Advanced Higher Biology

UNIT 2

BRIGHT MINDS MENTORING

Revision notes

Learning Outcomes

1. Field Techniques
1.1 Health & Safety
1.2 Sampling of Wild Organisms
1.3 Identification & Taxonomy
1.4 Monitoring Populations
1.5 Measuring & Recording Animal Behaviour

2. Evolution
2.1 Drift & Selection
2.2 Fitness
2.3 Co-evolution

3. Variation and Sexual Reproduction
3.1 Costs and Benefits
3.2 Meiosis
3.3 Sex Determination

4. Sex & Behaviour
4.1 Parental Investment
4.2 Courtship

5. Parasitism
5.1 The parasite niche
5.2 Parasite life cycles
5.3 Transmission and Virulence
5.4 Defence against parasitic attacks
5.5 Immune evasion
5.6 Challenges in Treatment and Control

Field Techniques: Health & Safety

Field Work

Aspects of fieldwork can present a hazard.

Field work poses a Wider range of hazards than when working in a laboratory.

Hazards

1. **Difficult terrain**

   how much the land goes up and down and what it is like underfoot.

   easy terrain =e.g a cultivated field.

2. **Adverse weather conditions**

   This could be caused by prevailing weather conditions expected in the area they are sampling or possible extremes of weather and how likely they are to occur.

3. **Problems associated with isolation**

   As soon as you move off the beaten track do you know exactly where you are and do you have mobile signal in case of emergency.

4. **Contact with harmful organisms**

Risk

Risk is the likelihood of harm arising from exposure to a hazard.

Risk assessments involve identifying control measures to minimise risk.

Control Measures

Appropriate equipment, clothing, footwear and means of communication are needed to control any hazards.

Field Techniques: Sampling of Wild Organisms

Sampling should be carried out in a manner that **minimises impact** on wild species and habitats.

Consideration must be given to **rare and vulnerable species** and **habitats that are protected by legislation.**

Rare / Vulnerable Species

Habitats protected by legislation

<u>Sampling Techniques</u>

1. Point Count
2. Remote Detection
3. Transect

Field Techniques: Sampling of Wild Organisms

Which technique?

1. Point Count

The observer records all individuals seen from a fixed point count location. This can be compared with other point count locations or with data from the same location gathered at other times.

e.g. Sampling birds in one area at one time.

2. Remote Detection

2.1 Capture Techniques

*Capture techniques are used for **mobile species** these techniques include **traps and nets**.*

2.2 Remote techniques

*Remote detection is used for **elusive species** that cannot easily be found.*

Direct - camera traps

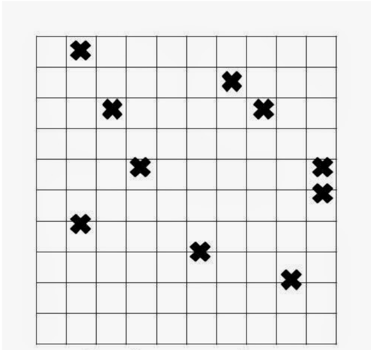
Indirect - scat sampling

Field Techniques: Sampling of Wild Organisms

3. <u>Transect</u>

1. Random Used to sample large areas using a random number generator.

Organisms have an equal chance of being selected.

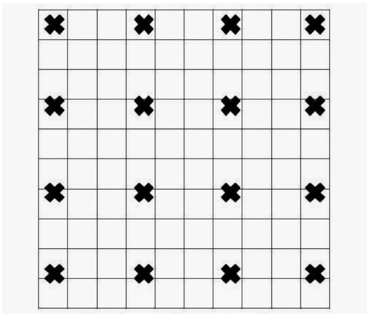

Random sampling

Problem— Random sampling could under represent the population.

2. Systematic Members of a population are selected at regular intervals

e.g. A quadrat every meter.

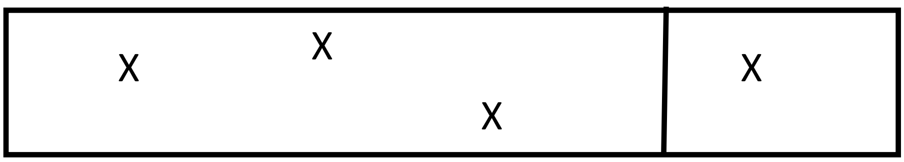
Line or Belt transects are used in systematic sampling.


Systematic sampling

Problem— Systematic sampling is more biased than random sampling.

3. Stratified When samples are divided into categories and then sampled proportionally.

Used to sample habitats that are not uniform. A standard formula is used to calculate the number of samples from each area.



Habitat - Hilly	Habitat - Forest
Proportion - 75%	Proportion - 25%
Quadrats - 3 out of 4	Quadrats - 1 out of 4

Field Techniques: Sampling of Wild Organisms

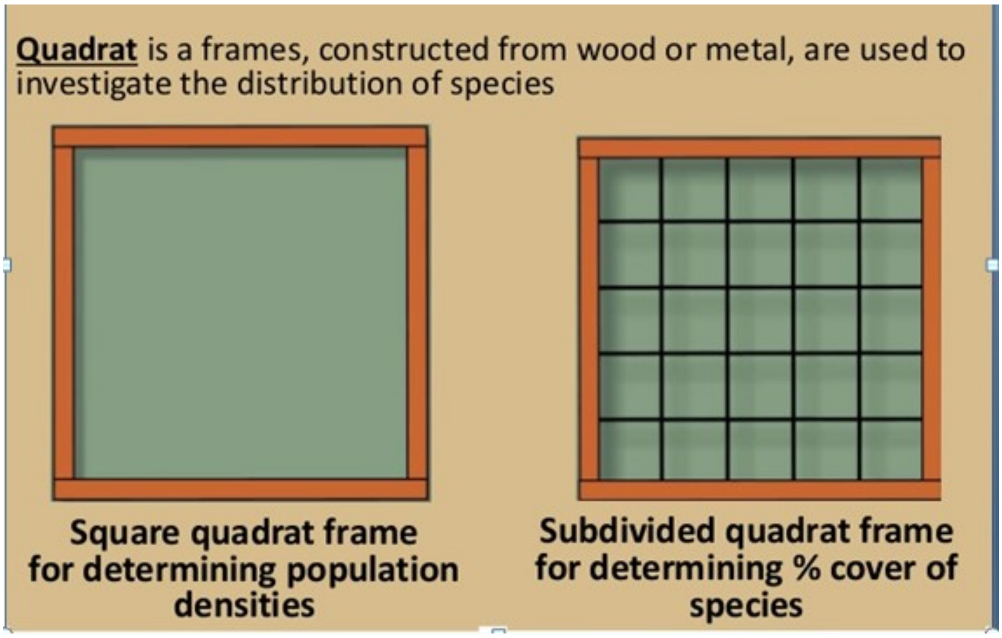
Quadrats are used as an appropriate technique to sample slow moving animals and sessile organism (organisms that are not able to move).

1. Size of Quadrat

Quadrats should be of suitable size and shape

2. Types of Quadrat measurement

1. Population densities - divide number of plants per square metre.
2. Percentage cover— count number of squares with plants not every plant.



3. Number of quadrats attempts

The more quadrats thrown the more reliable the results (representative sampling)

Two few quadrats fail to show the number of species present

Two many quadrats are a waste if the maximum is already being shown

In percentage cover quadrats the more squares per quadrat the more reliable the results

Identification & Taxonomy: Identification

Identification

Identification of a sample can be made using

1. Classification guides
2. Biological keys
3. Analysis of DNA or protein

Organisms can be classified by both taxonomy and phylogenetics.

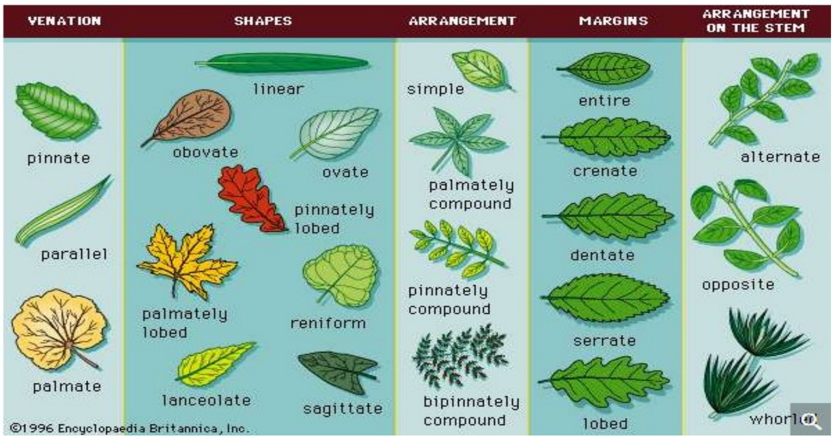
Taxonomy

Taxonomy involves the identification and naming of organisms and their classification into groups based on shared characteristics.

Classic taxonomy classification is based on morphology.

Morphology

A branch of biology that deals with the study of the structure of organisms.



Phylogenetics

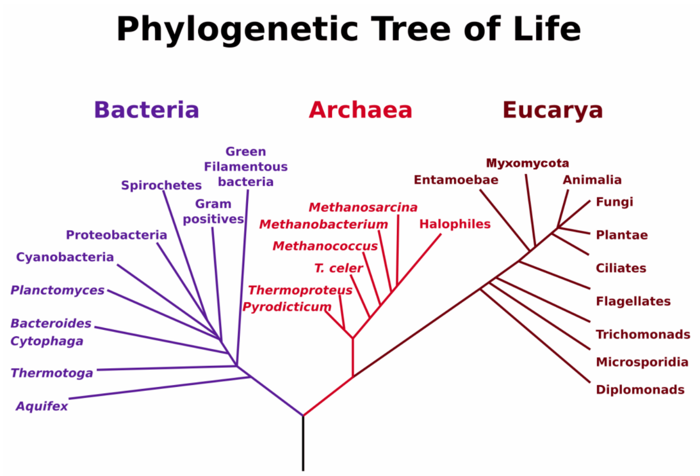
Phylogenetics is the study of the evolutionary history and relationships among individuals or groups of organisms .

Phylogenetics uses heritable traits such as morphology, DNA sequences, and protein structure to make inferences about an organism's evolutionary history and create a phylogenetic tree.

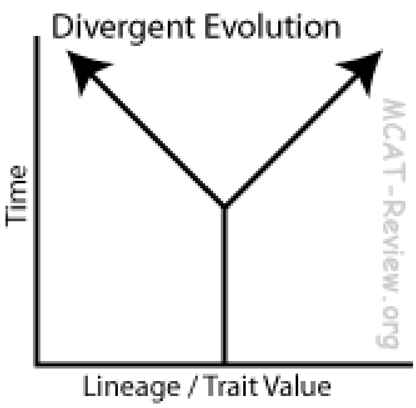
Identification & Taxonomy: Identification

Phylogenetic Tree

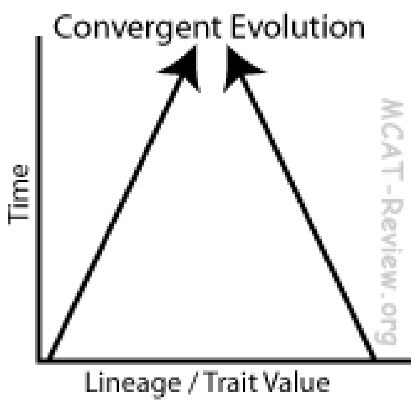
Diagrammatic hypothesis of an organisms relationships to other organisms.



Genetic evidence can reveal relatedness obscured by divergent or convergent evolution.



Divergent evolution is the accumulation of mutations within a species that leads to speciation.



Convergent evolution is the independent evolution of two species to become more similar. E.g. birds and bats.

Identification & Taxonomy: Taxonomic Group

Taxonomy

The study of classifying species according to an organism's physical appearance and genome.

Familiarity with taxonomic groupings allows predictions and inferences to be made about the biology of an organism from better-known (model) organisms.

Taxonomic Groups (Phyla) - Examples

1. Nematodes - *Round worms*

2. Arthropods - *Joint-legged invertebrates, with paired appendages & exoskeletons.*

3. Chordates - *Live bearing mammals, sea squirts.*

Model Organisms

Organisms that are either **easily studied** or have **been well studied.**

Studying these model organisms have been very important in the advancement of modern biology.

Information obtained from them can be applied to other species that are more difficult to study directly.

Model Organism - Examples

1. Bacterium - *E.coli*

2. Flowering plant - *Arabidopsis thaliana*

3. Nematode - *C.elegans*

4. Arthropod - *Drosophila melanogaster (fruit fly)*

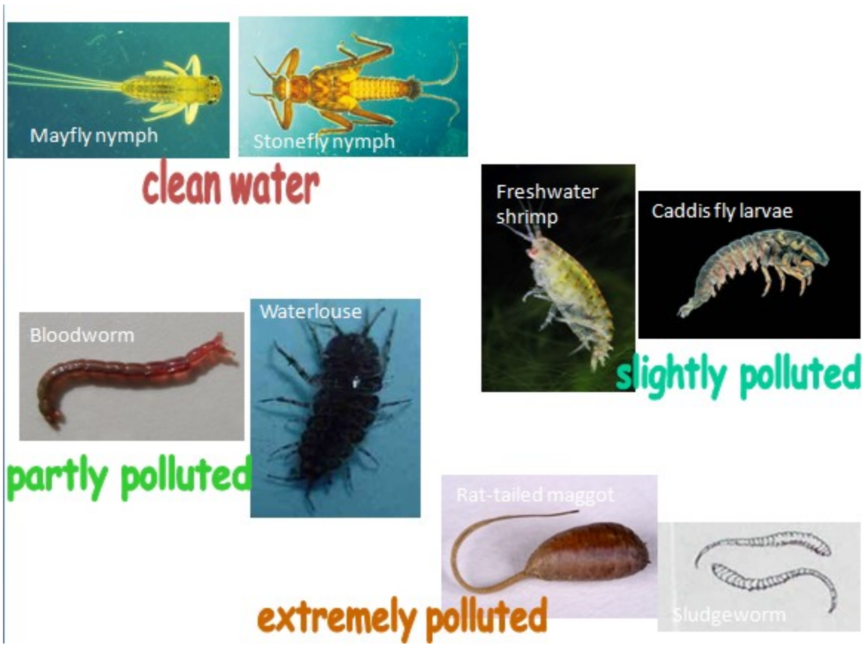
5. Chordates - *Mice, rats and zebrafish*

- ***Very important** in the advancement of modern biology.*

Field Techniques: Indicator Species

Indicator Species

The presence, absence or abundance of an indicator species gives information of environmental qualities such as presence of a pollutant.



Susceptible and favoured species can be used to monitor an ecosystem.

Susceptible species

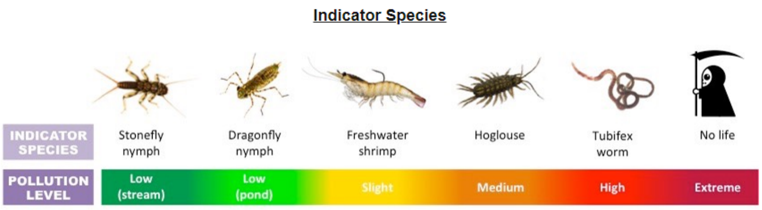
Absence or reduced population indicates a species is susceptible to a negative factor in the environment such as a pollution.

E.g. Stonefly nymph will not be present in polluted areas.

Favoured species

Abundance or increased population indicated it is favoured by the conditions in the environment such as a high concentration of oxygen.

E.g. Stonefly nymph will be present in areas that have a high concentration of oxygen.



Field Techniques: Monitoring Populations

<u>Marking Population</u>

The method of marking and subsequent observation must be effective but minimise impact on the study species.

Care must be given to **protected/endangered species.**

<u>Types of Marking</u>

1. Banding
2. Tagging
3. Painting
4. Surgical implantation
5. Hair clipping

Field Techniques: Monitoring Populations

Two Techniques

1. Direct Count

Count every organism in a given area.

Suitable for small populations.

2. Mark & Recapture

Sampling organisms by counting organisms on two occasions to estimate numbers of total population

Used in large populations where it is not possible to count every organism.

Mark and Recapture Technique

Stage one

A sample of the population is captured and marked (M) and then released

Stage two

After an interval of time, a second sample is captured (C).

Some of the individuals in this second sample are recaptures (R).

Formula

$$\boxed{N = \frac{M \times C}{R}}$$

N = total population   M = marked population   C = captured population   R = recaptured population

Mark & Recapture Assumptions

1. All individuals have an **equal chance** of capture.

2. No **immigration** or **emigration.**

3. Individuals that are marked and released can mix fully and randomly with the total population.

Measuring & Recording Animal Behaviour & Ethograms

Animal Behaviour

What the animal is doing or how they are reacting to a stimulus.

Ethogram

the study of animal behaviour shown by a species in a wild context. Ethograms allow the construction of time budgets.

An ethogram lists species-specific behaviours to be observed and recorded in the study.

Recording the duration of each of the behaviours in the ethogram, together with the total time of observation, allows the proportion of time spent on each behavior to be calculated in the time budget.

Ethogram Measurements

1. **Latency**

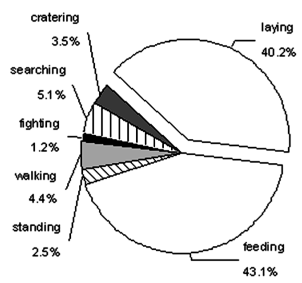
The time between the stimulus occurring and the response behaviour.

2. **Frequency**

The number of times a behaviour occurs within the observation period.

3. **Duration**

The length of time each behaviour occurs during the observation period.



Measuring & Recording Animal Behaviour & Ethograms

Anthropomorphism

Attributing human characteristics, emotions, personalities & behaviours to animals.

Example—animal smiling OR animal begging for food.

Why is anthropomorphism bad in animal behaviour studies?

Very similar behaviour, completely different meaning in different species.

Examples :

Showing teeth in humans is a smile to indicate happiness.

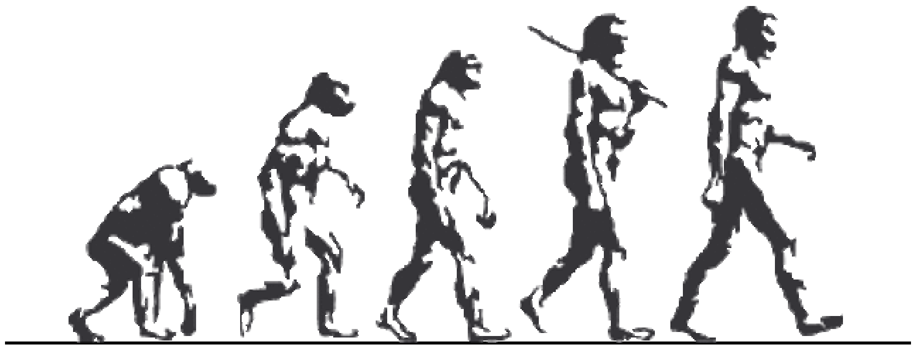
However, primates showing teeth is a subordinate behaviour.

Anthropomorphism can lead to invalid conclusions.

Evolution: Drift & Selection

Evolution

Change over time in the proportion of individuals in a population DIFFERING in the one or more inherited traits.



During evolution, changes in allele frequency occur through three processes:

1. **Genetic drift**

   Random increase/decrease in certain alleles

   Caused by neutral mutations and the founder effect

   More important in **small populations** as alleles are more likely to be lost from the gene pool.

3. **Natural selection**

   Non random increase in alleles that promote survival

   This is caused by an advantageous mutations that creates a selective advantage for survival.

2. **Sexual selection**

   Non random increase in alleles that increase reproduction

   Fecundity rate = fertility rate

   Animals that have high fecundity are selected by sexual selection.

Evolution: Drift & Selection

1. **Genetic drift**

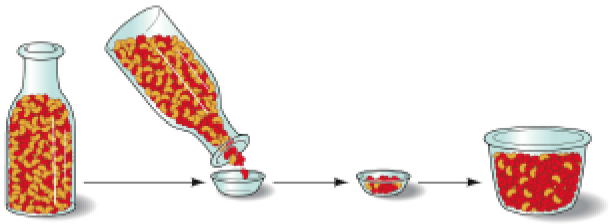
Genetic drift occurs when chance events cause unpredictable fluctuations in allele frequencies from one generation to the next.

Genetic drift is more important in **small populations** as alleles are more likely to be lost from the gene pool.

Genetic drift can be caused by bottlenecks and founder effects.

Bottlenecks

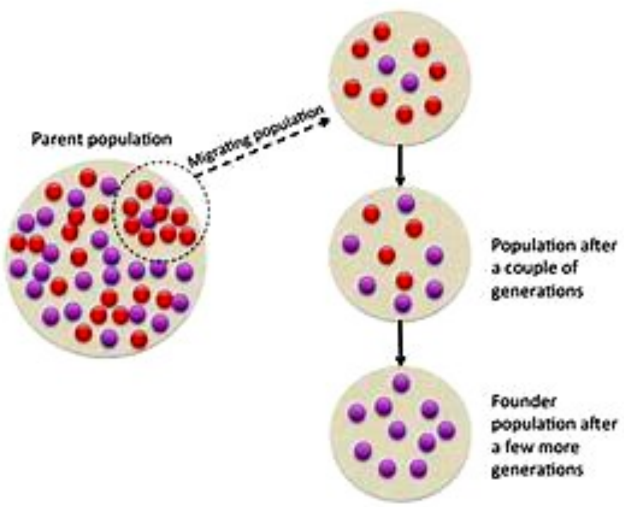
Population bottlenecks occur when a population size is reduced for at least one generation.



This results in surviving individuals having one allele that is more dominant than the original populations alleles.

Founder Effect

The founder effect occurs through the isolation of a few members of a population from a larger population. The gene pool of a new population is not representative of that in the original gene pool.



A gene pool is altered by genetic drift because certain alleles may be under-represented or over-represented and allele frequencies change.

Evolution: Drift & Selection

2. Natural selection - Non Random Selection

Natural selection results in the non-ransom increase in the frequency of advantageous alleles and the non-random decrease in the frequency of deleterious alleles.

Natural selection acts on genetic variation in populations.

Genetic variation arises as a result of mutations.

Mutations

Variation in traits arises as a result of mutation. Mutation is the original source of new sequences of DNA.

These new sequences can be novel alleles.

Most mutations are harmful or neutral, but in rare cases they may be beneficial to the fitness of an individual.

Populations produce more offspring than the environment can support.

Individuals with variations that are better suited to their environment tend to survive longer and produce more offspring, breeding to pass on those alleles that conferred an advantage to the next generation.

3. Sexual selection—Non -random selection

Non random process involving the selection of alleles that increase the individuals chances of mating and producing offspring.

Sexual selection may lead to **sexual dimorphism.**

Sexual Dimorphism—

Male pheasants are larger than female pheasants.

Reversed Sexual Dimorphism—

Female spiders are larger than male spiders.

Sexual selection can be due to male-male rivalry and female choice.

Male—Male Rivalry

Males are large in size or have weaponry. This increases their access to females through conflict.

Female Choice

A process where females assess the fitness of males.

Evolution: Drift & Selection

Rate of Evolution

Where selection pressures are strong, the rate of evolution can be rapid.

Selection Pressures

Selection pressures are the environmental factors that influence which individuals in a population pass on their alleles.

These include:

Biotic (living) Factors	Abiotic (non-living) Factors
Competition	Changes in temperature
Predation	Light
Disease	Humidity
Parisitism	pH
	Salinity

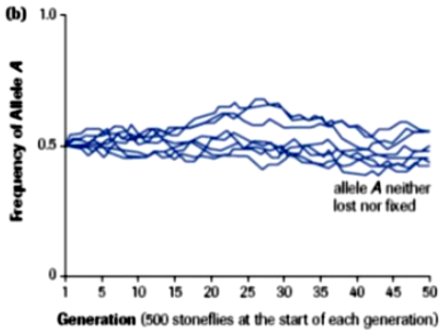
Evolution: The HW Principle

The Hardy-Weinburg (HW) Principle

The HW principle states that, in the absence of evolutionary influences, allele and genotype frequencies in a population will remain constant over generations.

The HW principle can be used to determine whether a change in allele frequency is occurring in a population over time.

Changes suggest that evolution is occurring.



Conditions for HW equilibrium

The conditions for maintaining the HW equilibrium are:

1. No natural selection
2. Random mating
3. No mutations
4. Large population size
5. No gene flow (through migration, in or out).

The HW Principle Calculation

$$p^2 + 2pq + q^2 = 1$$

p = frequency of dominant allele

q = frequency of recessive allele

p^2 = frequency of homozygous dominant genotype

$2pq$ = frequency of heterozygous genotype

q^2 = frequency of homozygous recessive genotype

The frequency of a given allele in a population is a measure of how common that allele is as a proportion of the total number of copies of all alleles at a specific locus. For a locus with one dominant allele (A) and one recessive allele (a), the frequency of the dominant allele (p) and the frequency of the recessive allele (q) can be used to calculate the genetic variation of a population using the equations below.

$p + q = 1$ p = frequency of A allele
q = frequency of a allele

$p^2 + 2pq + q^2 = 1$ p^2 = frequency of homozygous (AA) individuals
q^2 = frequency of homozygous (aa) individuals
$2pq$ = frequency of heterozygous (Aa) individuals

If the allele frequency of the recessive allele is 0·7, the proportion of individuals that would be heterozygous is

A 0·09
B 0·21
C 0·42
D 0·49.

Evolution: Fitness

Fitness

Fitness is an indication of an individuals ability to be successful at surviving and reproducing.

Fitness is a measure of the tendency of some organisms to produce more surviving offspring than competing members of the same species.

Fitness refers to the contribution made to the gene pool of the next generation by individual genotypes.

Fitness can be defined in absolute or relative terms.

Absolute Fitness

The ratio between the number of individuals of a particular genotype after selection, to those before selection.

$$\frac{\text{Frequency of a particular genotype after selection}}{\text{Frequency of a particular genotype before selection}}$$

If the absolute fitness is 1, then the frequency of that genotype is stable. A value greater than 1 conveys an increase in the genotype and a value less than 1 conveys a decrease.

Relative Fitness

The ratio of the number of surviving offspring per individual of a particular genotype to the number of surviving offspring per individual of the most successful genotype.

$$\frac{\text{Number of surviving offspring per individual of a particular genome.}}{\text{Number of surviving offspring per individual of the most successful genotype.}}$$

Evolution: Co evolution & The Red Queen Hypothesis

Red Queen Hypothesis

The Red Queen Hypothesis states that, in a co-evolutionary relationship, change in the traits of one species can act as a selection pressure on the other species.

This means that species in these relationships must adapt to avoid extinction.

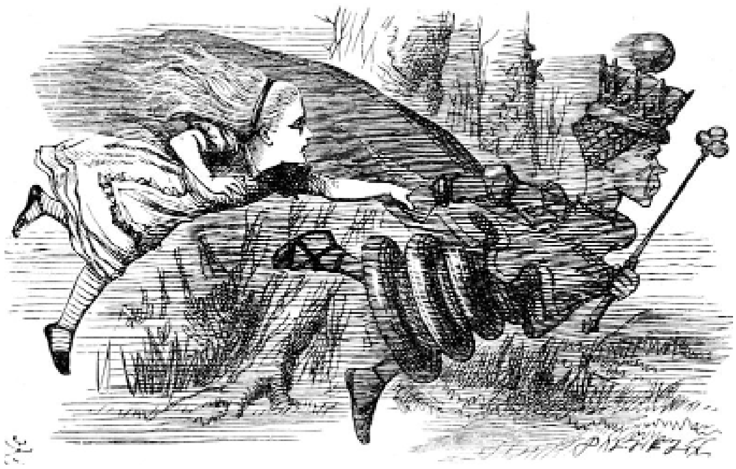
Host & Parasite Red Queen Hypothesis

Host with **greater fitness** are better able to resist and tolerate parasitism.

(improvements in specific & non specific immune system).

Parasites with **greater fitness** are better able to feed, reproduce and find new hosts.

The Red Queen Hypothesis states that both organisms must 'keep running in order to stay still'.



Evolution: Co evolution & The Red Queen Hypothesis

Co Evolution

The process by which two or more species evolve in response to selection pressures imposed by each other.

A change in the trait of one species acts as selection pressure on the other species.

Co-evolution is frequently seen in pairs of species that have symbiotic relationships.

Symbiosis

Co-evolved intimate relationships between members of two different species.

Symbiotic relationships can have;

Positive (+)

Negative (-)

or Neutral (0) impacts on the individuals involved.

Types of symbiotic interactions

1. Mutualism

   Both organisms in the interaction are interdependent on each other for resources or other services.

   Both organisms gain from the interaction **(+/+).**

   e.g. Anenome and clown fish

2. Commensalism

   Only one of the organisms benefit **(+/0).**

   e.g. Remora fish have disks on their heads to attach to larger fish to enable them to gain food.

3. Parasitism

   The parasite benefits in terms of energy or nutrients and the host is harmed as the result of the loss of these resources **(+/-).**

   e.g. Plasmodium and human host

Sexual & Asexual Reproduction: Costs & Benefits

Sexual Reproduction—Costs

* Males are unable to produce offspring.
* Only half of each parents genome is passed onto offspring; disrupting successful genomes.

Sexual Reproduction—Benefits

The benefits outweigh the costs due to an increase in **genetic variation.**

Genetic variation provides the raw materials required for adaptation, giving sexually reproducing organisms a better chance of survival under changing selection pressures.

Red Queen Hypothesis and Sexually Reproducing Hosts

The Red Queen Hypothesis can be used to explain the persistence of the method of sexual reproduction.

Co-evolutionary interactions between parasites and hosts may select for the sexually reproducing hosts rather than the parasites.

If hosts reproduce sexually, the genetic variability in their offspring reduces the chances that all will be susceptible to infection by parasites.

Sexual & Asexual Reproduction: Costs & Benefits

Asexual Reproduction—Costs

* Not able to adapt easily to changes in their environment

Asexual Reproduction – Benefits

Offspring can be reproduced more often and in larger numbers.

Asexual reproduction can be a successful reproductive strategy as whole genomes are passed on from parents to offspring.

One parent can produce daughter cells and establish a colony of virtually unlimited size over time.

Maintaining the exact same genome as the parent is an advantage particularly in very **narrow, stable niches** or when **recolonising disturbed habitats.**

Asexual Reproductive Methods

Vegetative Cloning

Asexual reproductive mechanism in plants.

Parthenogenesis

Asexual reproduction in lower plants and animals.

This is a form of reproduction from a female gamete without fertilisation.

Parthenogenesis is more common in cooler climates, which are disadvantageous to parasites, or regions of low parasite density or diversity.

Horizontal Gene Transfer

Asexual reproductive method in organisms such as Prokaryotes.

Allows a faster evolutionary change than in organisms that only use vertical transfer.

This allows variation to be increased in a population.

Sexual & Asexual Reproduction: Meiosis

What is Meiosis

Meiosis is the division of the nucleus that results in the formation of haploid gametes from a diploid gametocyte.

In diploid cells, chromosomes typically appear as homologous pairs.

Features of Homologous Chromosomes

1. Same size
2. Same gene loci
3. Same centromere position
4. Same sequence of genes

Meiosis

Meiosis occurs in two distinct stages.

Meiosis I

1. The chromosomes, which have replicated prior to meiosis I, each consist of two genetically identical chromatids attached at the centromere.
2. The chromosomes condense and the homologous chromosomes pair up.
3. Chiasmata form at points of contact between the non-sister chromatids of a homologous pair and sections of DNA are exchanged.
4. This crossing over of DNA is random and produces genetically different recombinant chromosomes.
5. Spindle fibres attach to the homologous pairs and line them up at the equator of the cell.
6. The orientation of the pairs of homologous chromosomes at the equator is random
7. The chromosomes of each homologous pair are separated and move towards opposite poles.
8. Cytokinesis occurs and two daughter cells form.

Meiosis II

Each of the two cells produced in meiosis I undergoes a further division during which the sister chromatids of each chromosome are separated.

A total of 4 genetically different haploid cells are produced.

Sexual & Asexual Reproduction: Meiosis

Causes of Genetically variable Gametes

1. Independent/Random assortment

Each pair of homologous chromosomes are positioned independently of the other pairs, irrespective of their maternal or paternal origin.

2. Crossing Over

Chromatids break and rejoin at points called chiasmata which shuffles sections of DNA between homologous chromosomes

Crossing over through recombination of alleles separates linked genes.

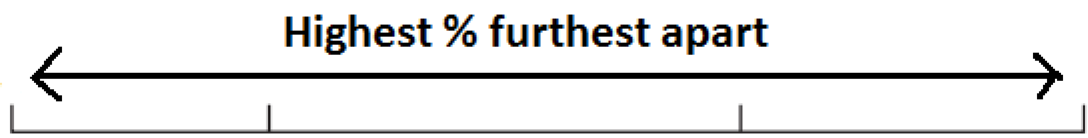
Linked genes are those on the same chromosomes. Crossing over can result in new combinations of the alleles of these genes.

Recombination Frequency Questions

Remember for crossing over recombination maps the further apart the genes the higher the recombination frequency

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



Sexual & Asexual Reproduction: Sex Determination

The sex of birds, mammals and some insects is determined by the presence of sex chromosomes.

In most mammals the SRY gene on the Y chromosome determines development of male characteristics as it produces high levels of testosterone.

Heterogametic—Different sex chromosomes *e.g. X and Y*

Homogametic—The same sex chromosomes *e.g. X and X*

Sex Linked Diseases

Heterogametic (XY) males lack most of the corresponding homologous alleles on the shorter (Y) chromosome.

This can result in sex-linked patterns of inheritance as seen with carrier females (X^BX^b) and affected males (X^bY).

X Inactivation

In homogametic females (XX) one of the two X chromosomes present in each cell is randomly inactivated at an early stage of development.

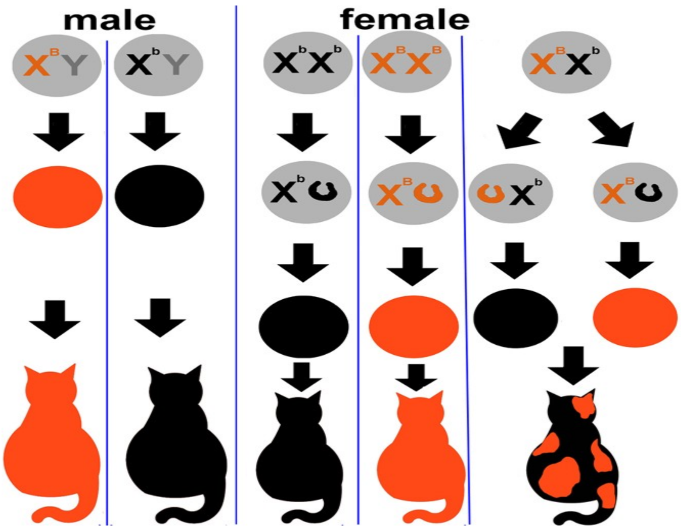
X chromosome inactivation is a process by which most of one X chromosome is inactivated.

X chromosome inactivation prevents a double dose of gene products, which could be harmful to cells.

Carriers are less likely to be affected by any deleterious mutations on these X chromosomes.

As the X chromosome inactivated in each cell is random, half of the cells in any tissue will have a working copy of the gene in question.

e.g. Tortoiseshell cats—In female tortoiseshell cats, the alleles for fur are randomly switched off, allowing for some orange fur alleles to be expressed and some black fur alleles to be expressed in the phenotype.



Sex and Behaviour: Sex Determination

Hermaphrodites

Hermaphrodites are species that have functioning male and female reproductive organs in each individual.

They produce both male and female gametes and usually have a partner with which to exchange gametes.

The benefit to the individual organism is that if the chance of encountering a partner is an uncommon event, there is no requirement for that partner to be of the opposite sex.

Environmental Sex Determination

For other species, environmental rather than genetic factors determine sex and sex ratio.

Environmental sex determination in reptiles is controlled by environmental temperature of egg incubation.

Sex can change within individuals of some species as a result of size, competition, parasitic infection, or temperature.

In some species the sex ratio of offspring can be adjusted in response to resource availability.

Sex and Behaviour: Parental Investment

Parental investment is costly but increases the probability and survival of young. The increased chance of survival then, increases the evolutionary fitness of the parent.

Sperm and egg production

There is an inequality in the investment required in production of individual eggs and sperm cells.

In humans– Females have around 2 million egg follicles but on invest in about 450 of these; only 1 or 2 are ovulated at any one time.

Males produce around 500 billion mature sperm in a lifetime, of which 500 million can be ejaculated at one time.

There is greater investment by females in individual gametes as well as in the uterus in mammals.

<u>R and K selected organisms</u>

R selected organisms

Small species

Shorter generation times

Mature more rapidly

Reproduce earlier in their lifetime

Producing a large number of smaller offspring

Lower chance of survival:

Each offspring only receives a small energy input

Limited parental care

K selected species

Larger species which live longer

Mature more slowly

Can reproduce many times in a lifetime

Produce few, larger offspring

High level of parental care

High probability of surviving to adulthood

K= Kind

Sex and Behaviour: Mating Systems

Mating systems are based on how many mates an individual has during one breeding season.

There are four mating systems that range from polygamy to monogamy.

Polygamy
Individuals of one sex have more than one mate.

Polygyny
One male mates exclusively with a group of females.

Polyandry
One female mates with a number of males in the same breeding season

Monogamy
The mating of a pair of animals to the exclusion off all others.

Sex and Behaviour: External and Internal Fertilisation

External fertilisation

Benefits:

* Very large numbers of offspring can be produced

Costs:

* Many gametes predated or not fertilised;
* No or limited parental care;
* Few offspring survive

Internal fertilisation

Benefits:

* Increased chance of successful fertilisation;
* Fewer eggs needed;
* Offspring can be retained internally for protection and/or development;
* Higher offspring survival rate

Costs:

* A mate must be located, which requires energy expenditure;
* Requires direct transfer of gametes from one partner to another.

Sex and Behaviour: Reproductive Behaviours

Sexual selection

non random way of evolving traits in males as females select males with greatest fitness (good genes/low parasite burden).

Females only mate with fittest males to **increase reproductive chance** as they invest a lot more energy in egg than males do in sperm production through the process of female choice.

Female Choice

Involves females **assessing male fitness (good genes/low parasite burden)** in terms of selecting males that will increase likelihood of **reproductive success.**

Females assess male fitness by **honest signals** given off by males.

Honest signals can indicate favourable alleles that increase the chances of survival of offspring (fitness) or a low parasite burden suggesting a healthy individual.

Sexual dimorphism

The two sexes of the same species exhibit different characteristics beyond the differences in their sexual organs themselves such as size, colour, and behavioural differences

Females

inconspicuous to remain camouflaged to avoid predators

Males

conspicuous markings, structures and behaviours to attract a male via female choice

Example—Male lions have a mane, female lions do not.

Reversed sexual dimorphism

Males smaller than females e.g. owls

Sex and Behaviour: Reproductive Behaviours

Courtship Behaviours

Behaviour aims to **attract/mate with a female** through female choice during sexual selection.

Any characteristic/courtship behaviour by males to **increase the chance of mating** or allow for female choice can be said to have undergone **sexual selection**.

1. Male: Male rivalry
2. Lekking dominant and satellite males
3. Sign stimuli and Fixed Action Pattern Responses

1. **Male-male rivalry:**

Increases access to females through (real or ritualized) conflict with the, victorious male selected by female choice.

Techniques

Large size : success of combat is positively related to male body size. (bigger the better)

Weaponry: success in male: male conflict has led to secondary sexual characteristics (including horns/antlers/tusks) termed "weapons" to be selected.

2. Lekking

Display behavior of Lekking species

Groups of Males displaying and being aggressive to one another to entice visiting females for copulation.

Females often mate with most dominant males at center territory of Lek.

In ruffs dark dominant males show male: male rivalry by fighting and displaying to one another. However dominant males seem to be tolerant of satellite non aggressive males such as paler ruffs.

Advantage of Lekking Behaviour

The advantage to dominant males of the presence of satellite males is that they attract more females but often reduce copulation frequency.

Trade off of dominant males between being tolerant to satellite males to attract females whilst being more aggressive to satellite males when rate of female visits is high

Courtship Behaviours

4. Fixed Action pattern response

<u>Sign Stimulus</u>

Denotes a feature of an animal's environment that elicits a particular response

<u>Fixed action pattern responses</u>

instinctive behavioural response termed fixed action pattern response triggered by a sign stimulus.

Example 1: Sticklebacks

Sign stimulus - red belly

Fixed action pattern response- head down attack behaviour in male sticklebacks

Example 2: Mating dances in peacocks

Sign stimulus- presence of female

Fixed action pattern response- display by male

Importance of Fixed Action Pattern responses

Fixed action pattern responses are invariant and un-influenced by the environment. Once triggered Once triggered, the FAP behaviour can't be stopped or altered but must play out to completion.

FAP's do not vary amongst members of a species and therefore must be necessary for their survival as they can be exploited due to their predictable nature.

Parasitism: Niche

Parasite

A symbiont that gains benefit in terms of nutrients at the expense of its host.

Common parasites– Protists, Platyhelminths, Nematodes, Arthropods, Bacteria, Viruses

Types of parasites

1. Ectoparasites

   Live on the surface of the host

2. Endoparasites

   Lives within the tissue of its host

Size of parasite

1. Macroparasites

   Visible to the naked eye

2. Microparasites

   Not visible to the naked eye

Ecological Niche

Multidimensional summary of tolerances and requirements of a species.

Parasites tend to have a narrow niche as they are very host specific..

Fundamental Niche

Niche a species occupies in absence of any interspecific competing influences.

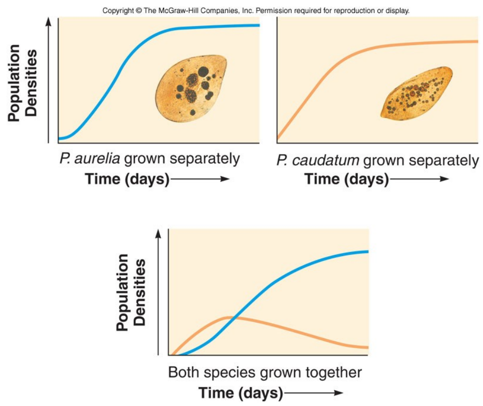
Realised Niche

Niche a species occupies in response to interspecific competition.

Interspecific competition in a realised niche causes two main outcomes-

Competition Exclusion

Where two species are so similar that they both want the same resource, one will have a slight advantage over the other which declines to local extinction.

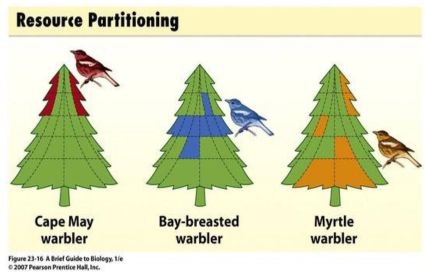


Resource Partitioning

Where realised niches are sufficiently different , potential competitors can co-exist by

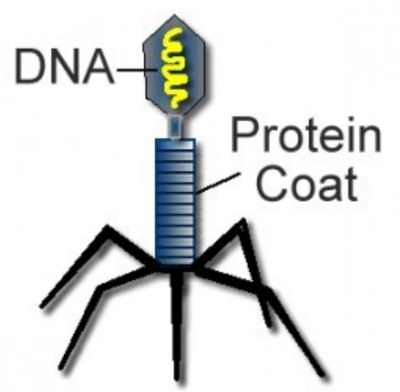
A) Using different resources (small/big seeds by having different beak shape).

B) Using the same resources at different times (diurnal/nocturnal).



Parasitism: Parasite Host

Virus parasites



Viruses are infectious agents that can only replicate inside a host cell by **stopping the host cell's metabolism by injecting DNA/RNA.**

Viruses contain ;

1. genetic material in the form of DNA or RNA (retro viruses)
2. protective protein coat

The outer surface of a virus contains antigens that a host cell may or may not be able to detect as foreign.

RNA retroviruses (HIV) use the enzyme **reverse transcriptase** to form DNA from RNA which is then inserted into the **genome of the host cell.**

The viral genes can then be expressed to form new viral particles

Viral life cycle stages

Stage 1– Genetic material injected into the host cell

Stage 2– host cell enzymes replicate the viral genome

Stage 3– transcription of viral genes and translation of viral proteins

Stage 4– assembly and release of new viral particles

Types of hosts

1. **Definitive Host**

   The organism on/in which parasite reaches sexual maturity

   Meiosis occurs at this point creating gametes (eggs) or zygotes

2. **Intermediate Host**

   Enable parasites to complete life cycles after sexual maturity. Mitosis occurs here.

   Unlike a predator/prey relationship, the reproductive potential of the parasite is far greater than the host due to asexual part of lifecycle where parasites increase rapidly by mitosis.

3. **Vectors**

   Often play an active role in the transmission of the parasite to host. These can also be classified as a host (intermediate or definitive). Examples include the mosquito vector of the malaria parasite.

Parasitism: Parasitic Life Cycles

Some parasites require only one host to complete their life cycle Many parasites require more than one host to complete their life cycle

The definitive host is the organism on or in which the parasite reaches sexual maturity. Intermediate hosts may also be required for the parasite to complete its life cycle.

A vector plays an active role in the transmission of the parasite and may also be a host

Parasites requiring more than one hpst to complete their life cycles

Schistosomiasis

Reproduces sexually in the human intestine. The fertilised eggs pass out via faeces into water to develop into larvae. The larvae then infect water snails, where asexual reproduction occurs.

This produces another motile larvae which escape the snail and penetrates the skin of the human.

Parasite– Schistosoma (macro & endo parasite)

Definitive host– Human

Intermediate host– Snail

Transmission– Water

Malaria

An infected mosquito, acting as a vector, bites a human. PLasmodioum enters the human blood stream allowing asexual reproduction to take place in the liver and blood stream. Gametocytes are released into the blood stream as red blood cells burst.

Another mosquito then bites the infected human and takes up the gametocyte. The gametocyte then matures into male and female gametes, allowing sexual reprocduction to occur.

The mosquito can then infect another human host.

Parasite– Plasmodium spp (micro & endo parasite)

Definitive host– Mosquito

Intermediate host– Human

Transmission– Vector

Some bacteria including bacteria causing Tuberculosis and viruses causing influenza and HIV in human hosts can complete their life cycles within one host.

Transmission and Virulence

Transmission is the spread of a parasite to a host.

Virulence is the harm caused to a host species by a parasite.

Ectoparasites- generally transmitted through direct contact or by consumption of intermediate host

Endoparasites—of body tissues- often transmitted by vectors

Factors increasing transmission rate

1. High host density (intensive farming/refugee camps/natural disasters)
2. Mechanisms (such as vectors and waterborne dispersal stages) that allow the parasite to spread even if the host is incapacitated.

Parasites maximise transmission by

1. Exploiting host behaviour

   -host behaviour can be modified. E.g. Preventing risk taking during sexual activity or anti -predator behaviour is an extended phenotype of the parasite.

2. Supressing host immune system

3. modification of the host size (infects hosts larger and so more spores)

4. Modification of host reproductive rate (infected hosts breed less)

5. Asexual life cycles allow rapid build up of parasites in intermediate host

Immune Response to Parasites

Host immune responses minimise the impact of parasites in mammals. Immune defence can be specific or non-specific

Non-specific immune defences

1. Physical barriers like the skin and chemical secretions like hydrolytic enzyme in mucus, saliva and tears prevents entry of parasites. Low pH environments of secretions in the stomach, vagina and sweat glands denatures cellular proteins of pathogens.

2. Injured cells release signalling molecules. This results in increased blood flow to the site, bringing antimicrobial proteins and phagocytes to the area.

3. Phagocytes engulf parasite into vesicle and lysosome fuses with vesical releasing digestive enzyme to destroy parasite.

4. Natural Killer cells can identify and attach to cells infected with viruses, releasing chemicals that leas to cell death by inducing apoptosis.

Specific natural defences

A range of white blood cells constantly circulate, monitoring the tissues.

If tissue becomes damaged or invaded, cells release cytokines that increase blood flow resulting in specific and non-specific white blood cells accumulating at the site of infection/damage.

A different lymphocyte is produced for each foreign antigen (specificity)

- Binding of an antigen to a lymphocyte's receptor selects that lymphocyte to then divide and produce a clonal population.

- Some lymphocytes produce antibodies while others can induce apoptosis in parasite-infected cells.

- Antibodies possess regions where amino acid sequence varies greatly between one antibody and another. This gives specificity to an antigen.

- Antigen binding forms an antigen-antibody complex which can result in the inactivation of the parasite. This renders the parasite susceptible to a phagocyte, or it can stimulate a response that results in cell lysis

Memory lymphocyte

Initial antigen exposure produces memory lymphocyte cells for a specific antigen. These can produce a secondary response when the same antigen enters the body in the future. At this point, antibody production is enhanced in terms of

-speed of production, concentration in the blood and duration

Immune Evasion

Parasites have evolved in such ways as to evade the immune system

- Endoparasites mimic host antigen to evade detection by the host immune system
- Endoparasites can modify host immune response to reduce the chance of destruction
- Antigen variation in some parasites allows them to change between different antigens during the course of infection of a host

Some viruses escape immune surveillance by integrating their genome into host genomes, existing in an inactive state known as **latency**.

The virus becomes active again when more favourable conditions arise.

Epidemiology

The study of the outbreak and spread of infectious diseases

Herd immunity threshold

Density of resistant hosts in the population required to prevent an epidemic

Challenges in Treatment and Control of Parasites

Vaccinations

Vaccines contain antigens that will elicit an immune response.

Challenges

1. Some parasites are difficult to culture in a laboratory making it difficult to design vaccines
2. Antigenic variation must be reflected in the design of vaccines.
3. The similarities between host and parasite metabolism makes it difficult to find drug compounds that will only target the parasite.
4. Challenges arise when parasites spread most rapidly as a result of-

    -Overcrowding (refugee camps in war torn countries)

    -Tropical climates following natural disasters or rapidly growing cities

    These situations make co-ordinated treatment and control programmes difficult.

Treatment/Control Solution

Civil engineering projects to improve sanitation combined with co-ordinated vector control may often be the only practical control strategies.

Importance of parasite control

Improvements in parasite control reduce child mortality and result in population-wide improvements in child development and intelligence, as individuals have more resources for growth and development.