Molluscs

Generalised Mollusc

- Generalised mollusc is benthic (lives on the sea floor)
- It has a poorly defined head
- Has a foot and shell
- Microphagous feeding (microscopic algae etc) via a radula

Radula

- A **radula** is a ribbon of chitinous teeth made of chiton
- Animals feed by projecting the radula out of their mouth
- Radula moves like a conveyor belt over the odontophore so that teeth can scrape the surface to bring in food
- Food is then moved back into the buccal cavity

Gastropods

- A radula has 1 central tooth (rachis), 1 or more lateral teeth (middle) and 1 or more marginal teeth (outer)
- Dental formula is 4 + 2 + 1 + 2 + 4

Gougers

- Docoglossate (spear) radula made with iron and silicon
- Dental formula 4 + 2 + 1 + 2 + 4

  eg. limpets

Scrapers/Sweepers

- Rhipidoglossate (fan) radula
- Dental formula ∞ + 6 + 1 + 6 + ∞

  eg. abalone

Carnivores - drillers

- Rachiglossate (spine) radula
- They release chemicals from their mouth that dissolve the shell to soften it
- The radula is then used to scrape the shell, creating a hole
- 3 large, multicusped teeth
- Dental formula 0 + 1 + 1 + 1 + 0

  eg. whelk, Thais

Carnivores

- Toxoglossate (archer) radula
- Highly specialised toxic teeth
- Poison/toxins kills prey
- They use 1 tooth at a time
- Dental formula 0 + 1 + 0 + 1 + 0

  eg. cone shell

Bivalves

- Bivalves are filter feeders
- Lamellibranch gills (ctenidia) have long filaments
- Ctenidia are used to extract oxygen from water and trap food particles
- Particles travel along the gill surface to the mucous string where palps then sort the particles
- The particles enter the mouth and then the stomach where they're grinded and digested

- Stomach contains crystalline style which pulls the mucous string towards the mouth and helps grind food

Endosymbionts in Vent Bivalves

- Bivalves form endosymbiotic relationships with bacteria
- Clam Lucina pectinata
  - Endosymbiotic bacteria feed on H_2S
- Mussel Bathymodiolus thermophilus
  - Small gut
  - So some food is obtained from bacteria that grow inside its gills
- Giant clam Calyptogena magnifica
  - No gut
  - All food obtained from bacteria that grow inside its gills

Asexual Reproduction

- Asexual reproduction mostly occurs in marine animals

Advantages

- Removes the requirement for a mate, saving energy (searching for a mate takes time and energy)
- Results in less encounters between individuals of the same species, allowing for more protection
- Is rapid and produces lots of offspring quickly (number of individuals quadruples with each generation)
- Reproduction of successful genotypes is on-going/perpetual

- Occurs in protozoa, most metazoa, including invertebrates and some vertebrates (fish, amphibians and reptiles)
- Asexual reproduction can be **agametic** (no eggs or sperm) or **parthenogenetic** (the development of unfertilised eggs)

Agametic Reproduction

Fission

- **Fission** is the separation of a parent into two or more individuals
- Progeny are approximately equal in size
- Occurs in Protozoa, Cnidaria, Platyhelminthes, Annelids, Hemichordata (Pterobranch) and Echinoderms

Budding

- **Budding** is where new individuals form from outgrowths in existing ones
- Differentiation of daughter individual before it detaches from parent
- Parent and offspring vary in size unlike in fission where they are equal
- Occurs in Protozoa, Porifera, Placozoa, Cnidaria, Platyhelminthes, Annelids, Kamptozoa, Cycliophora, Hemichordata (Pterobranch) and Tunicates

Fragmentation

- **Fragmentation** is where the parent breaks into irregular sized fragments
- These fragments are capable of regenerating into new individuals
- Fragmentation is accompanied by regeneration
- Occurs in Porifera, Placozoa, Cnidaria, Ctenophora, Platyhelminthes, Nemertea, Annelids, Hemichordata (acorn worms, Pterobranch) and Echinoderms

Parthenogenetic Reproduction

- **Parthenogenesis** is a form of reproduction where unfertilised eggs can develop into embryos, without being fertilised by sperm
- Occurs in less than 1% of animals
- Occurs in Dicyemida, Tardigrada, Crustacea (e.g. Cladocera, Ostracods), Nematodes, Rotifera and some Vertebrates (e.g. fish, amphibians, reptiles)
- **Cyclic parthenogens** alternate between parthenogenesis and sexual reproduction
- **Obligate parthenogens** must reproduce by parthenogenesis (lost the ability to reproduce sexually)
- **Facultative parthenogens** sometimes reproduce by parthenogenesis and sometimes by sexual reproduction
- **Spontaneous parthenogens** primarily reproduce via sexual reproduction, however they sometimes spontaneously reproduce by parthenogenesis

Apomixis

- **Apomixis** is the development of unfertilized diploid eggs, made by mitosis (suppression of meiosis), into individuals
- The individuals produced, are genetically identical clones of their parent
- Occurs in bdelloid rotifers, earthworms, snails, ostracods, Daphnia (water fleas), isopods, aphids, beetles, wasps, grasshoppers and stick insects
- In spring and summer, aphids reproduce pathogenetically
- In autumn, aphids parthenogenetically produce males (1 X chromosome) which undergo sexual reproduction with females to produce an egg which can survive the winter

Automixis

- **Automixis** is the development of unfertilized haploid eggs, made by meiosis, into individuals
- Diploidy is restored by the duplication/fusion of gametes
- Individuals can be clones of the parent if duplication of chromosomes occurs before meiosis, or if products of meiosis 1 fuse
- If fusion of haploid gametes occurs after meiosis 2, this is self fertilisation
- Occurs in brine shrimp, whiteflies, moths and lizards

Gynogenesis

- In gynogenesis, sperm is required, but DNA is not incorporated
- Sperm helps stimulate development of the egg, but genetic material from sperm is lost
- Females are clonal
- Occurs in some flatworms, bivalve molluscs, moths, fish and salamanders

Hybridogenesis

- In hybridogenesis, sperm is required, and DNA is incorporated & expressed
- Hybridogenetic females produce eggs and then mate with males from a sexual species
- In this way, genetic material from the sperm is incorporated into the egg
- Paternal DNA is discarded at oogenesis
- Females are hemiclonal
- Occurs in some fish and frogs

Haplodiploidy

- Fertilised eggs (diploid) are females
- Unfertilised eggs (haploid) develop into males via parthenogenesis
- The unfertilised eggs can be fertilised to develop into females
- Sisters share ¾ of their genetic material
- Occurs in bees and wasps, some other arthropods and rotifers

Parasite – Host Coevolution

- Parasites reduce the fitness of their hosts, so hosts have strong selection to mitigate these parasites and parasites have strong selection to continue invading hosts
- Parasites evolve ways to attack hosts and hosts evolve ways to defend themselves
- Non-specific (humoral) host defences include releasing chemicals into their bodies to kill off parasites
- Specific (immune system) host defences include the adaptive immune system which can remember parasites and induce an immune response against them (involves MHC in vertebrates)

Parasite Responses & Countermeasures to Host Defences

- Parasites respond to host defences to help them avoid eviction/death
- They have forms of physical protection (can create cysts that are resistant to attacks by the immune system, encapsulation)
- They can infect immunologically privileged sites where the immune system doesn't really function (such as in the eye), to reduce host defences
- Parasites can detoxify host humoral defences
- They can change antigens, making it hard for the host immune system to recognise them
- They can suppress the immune system of the host
- They release hormones to act on host receptors

Transmission

- Hosts have finite lifetimes, so parasites need to move between hosts
- Parasites produce many offspring because they have a high mortality rate
- Mechanisms under selection (enhance parasite success)
- Parasites can have complex life cycles (multiple hosts, intermediate hosts, vectors) to help them transmit from host to host
- Synchronise reproduction
- They can manipulate the appearance/behaviour of the host to make them more susceptible to predation

Temporal & Spatial Variation

- Parasites can infect different parts of the host
- They can have multiple hosts
- Parasites often host specific (co-speciation), they only infect a particular species
- When host species speciate, this can cause speciation in parasites, that's why there's so many species of parasites