

Homework 1

Q1. Which of the following would be true if a population's gene pool remained unaltered for many generations?

- A Genetic drift had occurred.
- B Mating was random.
- C Migration was common.
- D Certain alleles had a selective advantage.

Q2. A quadrat with sides 50 cm long was used to estimate the density of a plant species in two areas X and Y. Five random samples were taken in each of the two areas and the results are given below.

Quadrat	Number of plants	
	Area X	Area Y
A	27	15
B	19	16
C	39	42
D	19	31
E	11	16

The mean density per square metre in each of the two areas is

	Area X	Area Y
A	23	24
B	46	48
C	92	96
D	115	120

Q3. The formula $N = MC/R$ is used to estimate population size using mark and recapture data.

N = population estimate M = number first captured, marked and released C = total number in second capture R = number marked in second capture. In a survey to estimate a woodlouse population, the following data were obtained:

The estimated population of the woodlice was

- A 200
- B 320
- C 400
- D 3 840

Woodlice captured, marked and released = 80

Marked woodlice in second capture = 24

Unmarked woodlice in second capture = 96

Q4. Which line in the table correctly identifies genetic drift?

	Type of process	Size of population from which alleles are likely to be lost
A	Random	Small
B	Random	Large
C	Non-random	Small
D	Non-random	large

Which of the following factors increases the rate of evolution?

- A Longer generation times
- B Cold environments
- C Horizontal gene transfer
- D Low selection pressure

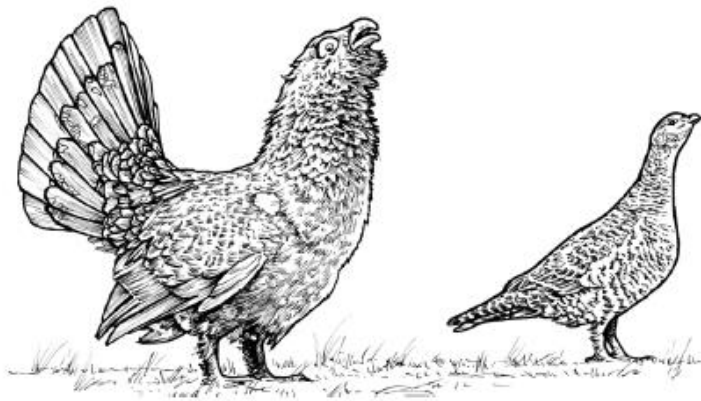
Q5. In evolutionary theory, fitness can be described in absolute or relative terms. Absolute fitness is the ratio of

- A surviving offspring of one phenotype compared with other phenotypes
- B surviving offspring of one genotype compared with other genotypes
- C frequencies of a particular phenotype from one generation to the next generation
- D frequencies of a particular genotype from one generation to the next generation.

Q6. Which line in the table below correctly describes processes underpinning evolution?

	Random	Non-random
A	Mutation	Genetic drift
B	Genetic drift	Mutation
C	Genetic drift	Sexual selection
D	Natural selection	Genetic Drift

Q7. The capercaillie (*Tetrao urogallus*) is the largest member of the grouse family. It is a lekking species found in some old Caledonian pine forests.

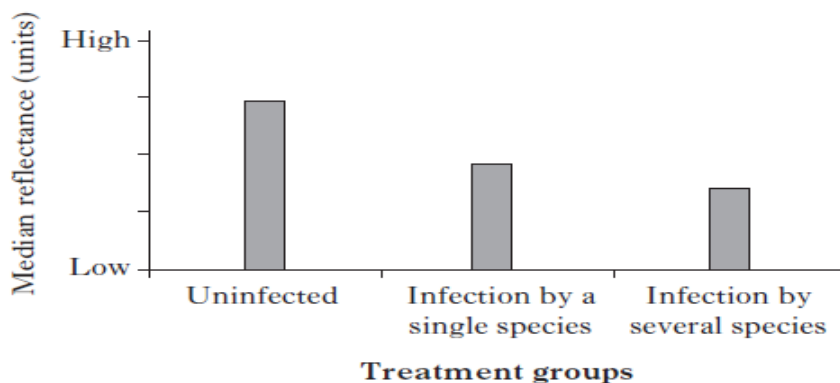


Males are larger and noisier than females, particularly in spring when their displays make them very conspicuous.

- (a) What term is used to describe the condition, shown in the capercaillie, where there are distinct differences between males and females? 1
- (b) State one function of the male displays in spring. 1
- (c) How do females benefit from being inconspicuous? 1
- (d) Explain what is meant by “lekking species”. 2

Total 5

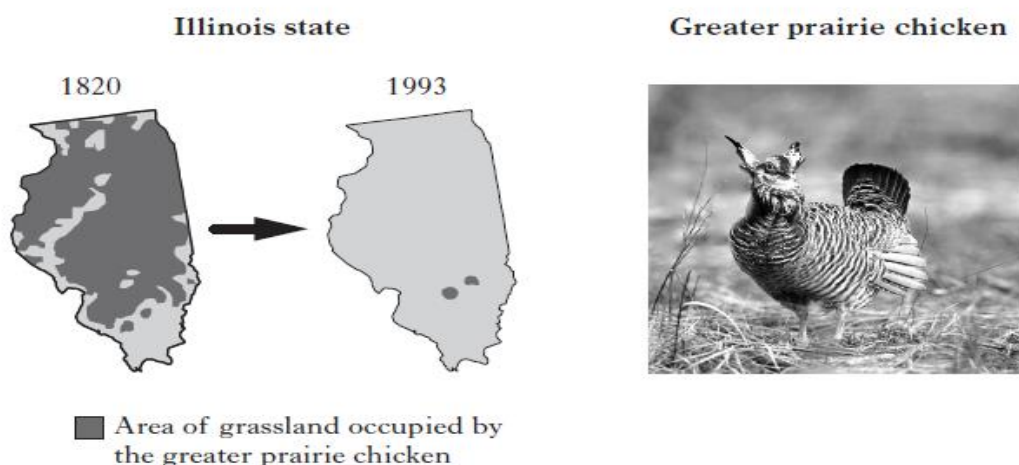
Q8. The North American wild turkey (*Meleagris gallopavo*) shows distinct differences between males and females. The males have vividly-coloured, iridescent plumage. An experiment was carried out to investigate the effect of parasite infections on the amount of light reflected by the males’ plumage. Results are shown in the chart below: lower reflectance scores indicate duller plumage.



- (a) What term is used to describe the differences between males and females? 1
- (b) Describe the relationship between parasitic infection and the male birds’ plumage. 1
- (c) The researchers have suggested that iridescent coloration in wild turkeys serves as an honest signal to females. How will this influence mating success? 2

Total 4

Q9. During the 19th and 20th centuries large areas of grassland in Illinois state (USA) were converted to farmland and the population of greater prairie chickens (*Tympanuchus cupido*) crashed. Researchers hypothesised that there would be a loss of genetic variation during this period of conversion.



(a) In this situation, what term describes any loss of genetic variation? 1

(b) To investigate the amount of genetic variation, DNA from museum specimens of greater prairie chickens collected in 1930 was compared with DNA from chickens sampled in 1993. Two large populations in the states of Kansas and Nebraska were surveyed in the same way in 1998. The numbers of alleles for six loci were compared. The table below summarises the data.

<i>State</i>	<i>Year</i>	<i>Population Size</i>	<i>Number of alleles per locus</i>	<i>Percentage of eggs hatched</i>
Illinois	1930	25 000	5.2	93
	1993	50	3.7	50
Kansas	1998	750 000	5.8	99
Nebraska	1998	200 000	5.8	96

(i) Use the data to show that a loss of genetic variation has followed the conversion to farmland in Illinois. 1

(ii) Why have the researchers included data for the other two states? 1

(iii) What evidence suggests that the frequency of harmful alleles may have increased following the conversion to farmland? 1

(iv) Suggest how the loss of genetic variation in Illinois could be counteracted. 1

Total 5

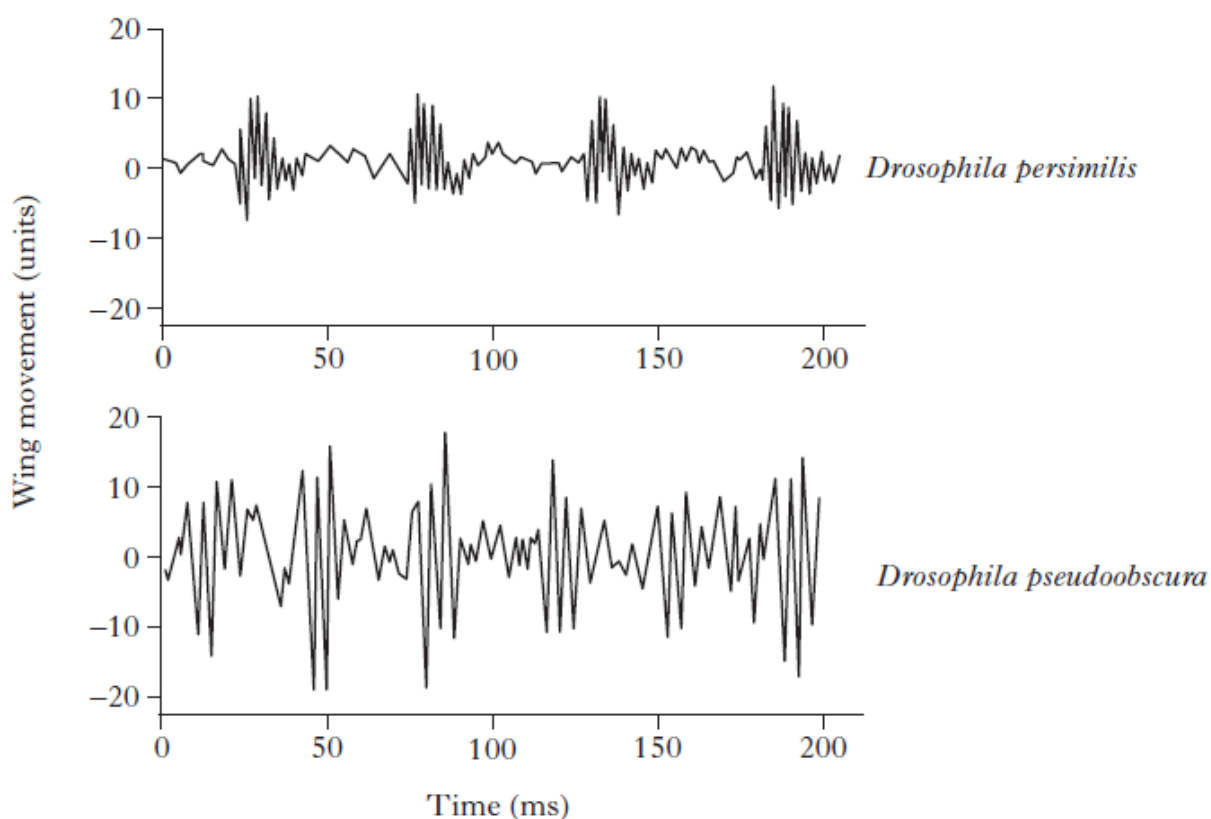
Q10. The 'songs' produced by male fruit flies (*Drosophila* spp.) are important courtship stimuli. The songs are produced by patterns of rapid wing vibration in short pulses.

(a) For a male fruit fly, what would constitute 'successful' courtship?

1

(b) The figure below shows recorded courtship songs of two related species of fruit fly, *Drosophila persimilis* and *Drosophila pseudoobscura*. These two species have similar distributions in western North America. Each song can be seen as a series of 'pulses' separated by short time intervals.

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(i) Use the figure to compare pulse frequencies of the two species.

1

(ii) Females of both species discriminate against males that are not of their own species, whilst males will court females of either species. Use the concept of investment to explain the importance of courtship songs to females.

2

(iii) Why can the courtship song of male *Drosophila* flies be regarded as a characteristic that has undergone sexual selection?

1

Total 5

Homework 2

Q1. Which of the following is not a source of DNA during horizontal gene transfer in bacteria?

- A Virus
- B Plasmids
- C Bacterial cells
- D Gametes

Q2. In evolutionary theory, fitness can be described in absolute or relative terms. Absolute fitness is the ratio of

- A surviving offspring of one phenotype compared with other phenotypes
- B surviving offspring of one genotype compared with other genotypes
- C frequencies of a particular phenotype from one generation to the next generation
- D frequencies of a particular genotype from one generation to the next generation

Q3. Rabbits can be infested with nematode parasites in their gut. Infestation by nematodes may be a major factor controlling population density of rabbits. Which of the following procedures would test this hypothesis? Comparing rabbit population densities in

- A infested populations from areas with different food supplies
- B rabbits infested with nematodes or with other parasites
- C areas with and without competition from other herbivores
- D infested and non-infested rabbit populations.

Q4. Which of the following factors increases the rate of evolution?

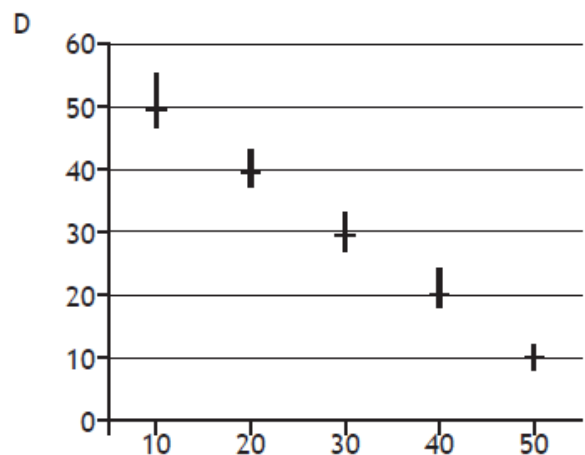
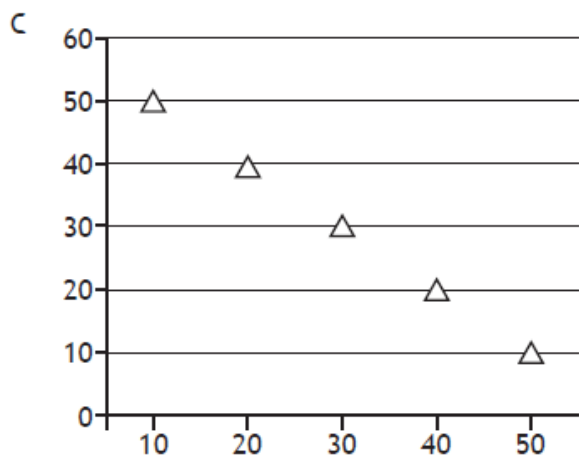
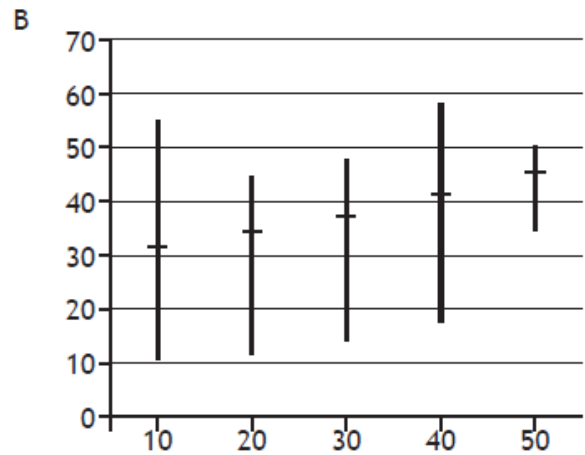
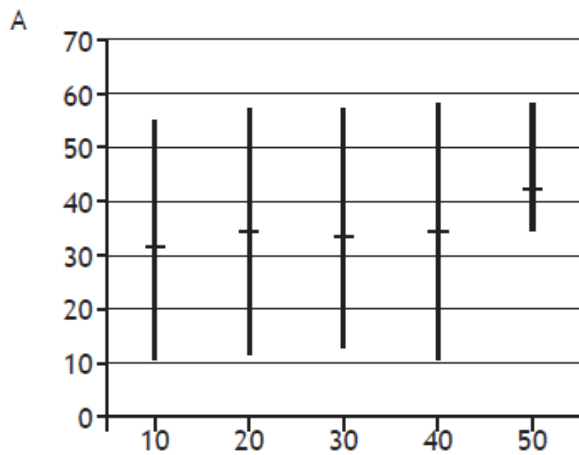
- A Longer generation times
- B Cold environments
- C Horizontal gene transfer
- D Low selection pressure

Q5. From the following list, identify all the possible sources of DNA during horizontal gene transfer.

1. viruses
2. plasmids
3. bacterial cells
4. gametes

- A 1 and 2 only
 B 2 and 3 only
 C 1, 2 and 3 only
 D 1, 2, 3 and 4

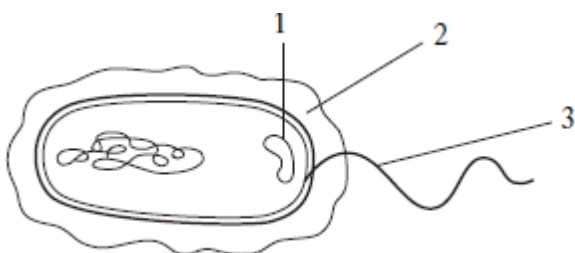
Q6. The error bars on the graphs represent standard errors in the mean (SEM). Which graph shows significantly different reliable data?



Q7. A species of Latin American ant inhabits the thorns of a species of Acacia. The ant receives nectar and shelter from the plant. The plant receives protection from the ants. This is an example of

- A parasitism
- B commensalism
- C mutualism
- D predation.

Q8. The following diagram represents a bacterial cell.



Which one of the following correctly identifies the structures labelled 1, 2 and 3

	1	2	3
A	plasmid	flagellum	capsule
B	flagellum	capsule	plasmid
C	plasmid	capsule	flagellum
D	capsule	plasmid	flagellum

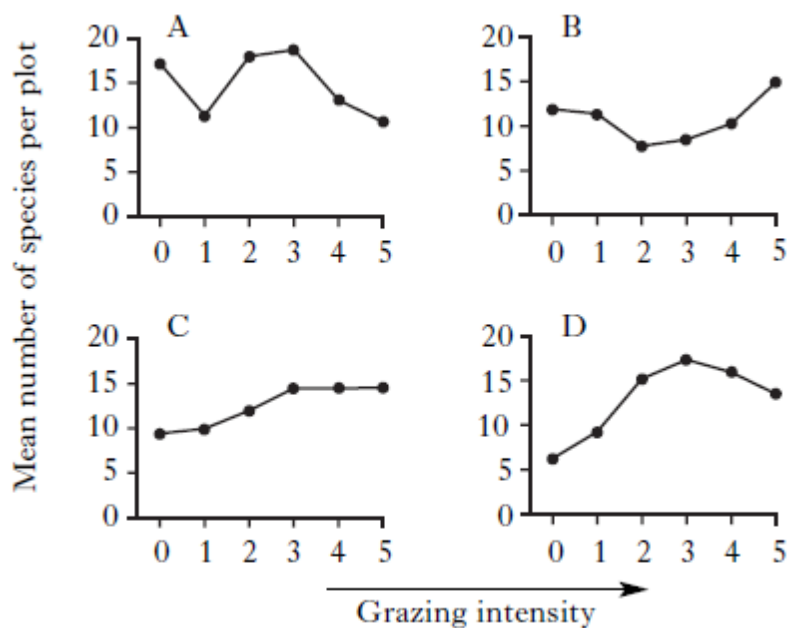
Q9. The table below shows the results of a population survey of Hydrobia snails using a quadrat in five random positions on a muddy beach

<i>Quadrat</i>	1	2	3	4	5
Number of snails	1800	2600	2100	1900	1600

The quadrat measured 50 cm × 50 cm. What was the average density of Hydrobia per square metre?

- A 2000
- B 4000
- C 8000
- D 10 000

Q10. Which of the graphs best represents the relationship between the intensity of rabbit grazing and the diversity of plant species in a series of grassland plots?



Q11. The beef tapeworm (*Taenia saginata*) lives within the small intestine of humans. For part of its life cycle, it does not have a digestive system. Therefore, the parasite is said to

- A be degenerate
- B be a micro-parasite
- C occupy its fundamental niche
- D co-exist by resource partitioning

Q12. Which line in the table below correctly describes the ecological niche of a parasite?

	<i>Niche</i>	<i>Host specificity</i>
A	Wide	High
B	Wide	Low
C	Narrow	High
D	Narrow	Low

Q13. Which of the following features of a parasite may be considered a part of its extended phenotype?

- A High genetic variability
- B Alteration of host behaviour
- C Rapid antigen change
- D Virulence

Q14. *Schistosoma mansoni* is a parasitic worm which causes the disease schistosomiasis in humans. The parasitic worm is found in body organs including the liver and intestines. *Schistosoma mansoni* is an example of

- A a microparasite and is ectoparasitic
- B a macroparasite and is ectoparasitic
- C a microparasite and is endoparasitic
- D a macroparasite and is endoparasitic.

Q15. virulence of an infectious organism is defined as the case fatality risk (CFR). CFR can be represented as the percentage of infections that result in death. The table below shows the numbers of people infected by the "bird flu" virus (H5N1) and the numbers who died from it over a five year period.

<i>Year</i>	<i>2004</i>	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>
Total infections of H5N1	46	98	115	88	44
Number dying from H5N1 infection	32	43	79	59	33

In which year was H5N1 most virulent?

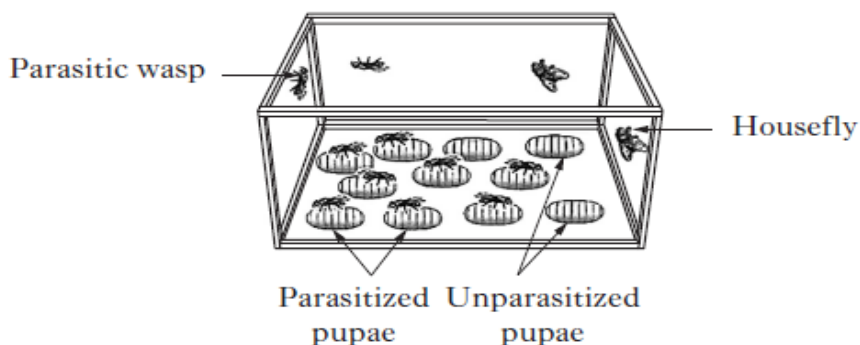
- A 2004
- B 2006
- C 2007
- D 2008

Q16. The parasitic wasp, *Nasonia vitripennis*, lays its eggs inside the pupa stage of the housefly, *Musca domestica* (Figure 1). Wasp eggs hatch into larvae that consume the housefly pupae. Figure 2 shows a cage set up with populations of the wasp and the housefly.

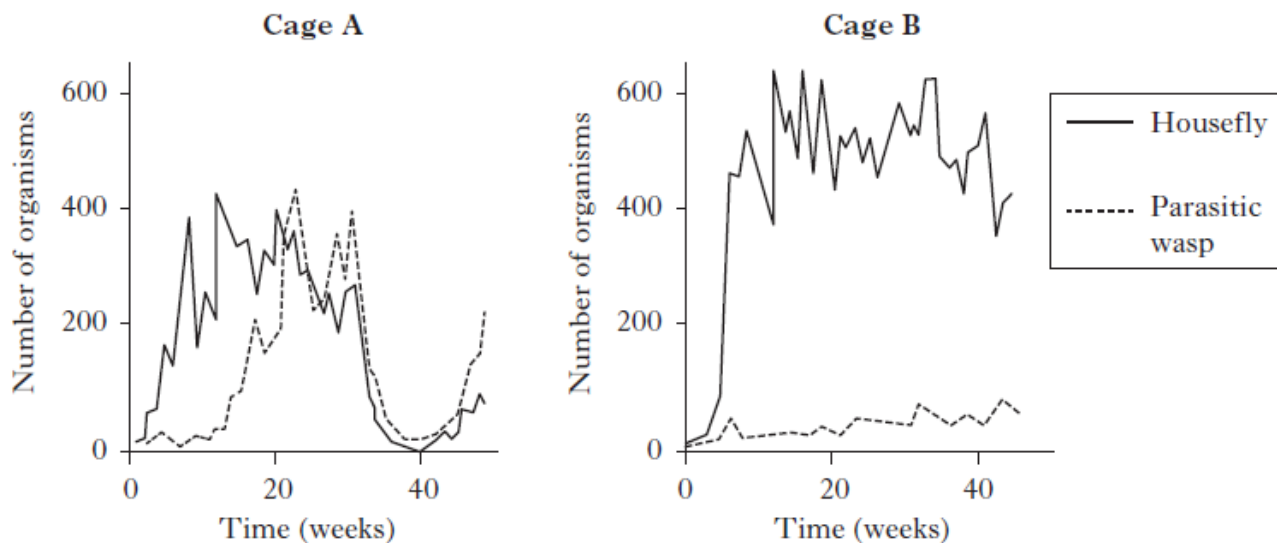
Figure 1



Figure 2



In a study to test the host's evolutionary response to the parasite, two cages were set up. In Cage A the housefly population had no previous exposure to wasps; in Cage B the housefly population had already been exposed to wasp parasitism for three years. The graphs below show population changes in both species in the two cages over a 40 week time period.



(a) (i) How do the results support the general conclusion that the houseflies had developed resistance to wasp parasitism? 1

(ii) Explain how the resistance would have evolved. 2

(b) The response of the housefly is an example of co-evolution.

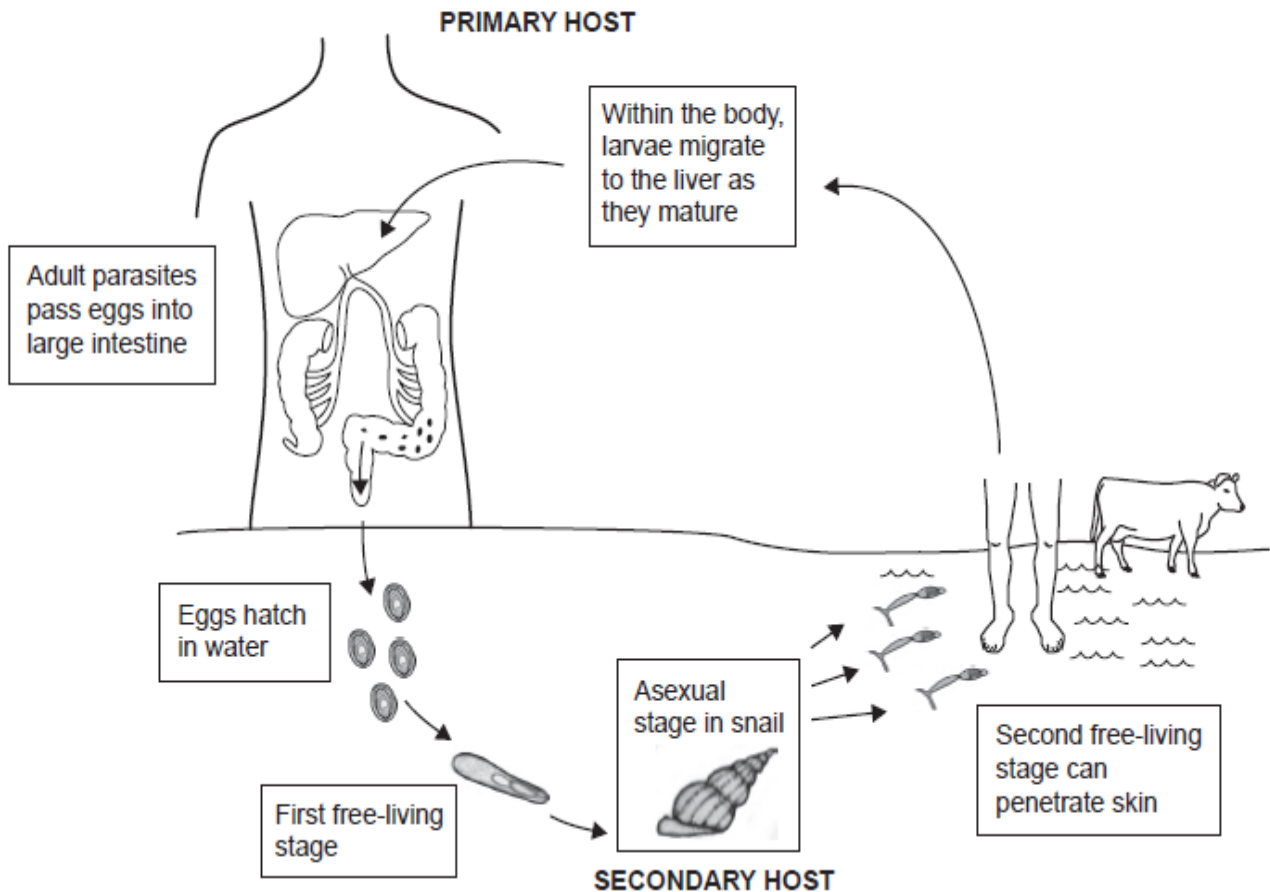
(i) What is meant by the term co-evolution? 1

(ii) According to the Red Queen hypothesis, what population change would be expected in Cage B if it is now left undisturbed? 1

Total 5

Q17. The figure shows the life cycle of the macroparasitic flatworm called *Schistosoma japonicum*. The flatworm can live for many years within a host. In humans, if untreated, it causes the disease schistosomiasis (bilharzia) that can be fatal.

Figure: Life cycle of *Schistosoma japonicum*



(a) (i) Explain why the snail may not be described as a vector. 1

(ii) Suggest a feature of the parasite's life cycle that can lead to a higher rate of transmission. 1

(iii) Name the phylum to which parasitic flatworms such as *Schistosoma* belong. 1

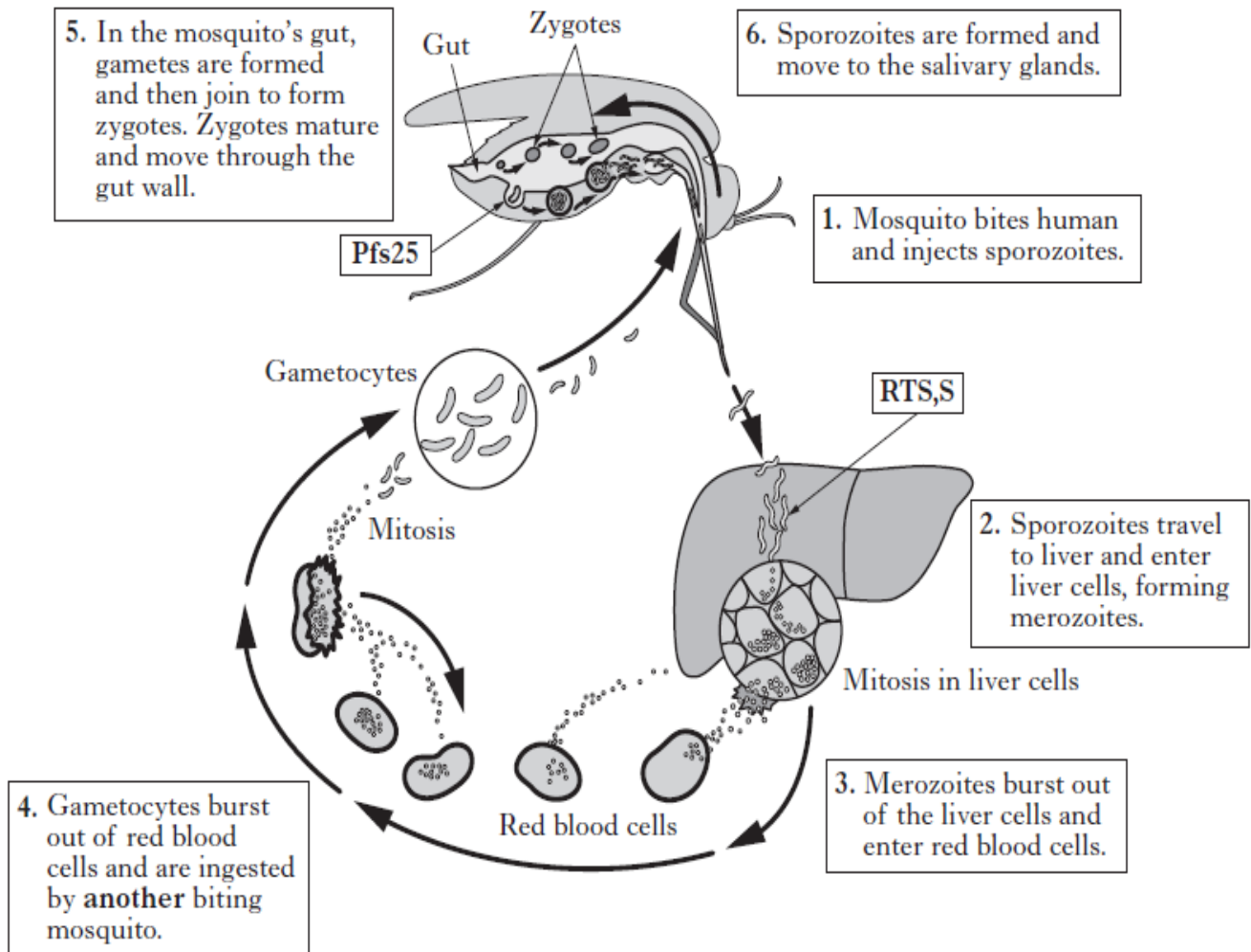
(b) Parasites living inside a host will be exposed to attack by the host's immune system.

(i) Describe one way in which parasites may overcome the immune response of their hosts. 1

(ii) Predict, in terms of the Red Queen hypothesis, how a host species would be expected to respond to the parasite adaptation. 2

Total 6

Q18. The figure below shows the life cycle of *Plasmodium falciparum*, a parasite that causes malaria in humans. The figure also shows stages in its life cycle targeted by two human vaccines, the zygote stage by Pfs25 and the sporozoite stage by RTS,S. Pfs25 is a protein produced by *P. falciparum* when in the mosquito's gut. It allows the mature zygote stage of the parasite to get through the gut wall so that it can pass back to the mosquito's salivary glands. RTS,S vaccine induces the production of antibodies against the main coat protein of the sporozoite stage and stimulates T lymphocyte formation.



- (a) Explain why the mosquito is described as a vector. 1
- (b) Which of the two hosts involved in this life cycle may be described as the definitive host? 1
Justify your answer.
- (c) (i) From the information given, describe how *P. falciparum* manages to avoid exposure to the human immune system. 1
- (ii) Describe one other way in which parasites in general can reduce their chance of being destroyed by the host immune responses. 1

Total 4

Q19A Discuss some of the challenges involved in the treatment and control of parasites.

10

OR

Q19B Discuss factors that maximise the transmission of parasites.

10

Homework 3

Q1. Which line in the table correctly describes cells in meiosis?

	Stage	Chromosome complement	Number of cells
A	Meiosis I	Haploid	4
B	Meiosis I	Diploid	2
C	Meiosis II	Haloid	4
D	Meiosis II	Diploid	2

Q2. The crossing over that generates new allele combinations in meiosis I occurs between

- A sister chromatids of homologous chromosomes
- B non-sister chromatids of homologous chromosomes
- C sister chromatids of non-homologous chromosomes
- D non-sister chromatids of non-homologous chromosomes.

Q3. What information can be derived from the recombination frequencies of linked genes?

- A The mutation rate of the genes
- B The order and location of genes on a chromosome
- C Whether genes are recessive or dominant
- D The genotype for a particular characteristic

Q4. In birds, females are heterogametic. The gene for feather-barring in chickens is sex linked and the allele for barred feathers is dominant to the allele for non-barred feathers. What ratio of offspring would be expected when a non-barred male is crossed with a barred female?

- A 1 barred male : 1 non-barred female
- B 1 non-barred male : 1 non-barred female
- C 1 barred female : 1 barred male
- D 1 non-barred male : 1 barred female

Q5. Independent assortment results in the production of gametes with varying combinations of maternal and paternal chromosomes. How many different combinations are possible in the gametes of an organism whose haploid number is 3?

- A 2
- B 4
- C 8
- D 1

Q6. A student observing the behaviour of a female chimpanzee and one of her offspring made the following field notes:

- 1 offspring displayed lower teeth to mother
- 2 offspring begged mother for food
- 3 offspring clung to mother's back
- 4 offspring smiled at mother

Which of the notes demonstrate anthropomorphism?

- A 2 and 3 only
- B 2 and 4 only
- C 1, 2 and 4 only
- D 2, 3 and 4 only

Q7. Frequency of recombination data were used to determine the relative positions of the linked genes P, Q, R and S on a chromosome. The results are shown in the table:

Gene pair	Percentage recombination
Q and R	14
S and Q	4
R and S	10
R and P	3
P and Q	11

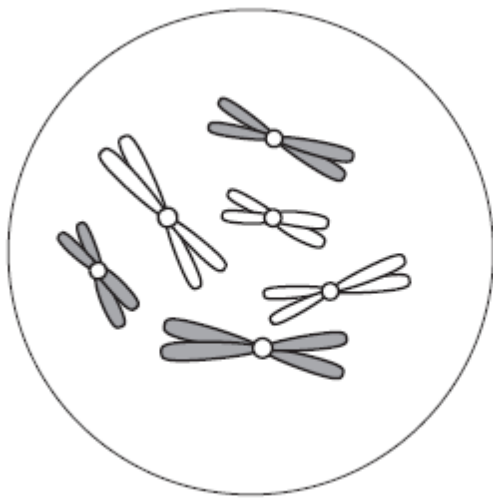
The correct order of genes on the chromosome is

- A RPSQ
- B QSRP
- C SPQR
- D QPSR.

Q8. In the insect order Hymenoptera (e.g. ants, bees and wasps), male individuals can be produced by parthenogenesis from an egg cell. When parthenogenesis does occur, how many sets of chromosomes does a male wasp have in each of its body cells compared to one of his sisters?

- A One extra
- B The same number
- C One fewer
- D Double the number

Q9. The figure below shows a nucleus in the early stages of meiosis I. Paternal chromosomes are shaded, maternal chromosomes are unshaded.



How many different gametes would be produced as a result of independent assortment?

- A 2
- B 6
- C 8
- D 12

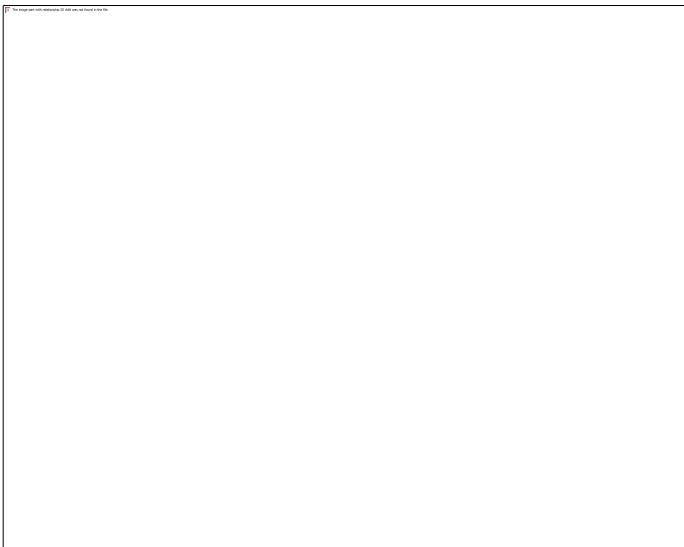
Q10. In mammals, some genes are present on the Y chromosome but not on the X chromosome. An allele of one such gene causes deafness. What is the chance of a male with deafness caused in this way having a child who inherits his condition?

- A 0%
- B 25%
- C 50%
- D 100%

Q11. In some species of bird the females are larger than the males. This is described as

- A lekking
- B reversed sexual dimorphism
- C sexual dimorphism
- D female choice.

Q12. Eggs from leopard geckos kept in breeding cages were collected and incubated at two temperatures over five breeding seasons. When each new gecko hatched, its gender was noted. The graph below shows how temperature affected gender in the population



How many females would be present in a population of 500 leopard geckos after four seasons at 32.5 °C?

- A 150
- B 200
- C 300
- D 350

Q13. Identify the line in the table that applies to r-selected species.

	Many offspring produced	Prolonged parental care
A	yes	yes
B	yes	no
C	no	yes
D	no	no

Q14. *C. elegans* is a model organism of the phylum

- A Chordata
- B Arthropoda
- C Nematoda
- D Mollusca.

Q15. The following diagram is drawn to scale and indicates the position of four linked genes on a chromosome.



Identify the column in the table that gives the correct recombination frequencies for the genes in the chromosome map shown above.

	Recombination Frequency %			
	A	B	C	D
X and Z	9	19	17	15
W and Z	25	25	23	23
Y and W	19	17	15	17
Z and Y	6	8	8	6
W and X	8	6	6	8

Q16. A type of haemophilia results when a gene that codes for a blood clotting factor, factor VIII, is mutated. This gene is located on the X chromosome. Mutated alleles do not produce functional factor VIII.

- (a) Explain why men are more likely than women to be affected by this type of haemophilia 2
- (b) An unaffected man and a carrier woman have a daughter and a son. State the probability of each child being able to produce functional factor VIII. 2
- (c) (i) Explain the importance of inactivation of the X chromosome in females. 1
- (ii) Analysis of a female carrier showed that her blood contained only 42% of the normal levels of functional factor VIII. Suggest why this value was lower than predicted 1

Total 6

Q17(a) Describe the features of chromosomes in homologous pairs.

3

(b) In *Drosophila*, the genes for wing length (W), eye colour (E), body colour (B) and presence of bristles (P) are linked. The table below gives the frequency of recombination obtained in crosses involving different pairs of the linked genes.

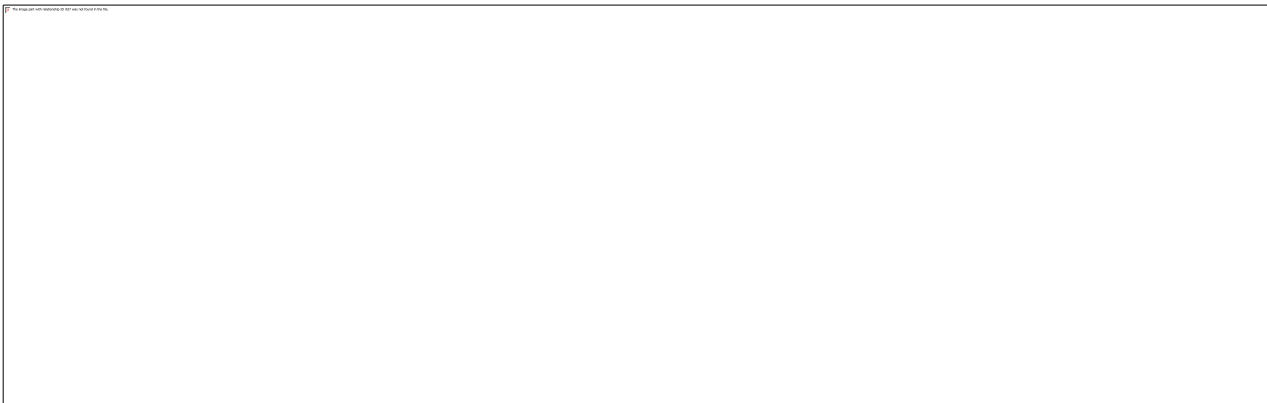
Gene pair in cross	Frequency of recombination (%)
Wing length x eye colour	12
Wing length x body colour	18
Wing length x presence of bristles	15
Eye colour x body colour	6
Body colour x presence of bristles	3

Using the letters W, E, B, and P to identify them, give the sequence in which the genes would be arranged on the chromosome.

1

Total 4

Q18. Figure 1 shows chromosomes of a gamete mother cell at the start of meiosis. The cell has three pairs of chromosomes, labelled A, B and C



(a) The chromosomes of each pair are described as homologous. Apart from being the same size, give two other features that are characteristic of homologous chromosomes.

2

(b) Explain how members of a homologous pair may differ genetically.

1

(c) Select two features from Figure 2 that show meiosis II is taking place.

2

Total 5

Q19(a) The spread of a buttercup plant, *Ranunculus repens*, from an established flowerbed into a nearby disturbed area, is shown in the illustration below.



- (i) What is meant by the term hermaphroditic as it applies to plants, such as the buttercup? 1
- (ii) Explain how asexual reproduction is of advantage to the buttercup in the colonisation of this disturbed area. 1
- (b) What term describes the mode of asexual reproduction in arthropods where offspring arise from unfertilised eggs? 1
- Total 3**

Q20. Describe courtship behaviours that affect reproductive success. 8

AND

Q21. Discuss meiosis under the following headings:

- (i) the sequence of events; 7
- (ii) the origin of genetically variable gametes. 3