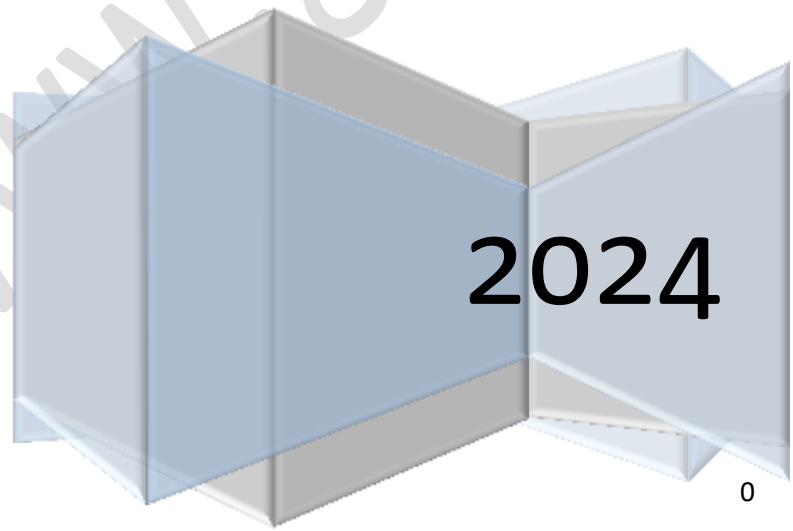
REPRODUCTION IN ORGANISMS

Short Note for UG NEET Examination

By gneet study



2024

REPRODUCTION

Name: Panchanan Maheshwari

- Birth: November 1904 in Jaipur, Rajasthan
- Achievements: Distinguished botanist of India and the world
- Education: Moved to Allahabad for higher education, obtained D.Sc.
- Inspiration: Dr W. Dudgeon, an American missionary teacher
- Area of interest: Botany, especially morphology
- Teacher-student relationship: Panchanan's progress would give great satisfaction to his teacher
- Contributions to embryology: Worked on embryological aspects and popularized the use of embryological characters in taxonomy
- Establishment: Established the Department of Botany, University of Delhi as a research center in embryology and tissue culture
- Emphasis on artificial culture: Advocated the initiation of work on artificial culture of immature embryos
- Impact of tissue culture: Tissue culture became a landmark in science

- Work on fertilization and pollination: Received worldwide acclaim for research on test tube fertilization and intra-ovarian pollination
- Honors: Honored with fellowship of Royal Society of London (FRS), Indian National Science Academy, and other prestigious institutions
- Contributions to education: Played a significant role in developing the first textbooks of Biology for Higher Secondary Schools published by NCERT in 1964

REPRODUCTION IN ORGANISMS

- Life span: Represents the period from birth to natural death of an organism
- Life spans of organisms: Vary greatly, ranging from a few days to a few thousand years
- No correlation between life span and size: Examples of crows and parrots, which have similar sizes but different life spans
- Tree life spans: Mango tree has a shorter life span compared to a peepal tree
- Death as a certainty: All individual organisms, except single-celled organisms, experience natural death
- Immortality in single-celled organisms: Single-celled organisms are considered immortal as they can divide and reproduce indefinitely

- Continuity of species: Vast numbers of plant and animal species have existed for thousands of years
- Reproduction: Essential process in living organisms that ensures continuity of species
- Reproduction: Biological process where an organism gives rise to offspring similar to itself
- Cycle of birth, growth, and death: Offspring grow, mature, and reproduce, ensuring species continuity
- Genetic variation: Inherited during reproduction, studied in Chapter 5 (Principles of Inheritance and Variation)
- Diversity in reproduction: Each organism has evolved its own mechanism to multiply and produce offspring
- Factors influencing reproduction: Organism's habitat, internal physiology, and other factors contribute to the reproductive process
- Types of reproduction:

  1.Asexual reproduction: Offspring produced by a single parent, with or without gamete formation

  2.Sexual reproduction: Two parents (opposite sex) participate, involving fusion of male and female gametes

ASEXUAL REPRODUCTION

- Asexual reproduction: Single individual (parent) capable of producing offspring
- Offspring characteristics: Offspring are genetically identical and exact copies of their parent
- Genetic identity of offspring: Offspring are likely to be genetically identical
- Clone: Term used to describe morphologically and genetically similar individuals produced through asexual reproduction
- Widespread occurrence of asexual reproduction:
    - Single-celled organisms: Asexual reproduction is common in Protists and Monerans.
    - Reproduction in Protists and Monerans: Organism or parent cell divides into two, giving rise to new individuals.
    - Binary fission: Many single-celled organisms reproduce by binary fission (e.g., Amoeba, Paramecium)
    - Budding: Unequal division in yeast produces small buds that remain attached to the parent cell and mature into new yeast organisms
- Encystation: Amoeba withdraws pseudopodia and forms a three-layered hard cyst during unfavorable conditions

- Sporulation: Encysted Amoeba divides by multiple fission and produces minute amoeba or pseudopodiospores that grow into new amoebae.
- Asexual reproduction in Kingdom Fungi and simple plants:
    - Asexual reproductive structures: Zoospores, conidia, buds, gemmules
    - Zoospores: Microscopic motile structures
    - Examples: Penicillium (conidia), Hydra (buds), sponge (gemmules)
- Vegetative reproduction in plants:
    - Type of asexual reproduction
    - Units of vegetative propagation: Runner, rhizome, sucker, tuber, offset, bulb
    - Formation of these structures does not involve two parents
- Clone in vegetative reproduction:
    - Offspring formed through vegetative reproduction can be considered clones
    - Clones are morphologically and genetically similar individuals
- Fragmentation in asexual reproduction:
    - Some organisms can reproduce asexually through fragmentation.

    - Body breaks into distinct pieces (fragments) that grow into adults capable of producing offspring
- Asexual reproduction term usage:
    - In animals and simple organisms, the term "asexual" is used unambiguously
    - In plants, the term "vegetative reproduction" is frequently used
- Water hyacinth: Invasive aquatic plant, drains oxygen from water bodies, negatively impacting fish populations
- Propagation of plants:
    - Potato: Small plants emerge from buds (eyes) of potato tuber
    - Sugarcane, banana, ginger: New plants arise from nodes present in modified stems
    - Dahlia: Adventitious buds arise from notches at leaf margins of Bryophyllum.
- Commercial propagation: Gardeners and farmers exploit asexual reproduction for commercial propagation of plants
- Asexual reproduction in organisms with simple organization: Algae and fungi commonly use asexual reproduction, shifting to sexual reproduction before adverse conditions

- Survival during unfavorable conditions: Sexual reproduction enables organisms to survive adverse conditions
- Advantages of sexual reproduction in adverse conditions: Allows for genetic variation and recombination, increasing chances of survival and adaptation
- Reproduction in higher plants: Both asexual (vegetative) and sexual modes of reproduction are present
- Reproduction in animals: Most animals primarily rely on sexual reproduction

SEXUAL REPRODUCTION

- Sexual reproduction: Involves formation of male and female gametes that fuse to form a zygote, leading to the development of a new organism
- Differences from asexual reproduction: Elaborate, complex, and slower process; results in offspring that are not identical to parents or amongst themselves
- Common features of sexual reproduction across diverse organisms:
    - Growth and maturity stage: Organisms need to reach a certain stage of growth and maturity before engaging in sexual reproduction

    - Juvenile phase: Period of growth before sexual reproduction (known as vegetative phase in plants)
    - Variable duration: Duration of the juvenile/vegetative phase varies among different organisms.
- Transition to reproductive phase in higher plants: Evident when plants come to flower
- Time to flowering in different plants: Varies (e.g., marigold, rice, wheat, coconut, mango)
- Inter-flowering period: Refers to the time between successive flowerings in plants that flower more than once
- Classification of inter-flowering period: It would be more appropriate to classify it as a mature phase rather than a juvenile phase.
- Flowering in trees: Trees may flower during the same month year after year, indicating a seasonal pattern of flowering.
- Seasonal availability of fruits: Fruits like mango, apple, and jackfruit are seasonal because they are produced as a result of the flowering and fertilization process, which occurs during specific seasons.

- Seasonal vs. year-round flowering: Some plants exhibit seasonal flowering, while others can flower throughout the year.
- Unusual flowering phenomena: Some plants, such as certain bamboo species and Strobilanthus kunthiana, have unusual flowering patterns, with long intervals between flowering events.
- Changes in human beings indicating reproductive maturity: Changes such as the onset of menstruation (in females), development of secondary sexual characteristics, and the ability to reproduce are indicative of reproductive maturity in human beings.
- Seasonal egg-laying in birds: Birds living in nature lay eggs seasonally, while birds in captivity (poultry farms) can be induced to lay eggs throughout the year.
- Reproductive cycles in mammals: Non-primate mammals exhibit estrus cycles, while primates (including humans) have menstrual cycles. Some mammals are seasonal breeders, exhibiting reproductive cycles only during favorable seasons, while others are continuous breeders, being reproductively active throughout their reproductive phase.

- Aging and senescence: The end of the reproductive phase can be considered as a parameter of senescence or old age, accompanied by changes in the body's metabolism and other factors.
- Hormones and reproductive processes: Hormones play a crucial role in regulating the transitions between the vegetative, reproductive, and senescent phases in both plants and animals, and their interaction with environmental factors influences reproductive processes and behaviors.
- Pre-fertilization events: These events occur before the fusion of male and female gametes.
    - Gamete production: Male and female gametes, such as sperm and eggs, are produced through the process of gametogenesis.
    - Gamete transfer: In organisms with separate sexes, male and female gametes are transferred to bring them in close proximity for fertilization. This can occur through various mechanisms such as pollination in plants or copulation in animals.
    - Gamete recognition: Recognition and compatibility between the male and female gametes are crucial for successful fertilization.

This involves specific molecular interactions and signaling processes.

- Fertilization events: Fertilization is the fusion of male and female gametes, resulting in the formation of a zygote.
    - Fusion of gametes: The sperm and egg fuse, typically through the process of sperm-egg interaction and fusion.
    - Formation of zygote: The fusion of gametes leads to the formation of a zygote, which contains the combined genetic material from both parents.
- Post-fertilization events: These events occur after fertilization and are associated with the development of the zygote into an embryo.
    - Embryogenesis: The zygote undergoes a series of cell divisions and differentiation processes to form an embryo.
    - Embryo development: The embryo develops into a multicellular organism, undergoing various stages of growth and differentiation.
    - Maturation and birth: The fully developed embryo matures and is eventually born as a new individual, capable of independent existence.

These stages and events in sexual reproduction ensure genetic variation, as each parent contributes unique genetic material to the offspring, leading to diversity within the population.

PRE-FERTILISATION EVENTS

- Gametogenesis: Gametogenesis is the process of gamete formation. It involves the development and maturation of specialized cells called germ cells into functional gametes.
    - In males, gametogenesis is called spermatogenesis, and it takes place in the testes. It involves the production of sperm cells (spermatozoa) through meiosis.
    - In females, gametogenesis is called oogenesis, and it occurs in the ovaries. It involves the production of eggs (ova) through meiosis, although only one functional egg is produced from each cell division.
- Gamete transfer: Gamete transfer is the mechanism by which male and female gametes are brought together for fertilization to occur.

- In plants, gamete transfer can occur through various means such as wind, water, or the transfer of pollen by animals, insects, or birds. This process is called pollination.
- In animals, gamete transfer can involve copulation or mating behavior, where male gametes are transferred to the female reproductive system for fertilization.

These pre-fertilization events are crucial for ensuring the production and transfer of mature and functional gametes, which are essential for successful fertilization to occur.

GAMETOGENESIS

- Gametogenesis: Gametogenesis is the process of gamete formation, which includes the development and maturation of male and female gametes.
- Homogametes (isogametes): In some algae, the gametes are similar in appearance and cannot be categorized as male or female. They are called homogametes or isogametes.
- Heterogametes: In most sexually reproducing organisms, the gametes are morphologically distinct. The male gamete is called the antherozoid or sperm, and the female gamete is called the egg or ovum.

- Self-fertilization: There are cases where organisms can undergo self-fertilization, meaning that the fusion of gametes occurs within the same individual. This is commonly observed in certain plants.
- Bisexual and unisexual plants: Plants can have both male and female reproductive structures in the same plant (bisexual) or on different plants (unisexual).
- Monoecious and dioecious plants: In flowering plants, monoecious refers to the condition where both male and female flowers are present on the same individual, while dioecious refers to the condition where male and female flowers are present on separate individuals.
- Staminate and pistillate flowers: In monoecious or dioecious plants, the male flowers are called staminate flowers and they bear stamens, while the female flowers are called pistillate flowers and they bear pistils.
- Types of gametes in staminate and pistillate flowers: Staminate flowers produce male gametes (sperm or pollen), while pistillate flowers produce female gametes (eggs or ovules).
- Unisexual and bisexual animals: In animals, there are species that are unisexual, meaning individuals are either male or female, and there are species that

are bisexual, possessing both male and female reproductive organs. Hermaphrodites are examples of bisexual animals, such as earthworms, sponges, tapeworms, and leeches. Cockroaches are an example of a unisexual species.

- Cell division during gamete formation: Gametes in heterogametic species (species with distinct male and female gametes) are haploid. Haploid parent organisms produce gametes through mitotic division. However, this does not mean that meiosis never occurs in haploid organisms. In organisms with diploid parent bodies, meiosis, the reduction division, occurs to produce haploid gametes.
- Relationship between meiocytes and gametes: In diploid organisms, specialized cells called meiocytes (gamete mother cells) undergo meiosis to produce gametes. At the end of meiosis, only one set of chromosomes is incorporated into each gamete. There is a relationship between the number of chromosomes in meiocytes and gametes, as meiosis ensures the halving of the chromosome number in gametes compared to the diploid parent cells. CHROMOSOME NUMBERS IN MEIOCYTES AND GAMETES.

- Human beings: Meiocyte chromosome number is 46 (2n), and gamete chromosome number is 23 (n).
- House fly: The chromosome number in meiocytes is 12, but the gamete chromosome number is not provided.
- Rat: Meiocyte chromosome number is not provided, but the gamete chromosome number is 21.
- Dog: Meiocyte chromosome number is 78, but the gamete chromosome number is not provided.
- Cat: Meiocyte chromosome number is not provided, but the gamete chromosome number is 19.
- Fruit fly: Meiocyte chromosome number is 8, but the gamete chromosome number is not provided.
- Ophioglossum (a fern): Meiocyte chromosome number is not provided, but the gamete chromosome number is 630.
- Apple: Meiocyte chromosome number is 34, but the gamete chromosome number is not provided.
- Rice: Meiocyte chromosome number is not provided, but the gamete chromosome number is 12.
- Maize: Meiocyte chromosome number is 20, but the gamete chromosome number is not provided.
- Potato: Meiocyte chromosome number is not provided, but the gamete chromosome number is 24.

- Butterfly: Meiocyte chromosome number is 380, but the gamete chromosome number is not provided.
- Onion: Meiocyte chromosome number is not provided, but the gamete chromosome number is 8.

GAMETE TRANSFER

- Male and female gametes need to be physically brought together for fertilization.
- In most organisms, the male gamete is motile, while the female gamete is stationary.
- Exceptions include some fungi and algae where both types of gametes are motile.
- Water is often the medium through which gamete transfer takes place in simple plants like algae, bryophytes, and pteridophytes.
- Many male gametes fail to reach the female gametes during transport, so a large number of male gametes are produced to compensate for this loss.
- In seed plants, pollen grains carry the male gametes and need to be transferred to the stigma for fertilization.
- In self-fertilizing plants, transfer of pollen grains to the stigma is relatively easy as the anthers and stigma are close to each other.

- In cross-pollinating plants and dioecious animals, specialized events like pollination facilitate the transfer of pollen grains or gametes.
- Pollen grains germinate on the stigma, and pollen tubes carry the male gametes to the ovule in plants.
- In dioecious animals, where male and female gametes are formed in different individuals, a special mechanism for gamete transfer must evolve.
- Successful transfer and fusion of gametes are crucial for fertilization, the most critical event in sexual reproduction.

FERTILISATION

- The fusion of gametes, known as syngamy or fertilization, is the most vital event in sexual reproduction, resulting in the formation of a diploid zygote.
- If syngamy does not occur, fertilization and the formation of a zygote would not take place, preventing the development of a new organism.
- However, in some organisms like rotifers, honeybees, lizards, birds (turkey), and others, the female gamete can undergo development to form new organisms without fertilization, a phenomenon known as parthenogenesis.

- Syngamy can occur in the external medium (water) in most aquatic organisms, including algae, fishes, and amphibians, through a process called external fertilization.
- Organisms exhibiting external fertilization release a large number of gametes into the surrounding water to increase the chances of syngamy, but this method makes the offspring highly vulnerable to predators.
- In terrestrial organisms such as fungi, reptiles, birds, mammals, and a majority of plants (bryophytes, pteridophytes, gymnosperms, and angiosperms), syngamy occurs inside the body of the organism, and this process is called internal fertilization.
- In internal fertilization, the male gamete is motile and must reach the egg within the female body to fuse with it.
- In seed plants, non-motile male gametes are carried to the female gamete by pollen tubes.
- Internal fertilization results in a significant reduction in the number of eggs produced compared to the large number of sperm produced by the male.

POST-FERTILISATION EVENTS

THE ZYGOTE

- Post-fertilization events occur after the formation of the diploid zygote in sexual reproduction.

- The zygote is formed universally in all sexually reproducing organisms.
- In organisms with external fertilization, the zygote is formed in the external medium, typically water. In organisms with internal fertilization, the zygote is formed inside the body of the organism.
- The further development of the zygote depends on the organism's life cycle and the environment it is exposed to.
- In fungi and algae, the zygote develops a thick wall that protects it from desiccation and damage. It undergoes a period of rest before germination.
- In organisms with a haplontic life cycle, the zygote undergoes meiosis to form haploid spores, which then develop into haploid individuals.
- The type of development that occurs in the zygote in organisms with diplontic and haplo-diplontic life cycles can be found in Class XI biology textbooks.
- The zygote is a vital link in ensuring the continuity of species between generations.
- Every sexually reproducing organism, including humans, begins life as a single cell, which is the zygote.

EMBRYOGENESIS

- Embryogenesis refers to the process of development of the embryo from the zygote.
- During embryogenesis, the zygote undergoes cell division (mitosis) and cell differentiation.
- Cell divisions increase the number of cells in the developing embryo, while cell differentiation helps groups of cells undergo modifications to form specialized tissues and organs.
- Animals are categorized as oviparous or viviparous based on whether the development of the zygote occurs outside or inside the body of the female parent.
- Oviparous animals, like reptiles and birds, lay fertilized eggs covered by a hard calcareous shell in a safe place in the environment. After a period of incubation, the young ones hatch out.
- Viviparous animals, including most mammals (including humans), develop the zygote into a young one inside the female organism's body. The young ones are delivered after reaching a certain stage of growth.
- Viviparous organisms generally have better chances of survival due to proper embryonic care and protection.

- In flowering plants, the zygote is formed inside the ovule. After fertilization, the sepals, petals, and stamens of the flower wither and fall off.
- In some plants, the sepals remain attached even after fertilization.
- The zygote develops into the embryo, and the ovules develop into seeds.
- The ovary of the flower develops into the fruit, which has a protective thick wall called the pericarp.
- After dispersal, seeds germinate under favorable conditions to produce new plants.