Chapter 04 : Reproduction in Animals

The conservation of the individual and the species is characterized by the ability of living beings to reproduce. Asexual reproduction, or multiplication, is carried out from a single individual who produces, from its soma, individuals conforming to a parent and identical to each other.

In sexual reproduction, the individual develops from a cell that generally results from the fusion of a male gamete and a female haploid gamete, generally produced by two individuals of different sexes, giving a diploid zygote (fertilized egg). This reproduction gives rise to original individuals.

Gametes are formed by meiosis of an animal cell. The female gamete, the ovum, is a relatively large and immobile cell. The male gamete, the spermatozoon, is generally a much smaller flagellated cell.

4.1. Overview of Reproduction in Animals :

For the vast majority of animals, reproduction is essentially or exclusively sexual. However, there are species that have a mainly asexual mode of reproduction, including some species, all females, in which reproduction is exclusively asexual. Among these are the microscopic bdelloid rotifers as well as some species of teiid lizards (Aspidoscelis spp.).

4.1.1. Mechanisms of Asexual Reproduction :

Certain forms of asexual reproduction are observed only in invertebrates.

Fission is a mechanism in which the parent splits to give two individuals of approximately equal size, as in the sea anemone (Anthopleura elegantissima).

Budding is also a common mechanism of asexual reproduction in invertebrates. In this case, new individuals form from growths on the external surface of the parent. Thus, in hard corals, the new individual forms from the body surface of the parent and remains associated with it, which will eventually form a colony more than a meter in diameter and containing several thousand attached individuals. Some invertebrates, particularly sponges, have another mechanism of asexual reproduction: they release groups of varied cells that give rise to new individuals.

Fragmentation, which takes place in two stages. During this process, the body dissociates into several fragments, which undergo regeneration, during which the missing parts are reformed. This is the case of starfish and planarians.

"Lost parts are reconstituted. If more than one piece grows and develops into a complete individual, there is reproduction. For example, some Annelids can split into several fragments, each becoming a whole worm in less than a week. Reproduction by fragmentation and regeneration is possible in many species of Sponges, Cnidarians, Polychaetes and Urochordates.

Parthenogenesis (from parthenos, meaning "virgin") is a mode of reproduction in which an egg develops without being fertilized. Invertebrates such as some species of bees, wasps, and ants reproduce by parthenogenesis. The offspring can be haploid or diploid. If the offspring are haploid, they become adults who make their eggs or sperm without meiosis. In bees, males, called drones, are fertile haploid adults that were born by parthenogenesis, while females, namely sterile workers and reproductive females (queens), come from fertilized eggs. Among vertebrates, parthenogenesis has been observed in about one species per thousand. Recently, zookeepers have observed parthenogenesis in a large lizard, a Komodo dragon (Varanus komodoensis) and in a species of hammerhead shark (Sphyrna tiburo). In both cases, the females had been kept completely isolated from males of their species, but they had nevertheless reproduced.

4.1.2. Variation of cycles and types of reproduction in animals :

In most animals, reproductive activity follows a precise cycle that is often associated with seasonal changes. Since reproduction is periodic, animals can save their resources and devote themselves to it when they have the necessary energy, after having met their vital needs and when environmental conditions favor the survival of the young. Thus, ewes have a 15-day reproductive cycle in the middle of which they ovulate. However, cycles only occur in the fall and early winter, so that lambs are born in late winter or spring. Similarly, animals that live in seemingly stable habitats, in the tropics or in the ocean for example, generally only reproduce at certain times of the year. Reproductive cycles are determined by a combination of hormonal and environmental factors, including temperature, precipitation, photoperiod, and lunar cycles.

Animals can reproduce exclusively asexually or sexually, or switch from one mode of reproduction to another. In Aphids, Rotifers, and some Crustaceans, the mode of reproduction varies according to the season or the state of the population. For example, in aphids, parthenogenetic reproduction occurs in the spring and summer, producing only females. In autumn, males appear and sexual reproduction occurs, producing eggs that will overwinter.

Daphnia (microscopic freshwater crustaceans), the female can produce two types of eggs depending on environmental conditions, particularly the season. The first category of eggs is fertilized, while the second is formed by parthenogenesis.

Sexual reproduction poses a particular problem for sessile or burrowing animals, as well as parasites such as tapeworms. Indeed, it can be difficult for these animals to meet a representative of the other sex. Hermaphroditism offers them a solution. Each individual possesses both a male and a female reproductive system. Although some hermaphrodites self-fertilize, most must mate with another individual of the species. Each animal then plays both the role of the male and the female, that is, it gives and receives sperm, as is the case with earthworms (Lumbricus sp.). All individuals encountered are potential partners. This type of union allows for the production of twice as many offspring as the fertilization of the eggs of a single individual.

Sequential or successive hermaphroditism is another remarkable type of reproduction. It is characterized by a change of sex in an individual during its life. In some species, individuals are protogynous (female first); in others, they are protandrous (male first).

4.1.3. Sexual reproduction: an enigma in evolution

Sexual reproduction must favor the production or survival of offspring, otherwise it would have quickly disappeared. What advantage does sexual reproduction have? The answer is not clear. Most hypotheses revolve around the unique genetic combinations that derive from parental genes during meiotic recombination and fertilization. By generating offspring with varied genotypes, sexual reproduction increases the chances of survival of a species given the relatively rapid changes in the environment (including pathogens). In contrast, asexual reproduction is thought to be more advantageous in stable and favorable environments as it faithfully and precisely preserves favorable genotypes.

4.2. The mechanisms of sexual reproduction

Fertilization, the union of the sperm and the egg, plays an important role in sexual reproduction. In some species, fertilization is external: the eggs are released by the female and fertilized by the male in the external environment. In others, fertilization is internal: the male deposits the sperm inside or at the entrance of the female's genital tract.

"female reproductive system, so that fertilization takes place within the female's body."

4.2.1. The production and meeting of gametes

Internal fertilization requires the cooperation of individuals, for mating, it also requires fairly complex reproductive systems. Indeed, it requires not only organs for mating, to transmit sperm, but also receptacles to store these sperm and guide them to the eggs. External fertilization, on the other hand, requires a favorable environment in which the egg can develop without drying out or suffering from excessive heat. It therefore occurs almost exclusively in humid habitats. Many aquatic invertebrates simply release their eggs and sperm into the external environment. Fertilization then takes place without physical contact between the parents. However, mature sperm must meet ripe eggs synchronously. Most fish and amphibians with external

fertilization have sexual behavior that allows a male to fertilize a female's eggs. For both individuals, courtship is a trigger that causes the release of gametes. Thus, on the one hand, fertilization has a better chance of success and, on the other hand, the choice of partner can be made selectively, to a certain extent. External factors such as temperature or photoperiod can also trigger the simultaneous release of gametes by all individuals in a population. Finally, an individual releasing its gametes can secrete chemical substances that trigger the same behavior in other individuals of the same species. Pheromones are chemical mediators that, when released by an individual, influence the behavior of other individuals of the same species. These small volatile or water-soluble molecules disperse easily in the environment and, like hormones, are active in minute quantities. Many pheromones are substances that exert a sexual attraction. A male insect can detect the pheromones of a female of its species from more than 1.5 km away. The pheromone of the female Gypsy Moth (Lymantria dispar) triggers reactions in males as soon as its concentration is 1 pheromone molecule among 10^17 molecules of other gases in the air.

4.2.2. Embryo protection

All species must produce many offspring for some of them to survive long enough to reproduce in turn. External fertilization usually produces a very large number of zygotes. But the proportion of those that survive Let's translate this section into English:

"continue their development often proves to be very low. Internal fertilization, on the other hand, generally produces a smaller number of zygotes. However, the embryos benefit from greater protection, and the young from parental care. Among the main protective mechanisms are the production of resistant eggshells, the development of the embryo in the female reproductive system and the protection of eggs and young by parents."

Many species of terrestrial animals lay eggs that can withstand a hostile environment. Birds, Reptiles, and Monotremes lay amniotic eggs whose shell, made of calcium and protein, prevents water loss and physical damage. In comparison, the eggs of Fish and Amphibians are only endowed with a gelatinous coating. Instead of developing in a protective shell, the embryo of many animals develops in the female reproductive system. Among Mammals, Marsupials such as Kangaroos and Opossums harbor the embryo in their uterus for a short time. The embryo then crawls out on its own to complete its fetal development attached to a mammary gland, in the mother's ventral pouch (marsupium). The embryos of Placental Mammals, on the other hand, develop entirely inside the uterus. The nutrients they need come from the maternal blood circulation through a special organ called the placenta. A small kangaroo emerging from its mother's pouch for the first time or a human baby being born are not yet able to live independently. It is well known that Birds feed their chicks and that Mammals nurse. But Animals that provide care for their young are far more numerous than one might think. This often occurs in unexpected forms. Thus, in a species of South American Frog, Darwin's Rhinoderma

(Rhinoderma darwini), the male carries the tadpoles in his hypertrophied vocal sac until they metamorphose and emerge from the sac in their final form. Many cases of parental care in Invertebrates are also known.

4.2.3. Diversity of reproductive

systems Sexual reproduction requires the presence of systems that are capable of carrying out gametogenesis and that facilitate the meeting of gametes of both sexes. These reproductive systems show great diversity. The simplest do not even have gonads, organs that produce gametes in most Animals. The most complex have several sets of ducts and accessory glands that transport and protect gametes as well as developing embryos." Among the simplest reproductive systems is that of Polychaetes (a phylum of Annelids). Although having separate sexes, most Polychaetes do not have true gonads. Eggs and sperm come from undifferentiated cells that line the coelom. As the gametes mature, they detach from the body wall and fill the coelom. Depending on the species, the openings of the urinary system release mature gametes, or the swelling of the egg mass causes the individual to burst, causing its death and scattering the eggs in the external environment. Most Insects have separate sexes and reproductive systems. In the male, sperm are produced by two testes and travel through a winding duct to the seminal vesicles, where they are stored. During mating, they are ejaculated into the female reproductive system. The female's eggs pass from the ovaries (two in number) to the oviducts, then are deposited in the vagina, where fertilization takes place. In many species, the female reproductive system also includes a spermatheca, a sac that allows sperm to be stored for a year or more. The reproductive systems of Vertebrates have a fairly similar general structure, but also some important variations. Thus, in many Vertebrates other than Mammals, the digestive, urinary, and reproductive systems all have the same opening, at the posterior end of the body: the cloaca. This was probably also the case in the ancestors of Vertebrates. On the other hand, in most Mammals, the digestive system has its own opening, at the posterior end of the body. In addition, most females have separate openings for the urinary and reproductive systems. In most Vertebrates, the uterus has two branches for the development of embryos. In Humans and other Mammals whose uterus only houses a small number of embryos at a time, but also in Birds and many Snakes, the uterus has only one cavity for embryonic development.