BIO 250
System and Maintainance
(Plants and Animals)

Chapter 2.3

Reproduction

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Objectives

- At the end of this lecture, students should know about:
  - Asexual and sexual reproduction,
  - Fertilization and development:
    - External and internal fertilization
    - Oviparity,
    - Ovoviparity,
    - Viviparity,
  - Fish and amphibians,
  - Reptiles and birds,
  - Mammals

Reproduction

- Reproduction – a biological process by which new “offspring” individual organisms are produced from their “parents”.

- Methods of reproduction:
  - Asexual reproduction,
  - Sexual reproduction.

1. Sexual and Asexual Reproduction

- Two methods of reproduction:
  - Asexual reproduction:
    - A process by which an organism creates a genetically similar or identical copy of itself without a contribution of genetic material from another individual.
  - Sexual reproduction
    - A process by which organisms creates descendants that have a combination of genetic material contributed from two different members of the species.
    - Allogamy, autogamy, mitosis and meiosis

1.1 Asexual Reproduction

- A mode of reproduction by which offspring arise from a single parent, and inherited the genes of that parent only.

- It is reproduction which almost always does not involve meiosis, ploidy reduction, or fertilization.

- The offspring will be exact genetic copies of the parent.

1.1 Asexual Reproduction

- Types of asexual reproduction:
  - Fission
    - Binary fission – the parent organism is replaced by two daughter organisms. E.g. Prokaryotes (archaea and bacteria) and eukaryotes (protists and unicellular fungi).
    - Multiple fission – the nucleus of the parent cell divides several times by mitosis, producing several nuclei. The cytoplasm the separates, creating multiple daughter cells.

1.1 Asexual Reproduction

- Budding – some cells split by budding, resulting in a `mother' and a `daughter'. E.g. yeast.

- Vegetative propagation – where new individuals are formed without the production of seeds or spores by meiosis and syngamy. E.g. kalanchoe (formation of plantlets on leaves), strawberry (new plants out of rhizomes), tulip (tulip bulbs) and dahlia (dahlia tubers).

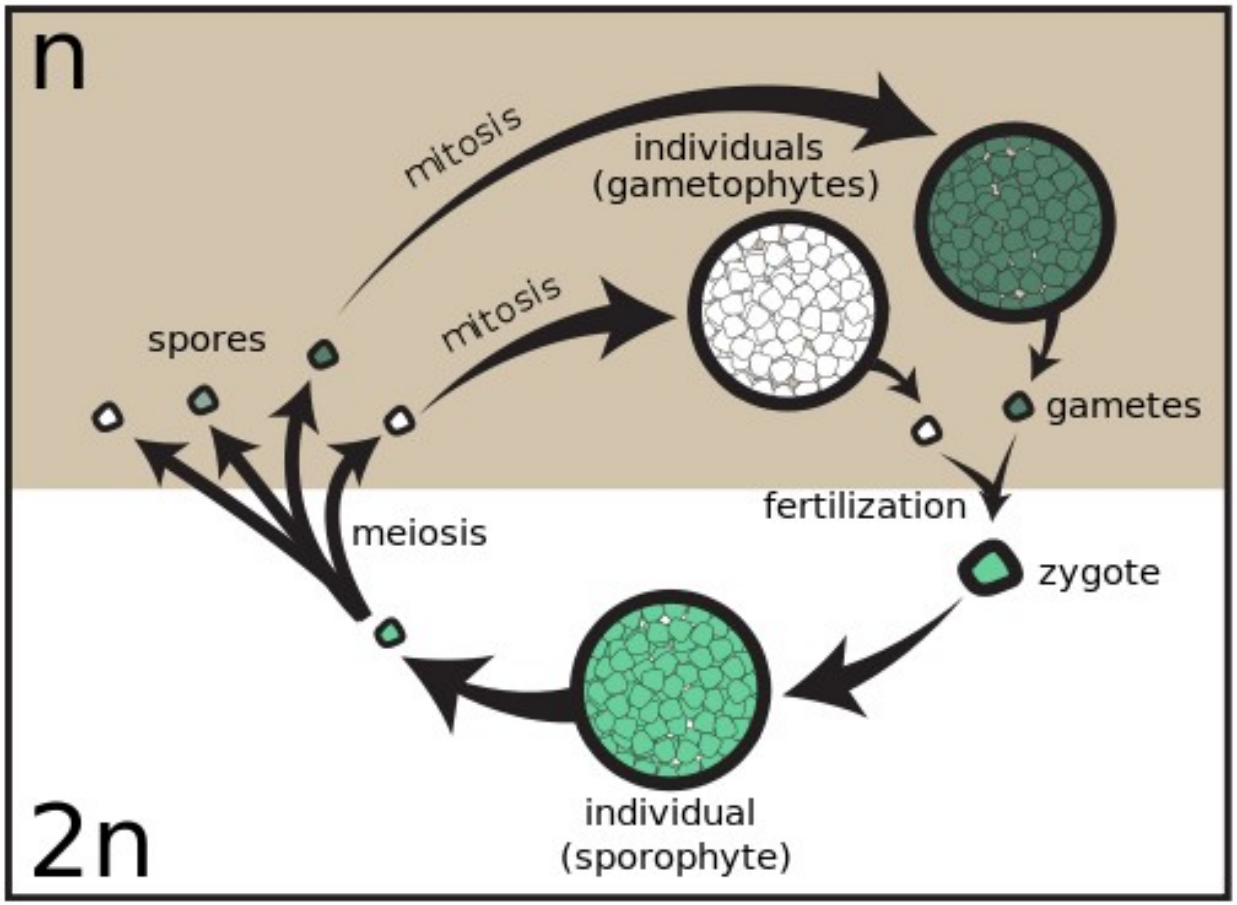
1.1 Asexual Reproduction

- Spore formation – production of spore. (Spore is a unit of asexual reproduction that may be adapted for dispersal and for survival for extended periods of time, in unfavourable conditions).

- Fragmentation – a form of asexual reproduction where a new organism grows from a fragment of a parent. E.g. annelids worm, turbellarians, sea stars, fungi, plants.

- Agamogenesis – a form of reproduction that does not involve a male gamete. E.g. parthenogenesis.

Spores forming on the underside of fern leaves



Spores produced in a sporic life cycle

Spore Formation

Starfish

Annelid – a large segmented worm, species including ragworms, earthworms and leeches.

Fragmentation

The asexual, all-female whiptail species *Cnemidophorus neomexicanus* (centre) which reproduces via **parthenogenesis**.

A comodo dragon, *Varanus komodoensis* able to reproduce by **parthenogenesis.**

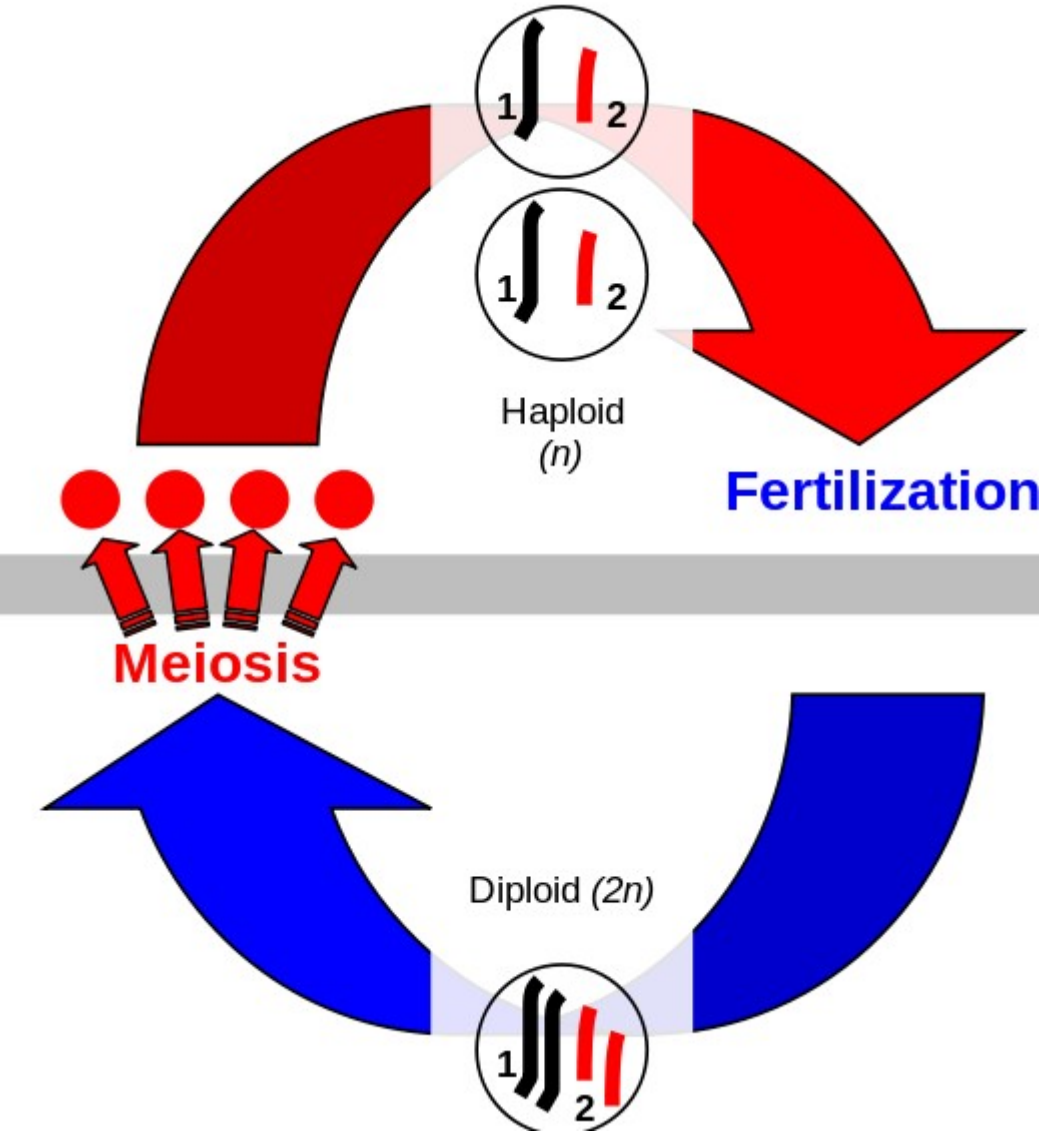
Parthenogenesis

1.2 Sexual Reproduction

- A process that creates a new organism by combining the genetic material of two organisms.
- Occurs in prokaryotes and eukaryotes.
- Primary method of reproduction for almost all animals and plants.

1.2 Sexual Reproduction

- 2 main processes during sexual reproduction in eukaryotes:
  - Meiosis – halving of the number of chromosomes,
  - Fertilization – fusion of 2 gametes and restoration of origional number of chromosomes.



In the first stage of sexual reproduction, "meiosis," the number of chromosomes is reduced from a diploid number (2n) to a haploid number (n). During "fertilization," haploid gametes come together to form a diploid zygote and the original number of chromosomes (2n) is restored

1.2 Sexual Reproduction

- Each of two parent organisms contributes half of the offspring's genetic makeup by creating haploid gametes.

- The two sexes referred to as male (producing sperms) and female (producing ova).

- Most animals (including humans) and plants reproduce sexually.

1.2 Sexual Reproduction

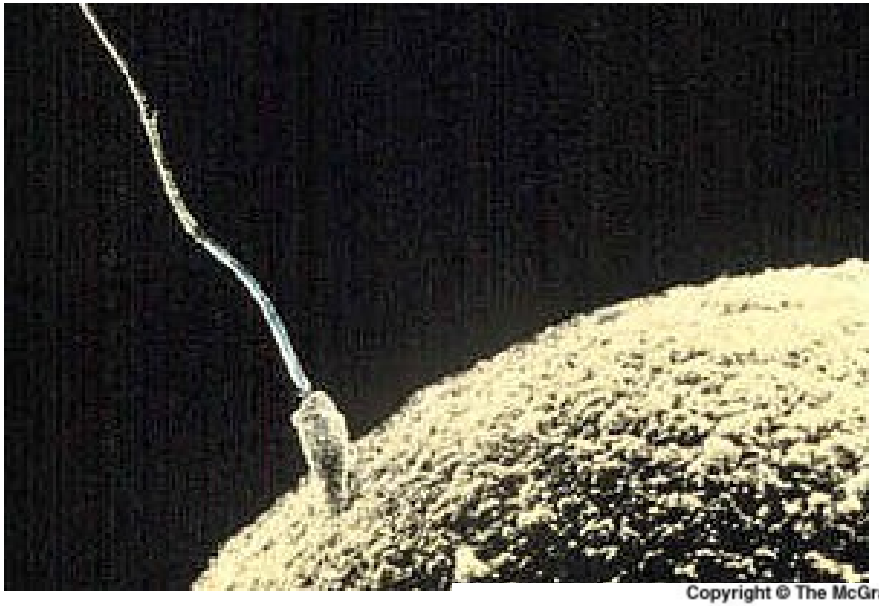
- Allogamy – describing the fertilization of an ovum from one individual with the spermatozoa from another.
- Autogamy – self-fertilization occurs in hermaphroditic organisms, where the two gametes fused in fertilization come from the same individual.
- Mitosis – part of cell division, occurs in somatic cells.
- Meiosis – part of cell division, occurs in gametes.

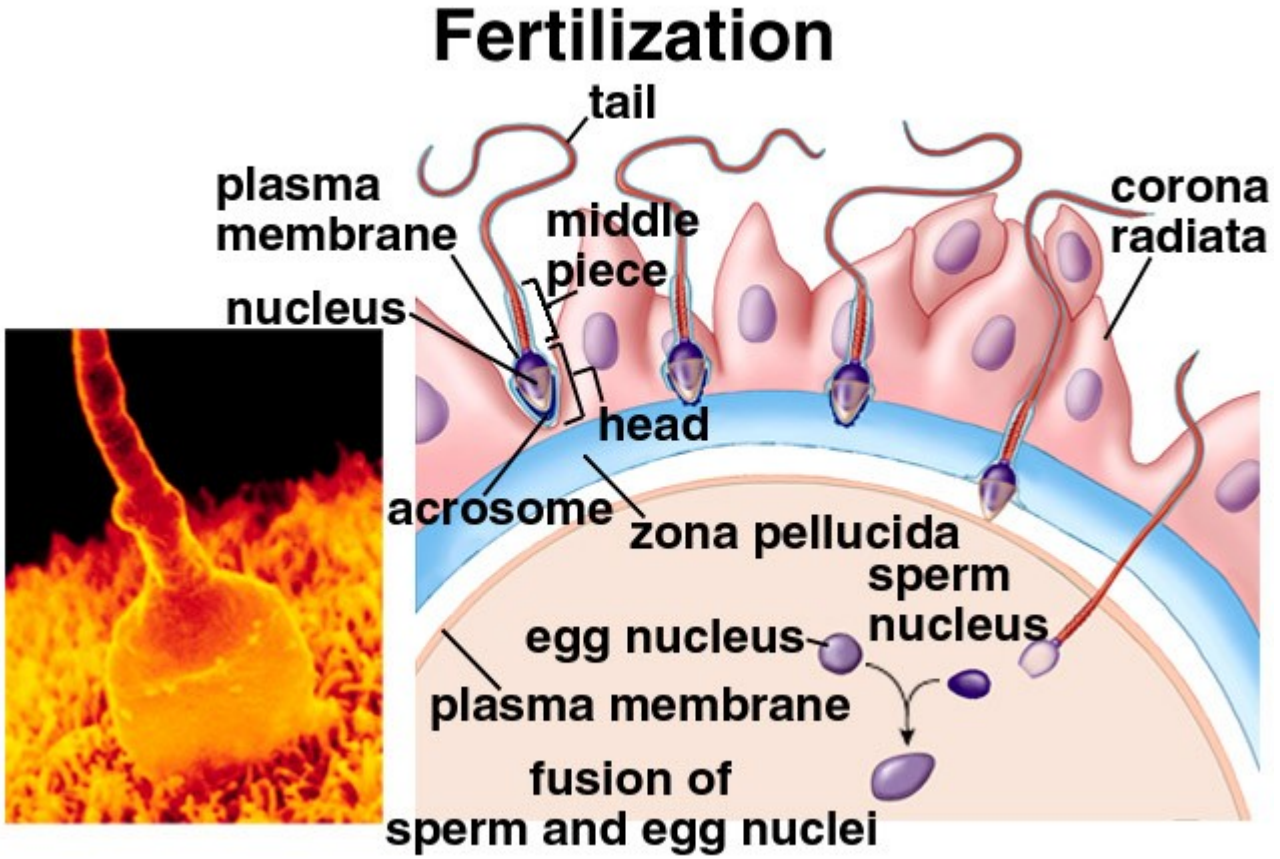
2. Fertilization and Development

- Fertilization – fusion of gametes to initiate the development of a new organism.

- In animals, the process involves the fusion of an ovum with the sperm.

- Depending on animal species, the process can occur within or outside the body of the female.





2.1 Internal Fertilization

- Internal fertilization – fertilization takes place inside the female body.

- In animals, IF involves the insertion of intromittent organ (e.g. penis):
  - Into the vagina (in most mammals), OR
  - To the cloaca (in monotremes, reptiles, some birds, some fish, non-vertebrate animals).

2.1 Internal Fertilization

- Cloaca – posterior opening that serves as the only opening for the intestinal, reproduction, and urinary tracts in certain animal species.

An avian cloaca or vent, of red-tailed hawk *(Buteo jamaicensis)*.

Cloacal opening in an Australian Brushtail Possum

2.1 Internal Fertilization

- In some birds that don't have intromittent organ, the IF is done by the means of the cloacal kiss (two animals touch their cloacae together in order to transfer the sperm from the male to the female).

2.1 Internal Fertilization

- Eventually, the growing eggs/offspting must be expelled in 3 ways, depending on organism:
  - Oviparous organisms (including most insects and reptiles, monotremes, dinosours, all birds) – lay eggs that continue to after being laid, and hatch later.
  - Viviparous organisms (including almost all mammals – whales, kangaroos, humans) – bear their young live.
  - Ovoviparous (garter snake, most vipers, hissing cockroach) – have eggs with shells that hatch as they laid, making it resemble live birth.

2.1.1 Oviparity

- Oviparous animals – animals that lay eggs, with little or no other embryonic development within the mother.

- Production method of most fish, amphibians, reptiles, all birds, the monotremes, and most insects, some molluscs and arachnids.

2.1.1 Oviparity

- Land-dwelling animals that lay eggs, often protected by a shell, such as reptiles and insects, do so after having completed the process of internal fertilization.

- Water-dwelling animals, such as fish and amphibians, lay their eggs before fertilization, and the male lays its sperm on top of the newly laid eggs in a process called internal fertilization.

- 5 know species of oviparous mammals (monotremes): 4 species of Echidna and the Platypus.

2.1.2 Vivipary

- Development of the embryo inside the body of the mother, eventually leading to live birth, as opposed to laying eggs.

- Examples are all mammals except the egg-laying monotremes (the platypus and echidnas).

Monotremes (from the Greek μονός monos "single" + τρῆμα trema "hole", referring to the cloaca) are mammals that lay eggs (Prototheria) instead of giving birth to live young like marsupials (Metatheria) and placental mammals (Eutheria).

Short-beaked echidna

Western long-beaked echidna

The platypus is a semiaquatic mammal endemic to eastern Australia, including Tasmania. Together with the four species of echidna, it is one of the five extant species of monotremes, the only mammals that lay eggs instead of giving birth.

Echidnas, sometimes known as spiny anteaters,[1] belong to the family Tachyglossidae in the monotreme order of egg-laying mammals. The four extant species, together with the platypus, are the only surviving members of that order and are the only extant mammals that lay eggs.

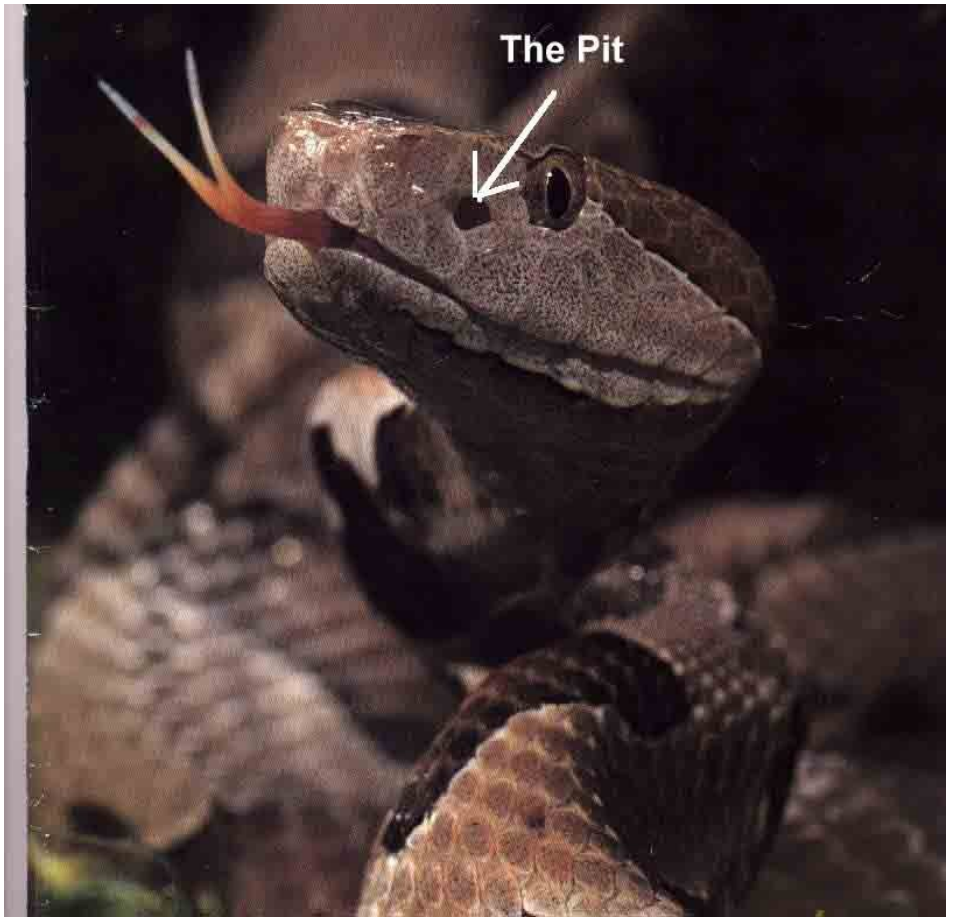
2.1.3 Ovoviviparity

- Ovoviviparity / ovovivipary / ovivipary – embryos develop inside eggs that are retained within the mother's body until they are ready to hatch.

- There is internal fertilization, and the young are born live, but there is no placental connection and the unborn young are nourished by egg yolk. The mother's body does provide gas exchange (respiration).

- Is employed by many aquatic life forms such as fish, reptiles, and invertebrates.

A Boa Constrictor is an example of an Ovoviviparous animal.



Pit viper

Rattlesnake

2.2 External Fertilization

- A form of fertilization in which a sperm cell is united with an egg cell external to the bodies of the reproducing individuals.

- In many aquatic animals such as coral and hydra, eggs and sperm are simultaneously shed into the water, and the sperm swim through the water to fertilize the egg.

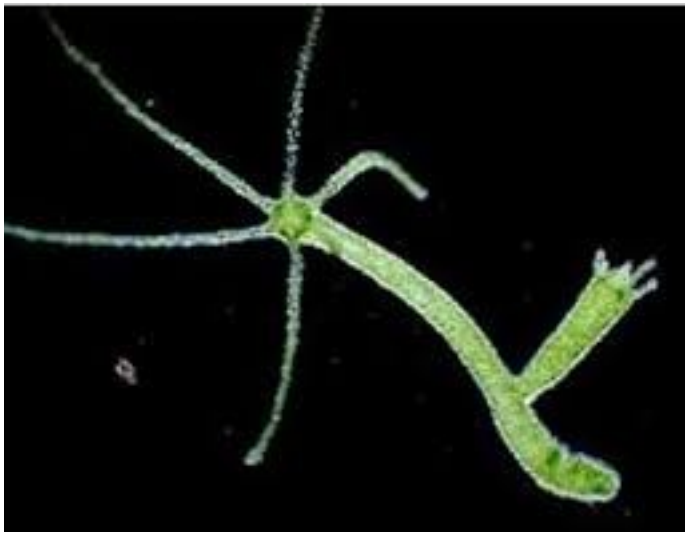
2.2 External Fertilization

- In many fish species, including salmon, the female will deposit unfertilized eggs in the substrate and the male will swim by and fertilize them.

- External fertilization also takes place in frogs.

A male star coral, Montastraea cavernosa, releases sperm into the water. Corals are marine invertebrates in class Anthozoa of phylum Cnidaria typically living in compact colonies of many identical individual "polyps". The group includes the important reef builders that inhabit tropical oceans and secrete calcium carbonate to form a hard skeleton.

A short tentacle plate coral in Papua New Guinea



Hydra is a genus of small, simple, fresh-water animals that possess radial symmetry. Hydra are predatory animals belonging to the phylum Cnidaria and the class Hydrozoa.[2][3] They can be found in most unpolluted fresh-water ponds, lakes, and streams in the temperate and tropical regions and can be found by gently sweeping a collecting net through weedy areas.

External fertilization in frogs

3. Amphibians

Amphibians are ectothermic, tetrapod vertebrates of the class Amphibia (Greek ἀμφί, amphi, "both" + βίος, bios, "life"). They inhabit a wide variety of habitats with most species living within terrestrial, fossorial, arboreal or freshwater aquatic ecosystems.

3. Amphibians

- Amphibians reproduce sexually whereby a female amphibian laying gelatinous eggs in water then a male deposits clouds of sperm over them.

- This is one reason why amphibians are seldom found far from water.

- The best-known amphibians are frogs, toads, and salamanders.

Fire Salamander. Salamanders are any of approximately 550 extant species of amphibians within the order Caudata. They are typically characterized by a superficially lizard-like appearance, with slender bodies, short noses, and long tails.

Australian green tree frog (Litoria caerulea). Frogs are a diverse and largely carnivorous group of short-bodied, tailless amphibians composing the order Anura.

A distinction between frogs and toads is not made in taxonomy, but is common in popular culture, in which toads are associated with drier skin and more terrestrial habitats than frogs.

Frogs laying gelatinous eggs in water.

4. Reptiles and Birds

- Reptiles, the class Reptilia, are an evolutionary grade of animals, comprising today's turtles, crocodilians, snakes, lizards, and tuataras, as well as many extinct groups.

- A reptile is any amniote (tetrapod that can lay eggs on land) that is neither a mammal nor a bird.

- Reptiles today have scales or scutes (rather than fur or feathers) and are cold-blooded.

Clockwise from above left: Green turtle (Chelonia mydas), tuatara (Sphenodon punctatus), Nile crocodile (Crocodylus niloticus), and Sinai agama (Pseudotrapelus sinaitus).

Most reptiles reproduce sexually such as this *Trachylepis maculilabris* skink

Reptiles have amniotic eggs with hard or leathery shells, requiring internal fertilization when mating.

4. Reptiles and Birds

- Reptiles generally reproduce sexually, though some are capable of asexual reproduction.

- All reproductive activity occurs through the cloaca, the single exit/entrance at the base of the tail where waste is also eliminated.

- Most reptiles have copulatory organs, which are usually retracted or inverted and stored inside the body.

4. Reptiles and Birds

- In turtles and crocodilians, the male has a single median penis, while squamates, including snakes and lizards, possess a pair of hemipenes.

- The Squamata, or the scaled reptiles, are the largest recent order of reptiles, comprising all lizards and snakes.

- Tuataras, however, lack copulatory organs, and so the male and female simply press their cloacas together as the male discharges sperm.

4. Reptiles and Birds

- Most reptiles lay amniotic eggs covered with leathery or calcareous shells.

- Viviparity and ovoviviparity have evolved in many extinct clades of reptiles and in squamates.

- In the latter group, many species, including all boas and most vipers, utilize this mode of reproduction.

4. Reptiles and Birds

- Most reptiles are oviparous (egg-laying), although several species of squamates and of extinct aquatic clades are viviparous—the fetus develops within the mother, contained in a placenta rather than an eggshell.

- As amniotes, reptile eggs are surrounded by membranes for protection and transport that adapt them to reproduction on dry land.

4. Reptiles and Birds

- Many of the viviparous species feed their fetuses through various forms of placenta analogous to those of mammals, with some providing initial care for their hatchlings.

4. Reptiles and Birds

- All birds lay amniotic eggs with hard shells made mostly of calcium carbonate.

- Bird eggs are usually laid in a nest.
- Some bird nests, however, are extremely primitive; albatross nests are no more than a scrape on the ground.

- Most birds build nests in sheltered, hidden areas to avoid predation, but large or colonial birds—which are more capable of defence—may build more open nests.

4. Reptiles and Birds

- Some bird species have no nests; the cliff-nesting Common Guillemot lays its eggs on bare rock, and male Emperor Penguins keep eggs between their body and feet.

- Incubation, which optimises temperature for chick development, usually begins after the last egg has been laid.

- Warmth from parents passes to the eggs through brood patches, areas of bare skin on the abdomen or breast of the incubating birds.

Male Golden-backed Weavers construct elaborate suspended nests out of grass.

Nest of an Eastern Phoebe that has been parasitised by a Brown-headed Cowbird.

5. Mammals

- Mammals are a clade of endothermic amniotes.