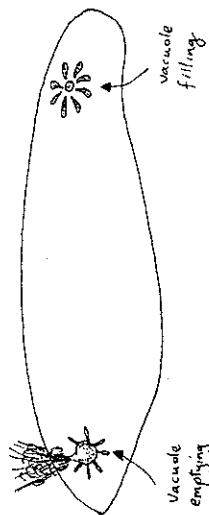
- (i) Imagine that you have been given the task of investigating the relationship between the predator and prey discussed above. Explain how you would carry it out.
- (ii) Explain the advantage to *Cepea* of the range of different phenotypes. Give your reasons why some of these are not eliminated from the species.

[Question 47(c) is on page 30]

SEE PAGE 30

47. OR

(c) *Paramecium*, a freshwater protozoan, has two contractile vacuoles which rhythmically contract and expel the contained fluid. The vacuoles thus get rid of the water which has entered the animal across its cell membrane.



There are three possible ways in which the vacuole can fill:

- X by hydrostatic pressure (water pressure in the cytoplasm forcing water into the vacuole)
- Y by osmosis
- Z by active secretion of water from cytoplasm to vacuole.

The following observations were made during experiments on *Paramecium*:

- (i) The rate at which the vacuole fills seems to be fairly constant regardless of whether it is just starting to fill or is nearly at its full size.
- (ii) Sometimes vacuoles are formed and still expel their contents even when the animal cell is shrunken.
- (iii) Numerous mitochondria lie close to the vacuolar membrane. There is a rough correlation between the number of mitochondria and the frequency of vacuole action.
- (iv) Treating a protozoan with a respiratory inhibitor stops the working of the contractile vacuole and the animal swells up as it takes up water.

Explain which of the ways of filling, X, Y or Z, is supported by all four of the observations. In each case point out why the other two ways could not be taking place.

END OF PAPER