

1. Field techniques for Biology

A - Health and Safety

1. C
2. Any 2 from:
 - Isolation
 - Terrain
 - Tidal changes
 - Weather conditions

B - Sampling of wild organisms

1. Any from
 - Camera traps
 - Remote detection
 - Scat sampling
2. C
3. A - 92
B - 96
C - samples were taken every 3m/at regular intervals
4. B
5. a) Species may be elusive OR disturbance/harm/impact is minimised. (1)
b) Systematic (sampling) (1)
c) i) Long length or river sampled OR 92/many sites sampled OR Large sample size/number of repeats (1)
ii) Only 1 site showed latrines OR No independent replicate (1)
d) Any two from (2)
 - Latrines have been washed away
 - Some sites not surveyed due to deep water
 - 5km between sample sites may miss vole territories
 - No evidence that decrease due to predation/mink OR No data for mink population OR Other predators of vole may exist

D - Monitoring populations

1. Any two from: (2)
Banding
Hairclipping painting

Surgical implantation

Tagging.

2. C
3. 500
4. 2160
5. D
6. B
7. D
8. C

E - Measuring and recording animal behaviour

1. Ethology (1)
2. An ethogram (1)
3. A
4. B and D
5. D
6. A - Ethogram (1)
B - (Use start times to) calculate duration of each behaviour to calculate proportion of time spent doing each behaviour. (1)
C - Remote recording OR Example such as: use cameras, use camera traps, video footage, satellite. (1)
7. Any 4 of the following
 - a. Ethogram is a list of behaviours
 - b. (measure) latency - time (interval) between stimulus and response
 - c. (measure) frequency - how often (specific) a behaviour occurs (in given time)
 - d. (measure) duration - how long (specific) behaviour lasts
 - e. Latency, frequency and duration
 - f. Construct time/activity budget (to allow comparison)
 - g. **Avoid** anthropomorphism

2. Evolution

A - Drift and selection

1. A - Genetic drift
B - Natural/sexual selection
C - Natural/sexual selection
D - Genetic drift
2. 1 and 2
3. D
4. B

5. C
6. D
7. C
8. A - (Much) greater proportion (of Mrcaru lizards diet) is plant matter. (1)
 Bi - (Mrcaru) lizards have microorganisms to break down plant matter/greater bite force (1) AND These individuals are (better) **adapted** to new environment/eating plant matter/digesting plant matter OR Have selective advantage/increased fitness. (1)
 li - Short(er) generation time OR warm(er) environment/climate/high(er) temperature OR High(er) selection pressure OR High(er) mutation rate OR Sexual reproduction/horizontal gene transfer (any 1 for 1 mark)
 C - Same mean as population as a whole OR Same degree of variation about/deviation from mean as the population (as a whole). (1)

B - Fitness

1. Absolute
2. Relative
3. Relative
4. Horizontal gene transfer and shorter generation times (2)
5. C

C - Co-evolution

1. B
2. A
3. B
4. C
5. Red Queen
6. A - 112.5%
 B - Number of nematodes in slug population 2 never increases higher than 25 in comparison to 450 in population 1
 C - Random mutation, resulting in resistance. Resistant individuals are more likely to reproduce so the resistance gene becomes more frequent in subsequent generations
 D - Nematode numbers would increase OR slug numbers would decrease
7. B
8. Any 5 from
 - a. **Parasite** benefits at expense of host
 - b. Example of parasite
 - c. Parasite and host interact closely/frequently OR parasite and host **co-evolve**
 - d. (In co-evolution) change in the traits of one species acts as a selection pressure on the other species OR idea of evolutionary arms race.

- e. (RQ hypothesis state species) adapt/evolve/change to survive/avoid extinction
- f. Hosts that are better able to resist/tolerate parasites/ have greater fitness/survival/number of offspring
- g. Sexual reproduction generates (genetic) variation
- h. (Variation) provides raw material for adaptation/evolution/natural selection.

3. Variation and Sexual Reproduction

A - Costs and Benefits of sexual and asexual reproduction

- 1. C
- 2. C
- 3. B
- 4. A
- 5. C
- 6. B
- 7. B
- 8. C
- 9. B
- 10. A - Males/half the population not able to produce offspring (1)
 (Only) half of each parent's genome passed to offspring OR Successful genomes disrupted (1)
 B - Sexual reproduction increases variation (1)
 To keep/maintain resistance to/tolerance of parasites OR to allow co-evolution between snail and parasite (1)
 C - Parasites (of these snails) absent/low density (in non-native habitats) OR (Parthenogenesis is more common when) parasite density low
- 11. A - No - does not support AND
 Squid of similar mantle length have different age/number of rings OR squid with similar age/number of rings have different mantle length OR some younger squid are larger than older squid (1)
 B - review (article) (1)
 Ci - water allows sperm to reach eggs (1)
 ii - large number of gametes required OR loss of (many) gametes/offspring OR low(er) chance of fertilisation (1)
 Di - (males with greater mantle length) produce longer/larger spermatophores
 ii - No - **some** males with large mantle length produced fewer spermatophores than males with small mantle length Or Yes - **weak** positive correlation between mantle length and number of spermatophores (1)
 Ei - March (1)
 ii - **increase** in proportion of stage 1 from March to April (1)

iii - (increased) migration/(higher levels of) predation/shortage of food/ disease/ environmental catastrophe (1)

12. Any 4 from following points

- a. males/50% are unable to produce offspring OR only females/50% able to produce offspring
- b. Only half of (each parent's) genome passed on (to offspring)
- c. Disrupts successful (parental) genomes OR (combinations of) beneficial alleles/traits lost
- d. Increases (genetic) variation
- e. (variation) allows evolution/adaptation (in response to changing environment)
- f. (variation allows organism) to keep running in the Red Queen arms race (eg between parasite and host)

B - Meiosis

1. B - Chromosomes undergo DNA replication

E - Homologous chromosomes line up at the equator of the cell

F - Homologous chromosomes touch at points called chiasmata

C - Crossing over occurs at points called chiasmata

G - Independent assortment occurs

H - Two haploid cells are formed

A - Chromatids are separated by spindle fibres

D - Four haploid gametes are produced

2. A - 6

B - 3

C - 8

3. LCPB or BPCL

4. A, B and C

5. Any 2 from (2)

- Same size
- Same centromere position
- Same genes at same gene loci
- Alleles may differ due to different parental origin

6. Independent assortment and crossing over (2)

7. Linked

8. A

9. Any 7 out of the following

- a. (Homologous chromosomes) have the same size/centromere position/genes at same loci
- b. Pairing of (homologous chromosomes)
- c. Chiasmata form where chromosomes/(non-sister) chromatids touch
- d. Chromatids break and rejoin OR crossing over occurs
- e. Exchange of DNA between (homologous) chromosomes/non-sister chromatids
- f. (Leads to) new combinations of/recombination of alleles (of linked genes)
- g. (Homologous chromosome pairs) line up randomly on equator

- h. **Separation** of parental chromosomes irrespective of maternal and paternal origin.

Any 2 of the following

- i. Chromosomes line up **singly** on equator
 - j. (Sister) chromatids/chromosomes separate
 - k. (And are) randomly distributed to the daughter cells/gametes.
 - l. (Four) haploid gametes formed
10. A - Gamete mother cell (1)
Bi - Crossing over (at chiasmata) OR Breakage and rejoining of DNA/chromatids (at chiasmata)(1)
(Leads to) exchange of DNA/alleles between (homologous) chromosomes OR New combinations of/ recombination of alleles (of linked genes) (1)
ii - independent assortment (1)

C - Sex determination

- 1. Hermaphrodite
- 2. A
- 3. A
- 4. B
- 5. Random inactivation of parts of the X chromosome OR half of the cells in any tissue will have a working copy of the gene
- 6. A - 50%
B - 50%
C - 50%
- 7. B
- 8. A - 20%
B - 10%
C - 240
D - 540
- 9. A - Presence of (Sry) gene on the Y chromosome (1)
B - Temperature of (egg) incubation OR Idea: ratio of males to females will alter at different temperatures (1)
Ci - Males lack homologous alleles of Y chromosome (so recessive allele always expressed) OR Males have one X so recessive allele always expressed OR Males only need one (copy of) recessive allele (to be affected by the disease) (1)
ii - X (chromosome) inactivation is **random** (1)
Half the (kidney) cells will have a functional copy of the (ADH) receptor/gene (1)
iii - 50(%) (1)
- 10. B

4. Sex and Behaviour

A - Parental Investment

1. A
2. B
3. A

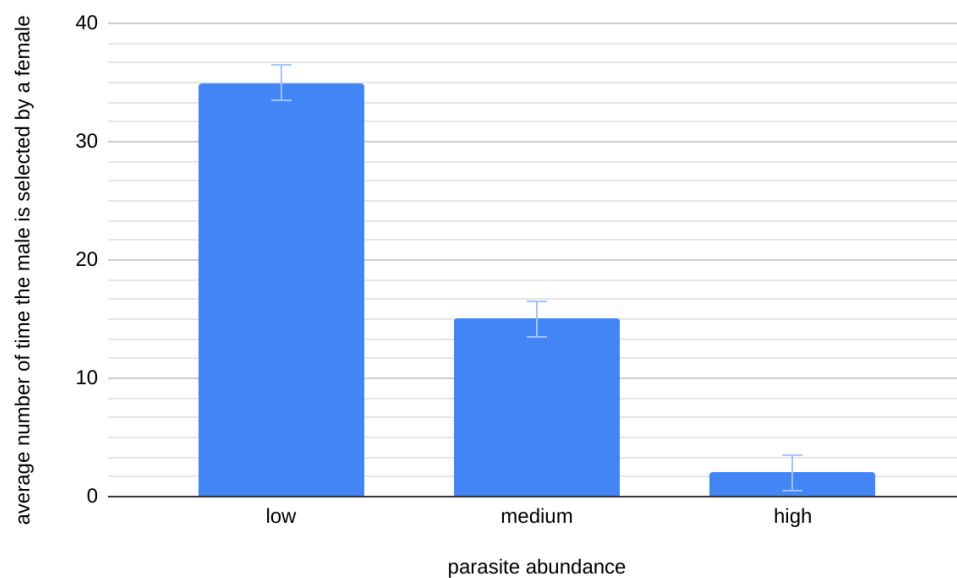
4.

Characteristic	r-selected population	K- selected population
Environment	unstable	stable
Lifespan	short	long
Number of offspring per reproductive episode	many	few
Number of reproductions in lifetime	Usually one	Often several
Size of offspring or eggs	small	large
Parental care	nope	Often extensive

5. B
6. C

B - Reproductive behaviours and mating systems in animals

1. C
2. B
3. Sexual dimorphism
4. B
5. A



B - 57.1%

C - The higher the parasite abundance the lower the mating success.

D - Low parasite abundance suggests that the male may have good parasite or disease resistant genes. These are 'honest' signals

6. A

7. D

8. A - (an organism that) has both male and female reproductive/sex organs/tissues/ structures/systems (1)

B - sexual dimorphism (1)

C - competition/parasitic infection (1)

Di - due to different numbers (of females/fish) in each group/treatment AND (the female/fish in each group) might have increased in size/grown by different amounts (1)

ii - (females from treatment group 2) grew more (than those from treatment group 1) (1)

iii - (greater size an advantage in) protecting females OR getting larger/defending territories OR male-male rivalry (1)

9. B

10. D

14. A - (Longer-necked animals obtain better feeding so) survival increased/selective advantage. (1)

Improved fitness/more surviving offspring (1)

B - Increased competition for (reduced number of) trees OR Increased selection pressure for long(er) necks (1)

Ci - Longer-necked (male) giraffes have better success in male-male rivalry, so get a mate/access to females to reproduce (1)

ii - If NFS hypothesis were supported:

Only males would have long necks OR females would have shorter necks

OR If NFS hypothesis not supported:

Females have long necks but do not use them for fighting (1)

15 D

16 Trait disappears in group treated (with antibiotic then hypothesis is supported) (1)

Compared to a control/no treatment/no antibiotic group (where no males produced) (1)

B - Transfer of genetic material (from one bacterium to another) outwith reproduction/ with same generation. (1)

C - Purpose - to attract males (for breeding) (1)

Females are competing so only occurs when males are in short supply (1)

D - Protect/care for/carry young OR feed young OR build nest

OR (Greater) parental care

17 C

18. A - sexual dimorphism (1)

Bi - Males gather/compete in (communal) area/lek (to display) AND females assess/choose male OR to allow female choice (1)

ii (Display) increases **male's** chance of mating/passing on genes/reproducing OR (Display) increases **male's** breeding success (1)

Ci - (Sound) allows communication over (long) distance OR (Sound) overcomes difficulty of limited visibility OR (Sound) allows communication in spite of forest/trees limiting visual signals OR Allows female to locate male(s)/lek

ii - (Dishonest as fake hoots emitted when) females not present/no mating occurring.

19. Sexual dimorphism - any 4

- a. Sexual dimorphism is the physical difference between males and females of the same species
- b. Usually, males are more conspicuous than females/a suitable description
- c. Being inconspicuous means that females can better protect their young due to camouflage.
- d. Sexual dimorphism is a product of sexual selection
- e. Sexual dimorphism can be reversed in some species.

Male-male rivalry - any 1

- f. Males often use large size to out compete other smaller males for mates
- g. Some males use weaponry to win females/suitable description of horn or antlers

Sneakers - 1 mark

- h. Smaller males may still be successful using sneakers/satellite behaviour

Lekking - any 4

- i. Lekking is where males collect in a display area and present to females.
- j. The display area is called a lek
- k. A suitable example, e.g. grouse, capercaillie
- l. Females assess male fitness...
- m. ... and choose based on 'honest signals...
- n. Such as low parasite burden

5. Parasitism

A - Niche and the Parasite Niche

1. 1e
2f
3a
4b
5g
6d
7c
2. Competitive exclusion principle
3. Resource partitioning
4. B and C
5. C
6. i) realised and fundamental niche (Any 3)

- a. Niche defined as the multi-dimensional summary of the tolerances and requirements of a species.
 - b. Fundamental niche is that occupied in the absence of interspecific competition
 - c. Realised niche is that occupied in response to interspecific competition
 - d. Where two realised niches are (very) similar competitive exclusion may occur/one species may become locally extinct
 - e. Resource partitioning may allow species with sufficiently different realised niches to co-exist.
- ii) features of parasite niches (Any 6)
- f. Parasites (are symbionts that) gain resources/nutrients at the expense of their host.
 - g. (Often) narrow niche **and** host specificity
 - h. (So) parasites **can be** degenerate.
 - i. Ectoparasites live on (the surface of) their host.
 - j. Endoparasites live within their host.
 - k. Definitive host - on/in which parasite reaches sexual maturity/produces gametes/undergoes sexual reproduction
 - l. Intermediate host - also required to complete parasite's lifecycle
 - m. Some parasites require/use a vector for transmission

B - Parasitic life cycles

- 1. A - Intermediate OR secondary host
B - Definitive OR primary host
- 2. a) False - single-celled
b) True
c) False - vectors
- 3. B
- 4. Ai - they are involved in close/intimate association AND are two/different species (1)
ii - the parasite reaches **sexual** maturity/carries out sexual reproduction (within the cricket) (1)
Bi - it allows transmission (of the parasite)
ii - any correct example of behaviour modification of host; eg (alteration of) foraging, sexual behaviour, habitat choice, anti-predator behaviour (1)
C - monogamy/monogamous
- 5. A

C - Transmission and virulence

- 1. A - 157.1%
B - 2011
C - 2012

D - Rabbits are an intermediate host so their greater numbers increased their role as a vector OR The fox population increased due to food availability and parasite transmission increased due to overcrowding.

2. C

3. B

4. C

5. Ai - Statement relating to quartiles

eg 25% lay more than/UQ is 200 eggs

Eg 50% lay more than 170 eggs OR median value is 170 eggs (laid)

Eg 75% lay more than/LQ is 125 eggs

Eg 50% lay between 125 and 200 eggs

OR Equivalents 'in opposite direction

OR Range of eggs (laid) is between 20 and 240/range of eggs (laid) is 220

OR Minimum and maximum values are 20 and 240 eggs (laid)

OR No. of eggs (laid) is **very** variable. (Any 2)

ii - Mean number of eggs laid/it is higher (than the median) OR Mean is greater than 90 (1)

iii - (infection) reduces (fecundity) (1)

Bi - the error bars don't overlap

Bii - Increases (chance of)/more time for transmission (of parasite) OR More time for (parasite) reproduction.

Ci - Negative correlation between survival and the number of eggs laid OR

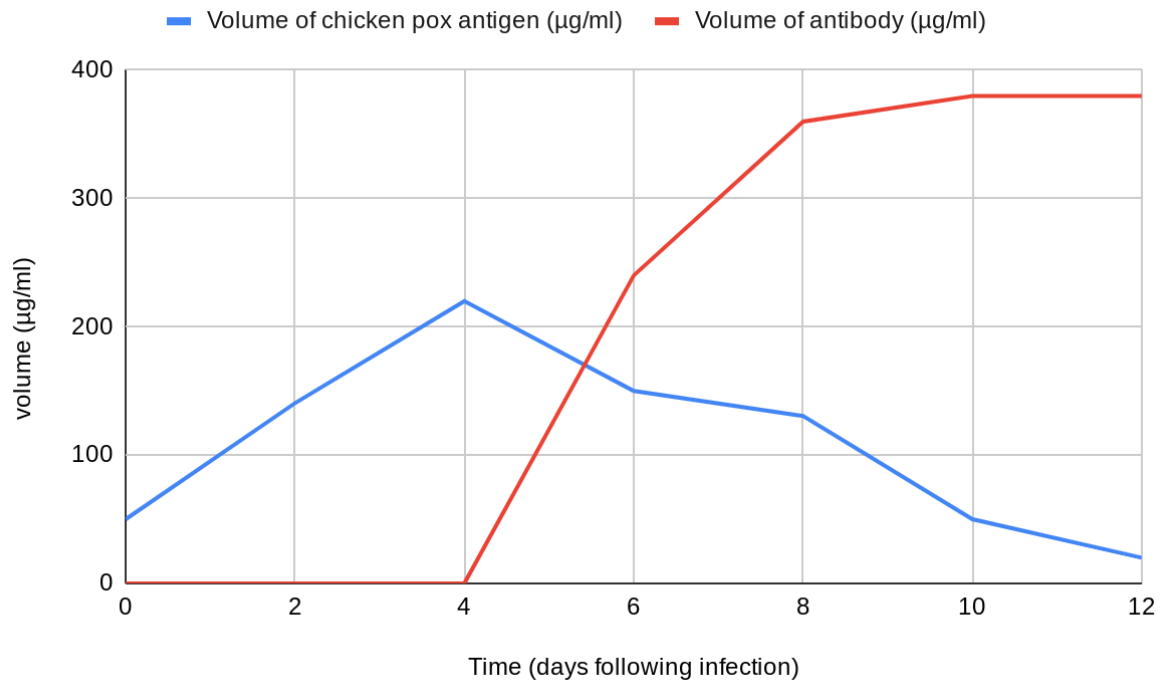
Mosquitoes that lay smaller numbers of eggs live longer (1)

Relationship is more negatively correlated in uninfected mosquitoes OR As fecundity increases the decrease in longevity is greater in uninfected mosquitoes (1)

ii - Not reliable because many points lie far from the line OR Reliable because a large sample was used (1)

D - Defence against parasitic attack

1. A -



B - The volume of chicken pox antigen starts at 50 $\mu\text{g/ml}$ on day 0(day of infection). This rises to a maximum volume of 220 $\mu\text{g/ml}$ 4 days following infection. The volume of chicken pox antigen then falls eventually to 20 $\mu\text{g/ml}$ 12 days following infection. (units needed at least once)

C - The volume of antibody remains at 0 $\mu\text{g/ml}$ from day 0 to 4 days following infection. This then increases to 240 $\mu\text{g/ml}$ 6 days following infection. This increases to 380 $\mu\text{g/ml}$ by 10 days following infection, where it remains steady to 12 days following infection. (units needed at least once.)

D - Volume of chicken pox antigen falls quickly from 50 $\mu\text{g/ml}$ on day 0 to 0 $\mu\text{g/ml}$ 2 days following infection. This is because the volume of antibody increases rapidly to 240 $\mu\text{g/ml}$ 2 days following infection. By 6 days following infection the volume of antibody is at a maximum of 400 $\mu\text{g/ml}$. This rapid secondary response is the result of clonal selection that occurred in the first chicken pox response and the immunological memory cells present in the individual.

2. Any for a total of 10 marks

- Defences can be non-specific/natural and specific/adaptive
- Physical barriers such as the skin prevent entry of parasites
- Chemical secretions such as mucus, tears, saliva and stomach acid
- Inflammatory response increases blood flow and therefore phagocytes to site of injury or parasite
- Natural killer cells destroy abnormal cells
- Phagocytosis is where phagocytes engulf parasites into vacuole/vesicle...
- ...and digestive enzymes in lysosomes digest the parasite
- White cells carry out 'surveillance'
- Phagocytes display foreign antigens to lymphocytes

- j) A specific lymphocyte is produced in response to each foreign antigen
- k) Lymphocytes undergo mitosis so are amplified
- l) This is called clonal selection
- m) Some cloned lymphocytes act as immunological memory cells.

E - Immune Evasion

- 1. A

F - Challenges in treatment and control

- 1. Herd or community immunity
- 2. Epidemiology
- 3. A
- 4. A
- 5. Ai - inflammatory (response)/inflammation OR phagocytosis OR apoptosis (1)
 ii - (rapid) change/variation of antigen/**surface** proteins (1)
 Appropriate antibodies/memory cells won't be present OR (new vaccine) must contain **new** antigens/trigger **new** antigens/trigger **new** antibody production (1)
 Bi virulence (1)
 ii - 1.1×10^9 or 1100000000 (1)
- 6. A - 80(nm)
 B - (the virus): does not use/have reverse transcriptase OR Does not use RNA (as a template) to produce DNA OR Does not integrate DNA into host (DNA) (1)
 C - Each new (viral) mutation would require a new vaccine OR vaccine antigens no longer match (virus) antigens OR once mutations occur, existing vaccines become ineffective OR vaccines might not contain all versions of the (target/viral) antigen/protein.
 D - AGREE or DISAGREE must be stated or clear from answer. AGREE: Trials with randomised control groups would be slower so more people would die (and this would be unethical). If treatment 'successful', control group would have higher death rate (and this would be unethical). DISAGREE: Evidence without a control group is weak/invalid. Safety/harm issues may only be revealed by presence of control group.
 E - Reduce overcrowding OR increase awareness of disease/ education OR (measures to prevent transmission) protective clothing/quarantine/improved sanitation OR reduced contact with (infected) wildlife (eg bushmeat)/control infection in wildlife.
- 7. A - Epidemiology/epideiological (1)
 B - (Epidemics/outbreaks/measles) occurring (roughly every 2 years)
 C - As vaccination (uptake) increases, cases decrease.
 Di - Articles evaluated by experts **in the field**
 ii - With larger number of susceptible individuals OR Number of immune individuals falls below the herd immunity threshold.
 AND Infection more easily transferred/spread/transmitted (1)

iii - (In Swansea) as vaccinations go down number of cases increases (1)

E - Herd immunity (1)

8. Difficulties involved in treatment and control (any 7)

- a. Endoparasite defined as living within host
- b. Rapid antigen change/high antigenic variation
- c. Vaccines difficult to design/produce
- d. (some) parasites difficult to culture (in vitro/laboratory)
- e. Similarity between host and parasite **metabolism**
- f. Difficult to find drugs only toxic to parasite
- g. Difficulty associated with vector control OR indirect transmission
- h. Transmission rate high in tropical climate/overcrowded situations
- i. Overcrowding (can occur) in refugee camps/rapidly growing cities (in LEDC's)
- j. Difficult/expensive to improve sanitation

Benefits of improved parasite control to human populations (any 2)

- k. Reduction in child mortality
- l. Improvements in child development/intelligence
- m. Body uses more resources for growth/development