

## Mark schemes

(a) (i) 22;

1

1

- (ii) 1. Odd number of chromosomes / 33 chromosomes (in leaf cell);
2. Chromosomes cannot pair / cannot undergo meiosis / would result in half chromosomes / cannot form haploid cells;

2

(b) (i) Fast growth / produces crop fast / produces large crop; *Do not insist on relative statement.*

*Accept similar terms for fast. E.g. "better" growth*

*Do not accept unqualified references to profit.*

1

(ii) Leaves less likely to break / higher breaking strength;

1

(c) Low genetic diversity because they are produced by mitosis;

Will all have the same DNA / genes / alleles / will be genetically identical / will be clones;

**OR**

Low genetic diversity because they are not produced by meiosis;

No crossing over / independent segregation / will not be genetically different;

*Independent segregation is the specification term. Accept other such as random assortment.*

2

[7] (a) **Shape**

2

1. Different penicillin has different shape / structure / enzyme / active site has specific shape / structure;

*Not different*

**Binding**

2. No longer fits / binds to active site / not complementary to active site / does not form E-S complex;

**Consequence**

3. (Different) penicillin not broken down;

- (b) (i) 1. Kills pathogenic / harmful bacteria / pathogens;
2. Disease less likely / improves health / animals healthier / reduces spread of infection;
3. Faster growth / more productive animals / more food converted to meat / greater survival / lower vet's bills / increased yield / less energy (for "fighting infection"); *Principles:*  
*Action of antibiotic. Do not accept stops all disease*  
*Action on health*  
*Effect on production*

2 max

- (ii) 1. (Adding antibiotics) selects in favour of antibiotic resistance / resistant bacteria more likely to survive;
2. Increase in numbers / higher proportion of resistant bacteria;  
*Penalise immune only on the first occasion it occurs in this part of the question.*

2

[7

- 1 (a) (So results) can be compared / so measurement is the same each time / because eye is

3

not perfectly round / uniform;

*Accept eye opens to different amounts*

1

- (b) (i) 1. Eye (diameter) is smaller and antennae longer;
2. Antennae detecting touch;
3. Data only refers to shrimps / data may not apply to all animals / only in one area;  
*The principle here is that candidate has recognised that both features confirm suggestion. Exact wording does not matter.*

2 max

- (ii) 1. Standard deviation gives a measure of spread / variation;
2. More standard deviations overlap, the less likely it is that differences are real / significant / the more likely they are caused by chance;  
*Do not accept range*  
*Accept converse.*  
*Although we are looking for the idea of significance, we cannot require this term.*

2

(c) (i) Qualitative statement about

difference in size /

difference in variation /

overlap in size;

Quantitative statement about

difference in size /

difference in variation /

overlap in size;

Supported by relevant two sets of figures from graph;;

*Note simplistic answer involving a quantitative statement gains 1 mark.*

*More specific answer involving quantitative information gains 2 marks.*

2

(ii) (No) for same body length, antenna are longer / antenna are shorter / some with longer body have short antennae / some with shorter body length have longer antennae;

**OR**

(Yes) positive correlation in open / in cave;

*Habitat not critical as a term.*

*Must refer to idea of same habitat*

*Accept description*

1

(d) More alleles of each gene / shrimps in open have all the alleles;

*Candidates are required to use the information from the table. Must therefore refer to alleles.*

1

(e) 1. A small number of shrimps were / went into the cave;

2. All / high proportion of shrimps had allele L;

3. Cave population descended from these / these reproduce;

3

(f) (i) 1. Cross shrimps from two sites / watch courtship;

2. Breed young together / observe mating;

3. Allow 1 mark for any method of improving quality of results e.g. carry out reciprocal crosses / large number of crosses / isolate beforehand; *Other valid equivalent suggestions should be accepted.*

(ii) If same species the shrimps would breed, producing fertile young / courtship species specific;

*Accept any form of evidence – mating / laying eggs / giving birth to young.*

3

[15] (a) (i) Faster / greater / more effective response in children;

4

*Do not accept children have more haemoglobin*

1

(ii) Use line of best fit;

1

Extrapolate / extend line (and read from graph);

*Allow calculation using rate of increase per day = one mark.*

*However for both marks this must be linked to line of best fit.*

1

(iii) More than one polypeptide chain;

*Allow many polypeptide chains.*

*'Haemoglobin has four polypeptide chains' must be in correct context to gain mark.*

1

(b) (i) Has same water potential;

*Allow converse for effect of using distilled water or a concentrated solution.*

1

No (net) water movement / osmosis;

1

Cells will not swell / burst / change size;

*No osmotic lysis = two marks*

1

(ii) Pernicious anaemia (cells) greater range / spread / variation of diameters / widths;

Some pernicious anaemia (cells) wider than 9 ( $\mu\text{m}$ ) / some less than 5.5 ( $\mu\text{m}$ ) / without pernicious anaemia none more than 9 ( $\mu\text{m}$ ) / none less than 5.5 ( $\mu\text{m}$ );

Pernicious anaemia (cells) peak / most frequent at 8.5 ( $\mu\text{m}$ ) / peak / most frequent at higher diameter / / without pernicious anaemia peak / most frequent at 7 ( $\mu\text{m}$ ) / peaks at lower diameter;

*There are several alternatives for marking points 2 and 3*

2 max

[9]

5

(b) Isolation / quarantine / 'kept separate';

Screening / testing (of patients / doctors etc);

Sterilisation of wards / equipment / method to improve hygiene;

*Do not allow improve 'hygiene' or 'cleanliness' without named example such as 'washing hands' use of gloves etc.*

2 max

(c) May not all be absorbed;

May be broken down / metabolised / excreted quickly;

To kill the microorganisms / bacteria;

Reference to antibiotic resistance;

*Reference to becoming 'immune' negates last marking point.*

2 max

(d) (i) P;

1

(ii) S;

1

(e) (i) Prevents bias;

Vested interest (of scientists);

Prevents 'placebo' / positive / negative / psychological effects / 'demand characteristics' (in volunteers);

2 max

(ii) Age;

Ethnicity;

Lifestyle;

Body mass;

Health;

Sex of person;

*Ignore references to same or different*

2 max

(f) Gradual / slight increase followed by rapid / greater increase;

*Allow more detailed descriptions which describe similar trend of gradual increase followed by rapid increase.*

1

[11]

6

- (a) Shows trend of mean temperature rise;

Higher temperatures more frequent since 1984 (in January and February);  
Considerable variation in temperature from year to year;  
Which may be due to chance;

*No mark for yes or no Do not penalise candidates who state there is no trend*

2 max

- (b) Construct null hypothesis;

Use Spearman rank (and calculate test statistic);  
Look up in table (to find critical value of  $P = 0.05 / 5\%$ );  
Use figure (in table) to accept or reject null hypothesis;

3 max

- (c) (i) (Particular daylength) always occurs at same time of year / valid example;  
Birds do not start laying eggs when period of warm weather occurs early in year;  
Synchronises breeding behaviour;  
Sufficient foraging time for food collection for young;

2 max

- (ii) Birds able to respond to changing climate;  
Food availability (mainly) determined by temperature;  
As insect / invertebrate development temperature-dependent;

2 max

- (d) A correlation does not indicate a causal relationship;  
As may be due to another factor / named factor;

2

- (e) Visits could be up to 5 days apart;  
Date of egg-laying may be inaccurate by 5+ days;

2

[13] (a) Recognition of same species;

7

Stimulates release of gametes;

Recognition of mate / opposite gender;

Indication of sexual maturity / fertility;

2 max

- (b) (i) Internal fertilisation / fertilisation occurs in pouch / limited area;

*Q The term fertilisation is not required in the answer but must be implied.*

1

(ii) Protection from predators (developing in pouch);

1

(c) (i) Less stress caused to seahorse / quicker / more accurate method / body is curved / head is linear;

*Q Do not accept "easier" unless qualified.*

1

(ii) Head length proportional to body length / or described;

1

(d) Positive correlation between head / body lengths of male and female / female and male with similar head / body lengths pair together;

1

(e) Use line of best fit;

And extrapolate / extend line as required;

2

(f) (Compare) DNA;

Sequence of bases / nucleotides;

Compare same / named protein;

Sequence of amino acids / primary structure;

Immunological evidence – not a mark

Inject (seahorse) protein / serum into animal;

(Obtain) antibodies / serum;

Add protein / serum / plasma from other (seahorse) species;

Amount of precipitate indicates relationship;

*Q The marks awarded for reference to DNA and sequence of bases / nucleotides must be in a different context to DNA hybridisation.*

6 max

[15] (a) group of organisms with similar features;

**8** can (interbreed to) produce fertile offspring;

2

(b) directional selection;  
any TWO from

selection against one extreme / for one extreme;  
against broadest beaks in B and narrowest beaks  
in A / for narrowest in B and broadest in A; whole  
distribution / range / mean / mode / median is  
shifted towards favoured extreme;

3 max

[5]

9

- (a) Excitation of chlorophyll molecule / electrons / energy of (pairs of)

electrons raised to higher energy level;

Electron(s) emitted from chlorophyll molecule;

Electron(s) to electron transport chain;

Loss of energy by electron(s) along electron transport chain;

Energy lost by electron(s) is used to synthesise ATP;

From ADP + Pi;

*“By electrons” need not be stated in each marking point if it can be reasonably inferred that the candidate is referring to electrons*

max 5

- (b) Little green light reaches bottom as absorbed by surface dwellers / water;  
Red and blue not absorbed and so penetrate;  
Variation in pigments of sediment dwellers;  
Bacteria with chlorophyll at an advantage as chlorophyll absorbs red and blue; (Survive to) reproduce in greater numbers and pass on advantageous alleles / genes in greater numbers / increase in frequency of advantageous alleles in subsequent generations;  
Increase in frequency / numbers of bacteria with chlorophyll;

6

[11] (a) 1. frequent use of antibiotic creates selection pressure / antibiotic kills bacteria;

10

2. bacteria with mutation / resistance have (selective) advantage over others / described;  
3. (survive to) reproduce more than other types pass on advantageous allele / mutated allele in greater numbers;  
4. frequency of (advantageous) allele increases in subsequent generations;  
*(penalise use of “gene” instead of allele once only)*  
5. frequency of resistant types increases in subsequent generations;

5

- (b) correct answer = 0.18; And  
three marks for three of:  $p + q$   
 $= 1$  and  $p^2 + 2pq + q^2 = 1$ ;



$0.01 = q^2$ ;  $q = 0.1$ ;  $p = 0.9$  frequency of heterozygotes =  $2pq = 2 \times 0.1 \times 0.9 / 2 \times$  candidates  $p \times$  candidates  $q$ ;

4 max

[9]

(a) (i) Continuous variation – range of values / not discrete categories / many  
**11** categories / no gaps;

1

(ii) Crossing over / chiasmata;  
Random segregation / independent assortment;  
In meiosis I and meiosis II;

max 2

(b) Range influenced by single 'outlier' ( *accept anomaly* ) /  
converse for S.D.;  
S.D. shows dispersion / spread about mean / range only shows highest  
and lowest values / extremes;  
Or  
S.D. allows statistical use;  
Tests whether or not differences are significant;

max 2

[4] (a) 1. Occurs in an unchanging environment;

**12**

1

+  
2. Selection against extremes / selection for the mean / mean / median / modeunaltered  
3. Range / S.D is reduced  
4. Increasing proportion of populations becomes well adapted to environment;

4

(b) 1. All plants are acyanogenic below  $-4^\circ\text{C}$  and (most) cyanogenic above  $+10^\circ\text{C}$ ;  
2. Cyanogenic plants' cells freeze below  $-4^\circ$ ;  
3. Releasing cyanide (into their own tissues) / damaging / killing plants /  
disrupting metabolism;  
4. Selective advantage not to produce cyanide at  $-4^\circ\text{C}$ ;  
5. Slugs present at higher temperatures / not usually present / inactive at  
low temperatures and cyanide production kills / deters slugs;

5

[10] (a) (i) to ensure that no unwanted bacteria will be present;

**13**

1

(ii) to check that bacteria cells do not die anyway / to show  
water / solvent has no effect on growth;

1

(b) some bacteria are resistant / some areas of dish have no antibiotic /  
antibiotic not spread evenly;

1

14

(a) (i) EITHER: Correct answer: 3.45 / 3.44 / 3.4 = 2 marks

OR: Understanding of  $\sum n(n-1)$  / use of  
134 / (2 + 90 + 12 + 30)  
+ wrong answer = 1 mark

max 2

(ii) Takes account of number of individuals / abundance /  
population size (as well as number of species);

1

(b) The species at A / *F. spiralis* loses less water /  
loses water less rapidly / loses less mass;

The species at A / *F. spiralis* better adapted to / can survive where  
exposed for longer / to drier conditions;

The species at A / *F. spiralis* avoids competition For named aspect  
– e.g. light / substratum / space / CO<sub>2</sub>;

*ACCEPT converse argument re. F. serratus*

3

[6] (a) Tapes / string / axes laid out at right angles / grid area;

15

Method of obtaining random co-ordinates;

*Do not allow "Use random number generator"*

2

(b) (i) Decrease then remain constant;  
From 200 cm / over 150 cm;

2

(ii) Oxygen decreasing because soil becomes more compacted / not replaced;  
Decrease in oxygen leads to fewer aerobes surviving;

2

(c) Anaerobic bacteria replace aerobic as oxygen decreased by aerobic bacteria;  
Remove competition;  
Aerobic bacteria no longer able to survive in these conditions;

3

(d) (i) Near the surface / in top 50 cm;  
Table shows decrease with time at greater depths;

2

(ii) Decrease;  
Fewer aerobic bacteria with depth;  
Oxygen concentration decreases / less oxygen at depth;

3

(e) Probability greater than 95% / 0.95;  
Results are not due to chance / results are significant;  
Because bars do not overlap;

3

(f) Plot as graph;  
Draw line of best fit;  
Read off appropriate value;

3

[20] (a) greater environmental influence than genetic;

**16** 1

(b) identical twins have same genotype / converse for non-identical; compare identical and non-identical twins / identical twins who have been separated / non-identical twins in same environment; if genetic - similarity between identical twins / converse; large sample required / use a statistical test;

4

[5] (a) mitosis;

**17**

genetically / genes / genotype identical;

*(reject same genes)*

*(ignore references to asexual reproduction)*

2

(b) (different) environmental conditions / named environmental factor / mutation;

1

(c) dispersal / prevent overcrowding / competition / colonise  
;increased number of (proven) offspring; *(not quicker)*

2

[5] (a) breed together;

**18** if fertile offspring, then same species;

2

(b) isolation of two populations; variation already present due to mutations;

different environmental conditions / selection pressures leading to selection of different features and hence different alleles;  
different frequency of alleles; separate gene pools / no interbreeding;

4

(c) selection of mate dependent on colour pattern; prevents interbreeding / keeps gene pools separate;

2

[8]

19

(a) zooplankton nearer surface at night;

algae only found at surface;  
photosynthetic;  
no / little light below 30 / 40m;

3

(b) (i) with increasing time predators have been present in the lake, the greater the depth at which the zooplankton occur during the day;

1

(ii) variation in migration behaviour; vertical migration reduces chance of predation / prey can't be seen in low light intensity; those that migrated more likely to reproduce; genes / alleles (for behaviour) passed to next generation; increase in frequency of gene / allele in population;

3 max

[7]

20

(a) lower enzyme activity;

decrease in rate of photosynthesis so less carbohydrate formed / named carbohydrate / lower translocation of sucrose / to growing point;  
lower respiration;  
lower rate of nutrient uptake / protein synthesis / cell division;

4

(b) (i) differ in height when plants from different altitudes grown in same environment;

1

(ii) plants from 1500 / 3000m differ in height when grown at different altitudes;

1

[6] (a) sections of chromatids exchanged;

21

sections have different alleles; new combinations of (linked) alleles;

*(allow 1 mark for idea that 'genes' are exchanged, if no other marks gained)*

- (b) (i) length controlled by many genes / polygenes; each gene may have different alleles / idea of additive effects;  
OR  
environmental factors / or named factor; how named factor may affect growth of seeds;

2 max

- (ii) 1. selection of large seeds for sowing;  
2. higher proportion of alleles for long length / loss of alleles for short seeds from population;  
3. (possible appearance of) new alleles through mutation;  
4. process repeated over many generations;  
(G - allow 1 mark idea for that 'largeness' selected, survives and inherited)

4

[9]

QWC 1

- 22** (a) description of interspecific competition / competition between species / birds with beaks of different lengths; link length of beaks to different positions of prey / reference to named bird with particular prey e.g. curlews with longer beaks able to feed on ragworms;

2

- (b) variation in beak length in curlews / one species; longer / more curved beaked curlews outcompete / at advantage / suggested advantage e.g. larger / curled beaks access more food; reproduction; genes passed on (to offspring);

4

- (c) body has lower water potential; water diffuses along a water potential gradient / by osmosis;

2

[8] (a) generation of random co-ordinates;**23**

use of 10 or more quadrats; collection of all dog whelks in quadrat;

3

- (b) greater variation for sheltered population / population A; range / spread around the mean;  
(or converse)

2

- (c) (i) smaller ratio means relatively larger foot / population B has relatively large foot; better able to grip; larger / longer shells have greater area exposed / are subject to greater force;

- (ii) wave action limits the max. L / A ratio / extremes; valid point about age, e.g. greater age range on sheltered shore / live longer on sheltered shore;

*(allow shell size marking point in either (c)(i) or (c)(ii) but only credit once)*

4 max

[9]

- (a) To sterilise/kill bacteria;

24

So that only one kind of bacteria present on agar plate/to prevent contamination (by bacteria);

2

- (b) Clear zone / inhibition zone is where bacteria have not grown/been inhibited/killed; Antibiotic diffuses out of paper disc/into agar; Bacterium **A** inhibited/killed by tetracycline/tetracycline has little effect on bacterium **B**; Bacterium **B** inhibited/killed by penicillin/bacterium **A** resistant to penicillin; Both kinds of bacteria resistant to streptomycin;

*Q Ignore references to 'immune'*

4 max

[6] (a) Hydrolysis;

25

*Accept breaking of peptide bonds*

1

- (b) Adding fluorine changes shape/different shape from other proteins; Do not fit active site (of protease); Induced fit not produced;

2 max

- (c) (i) Suitable example; e.g. Flaming spreader/ use lid of Petri dish as umbrella/ clean bench with disinfectant/ sterilise agar in autoclave;

*Ignore references to wearing gloves, unless suitably qualified and unqualified references to 'clean'*

1

- (ii) All the AMPs killed/inhibited the bacteria/AMPs with fluorine more effective than frog AMP; Not All fluorine AMPs are equally effective; Diameter/area of clear zone indicates effectiveness; Only used one kind of bacterium/need to repeat using other bacteria; Need to repeat the investigation/only one plate used; Credit suitable measurements or calculations;

3 max

[7]