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.

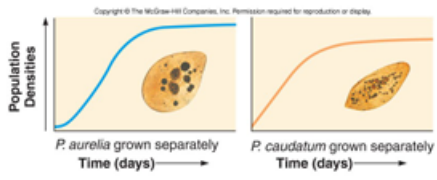
Realised Niche

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.

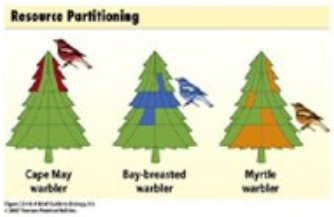


Resource Partitioning

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

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

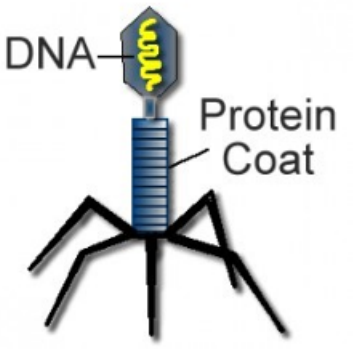
B) Using the same resources at different times (diurnal/nocturnal).



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

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

Some bacteria including TB and influenza/HIV viruses can complete their life cycles within one host.

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.

Ectoparasites
On body surfaces & generally transmitted through direct contact/consumption of intermediate host

Endoparasites
Within body tissues- often transmitted by vectors

Macro/micro parasites

1. Macroparasites
   Visible to naked eye e.g. round worm

2. Microparasites
   Invisible to naked eye e.g. bacteria/virus

Parasite Life Cycles

Schistosomasis

Parasite :
schistosoma (macro endoparasite)

Definitive host:
human small intestine

Intermediate host:
snail

Transmission type:
water

Schistosoma reproduces sexually in the human intestine producing eggs. 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.

Malaria

Type of transmission
Vector

Parasite-
Plasmodium (micro endo parasite)

Definitive host
Mosquito

Intermediate host
Human

An infected mosquito, acting as a vector, bites a human. Plasmodium 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 reproduction to occur.

The mosquito can then infect another human host.

Transmission/Virulence

Transmission
Spread of a parasite to a host.

Virulence
Harm caused to a host species by a parasite.

Factors increasing transmission rate

1. High host density (intensive farming/refugee camps/natural disasters)
2. Mechanisms that allow the parasite to spread even if the host is incapacitated (water/vector transmission)

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 (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

Parasitic Immune system evasion strategies

1. Endoparasites mimic host antigen to evade detection by the host immune system

2. Endoparasites can modify host immune response to reduce the chance of destruction

3. Antigen variation in some parasites allows them to change between different antigens during the course of infection of a host

4. 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

Immune System Host Response

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
Tightly packed epithelial cells in skin/digestive/respiratory systems

2. Chemical secretions
Contain 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.

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

4. Phagocytes
Engulf parasite into vesicle and lysosome fuses with vesical releasing digestive enzyme to destroy parasite.

5. Natural Killer cells
Identify and attach to cells infected with viruses, releasing molecules that leads 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 anti body 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

Immune System Host Response

Memory lymphocytes
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.

Antibody production is enhanced in terms of

1.speed of production
2.concentration in the blood
3.duration

Challenges & Treatments/Control Solutions

Vaccinations
Vaccines contain foreignantigens 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 as the two following situations make co-ordinated treatment and control programmes difficult.

- Overcrowding (refugee camps in war torn countries)

- Tropical climates following natural disasters or rapidly growing cities

Treatment/Control Solution
Civil engineering projects to improve sanitation & co-ordinated vector control may often be the only practical control strategies.

Importance of parasite control
Improvements in parasite control reduce child mortality and improvements in child development / intelligence as individuals have more resources for growth & development.