ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)

path to success

PRE-MEDICAL

BIOLOGY

ENTHUSIAST | LEADER | ACHIEVER

STUDY MATERIAL

Reproduction in organisms

ENGLISH MEDIUM

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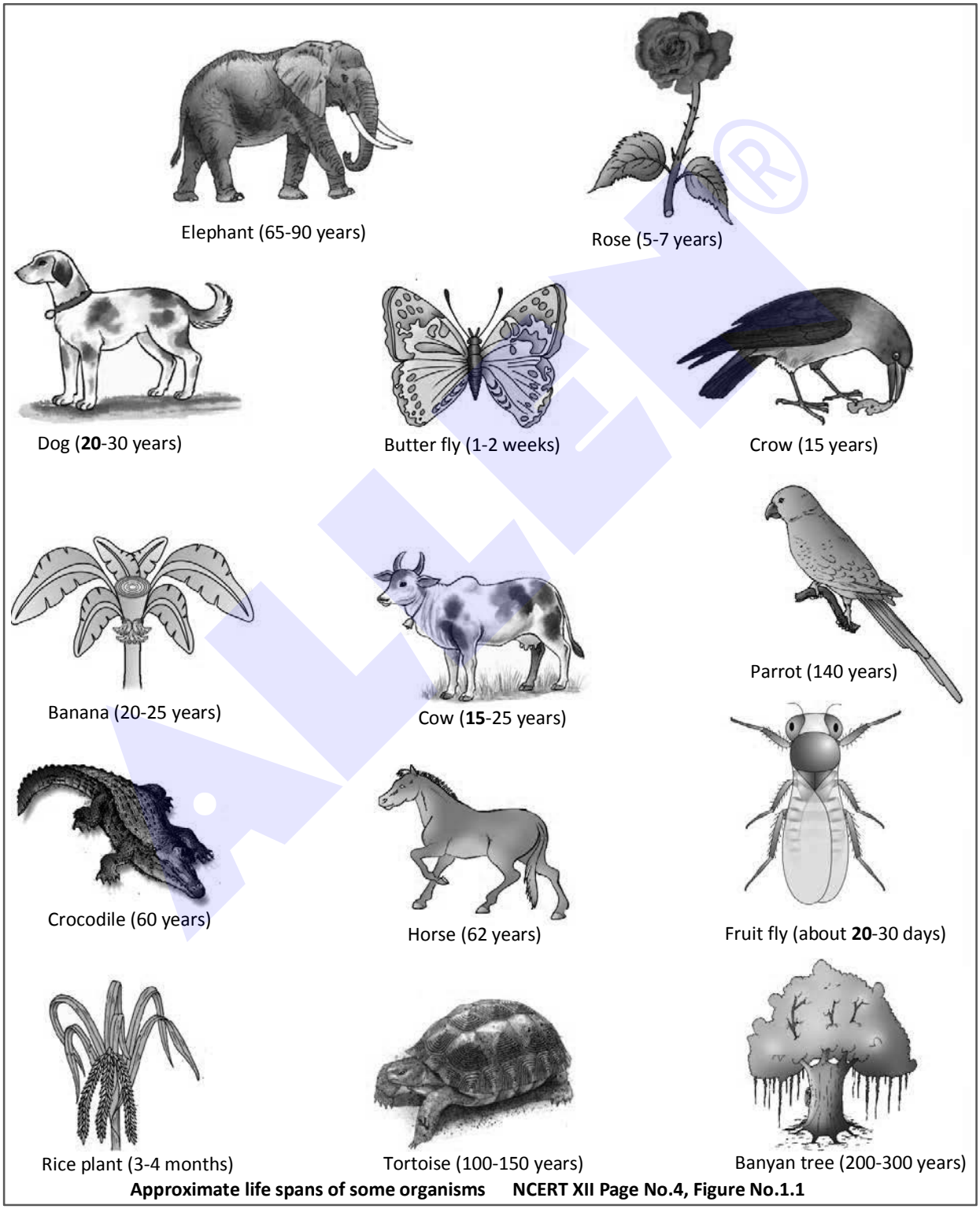
01. REPRODUCTION IN ORGANISMS

LIFE SPAN

- The period from birth to the natural death of an organism represents its **life span**.
- Life spans of organisms are not necessarily correlated with their sizes; the sizes of crows and parrots are not very different yet their life spans show a wide difference.
- Similarly, a mango tree has a much shorter life span as compared to a peepal tree. Whatever be the life span, death of every individual organism is a certainty, i.e., no individual is immortal, except single-celled organisms.



Approximate life spans of some organisms **NCERT XII Page No.4, Figure No.1.1**

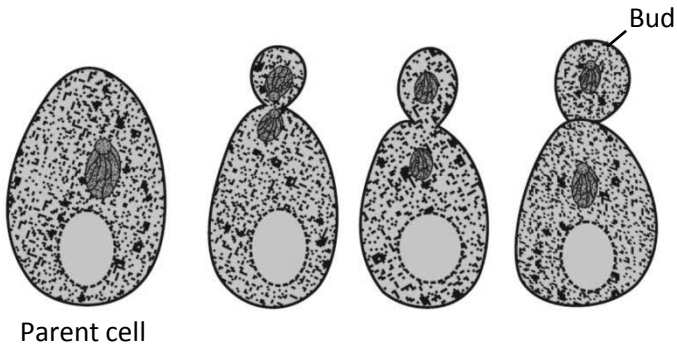
Note :- Life span of mango tree – Approximate 50 years
Life span of peepal tree – Approximate 2500 years

*There is no natural death in single celled organism like Amoeba and bacteria because parental body is distributed among the offspring.

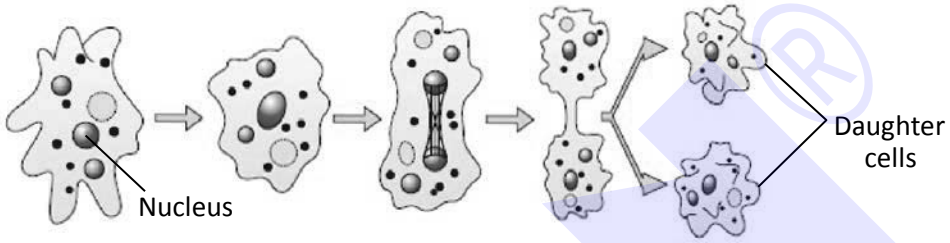
- Reproduction is defined as a biological process in which an organism gives rise to young ones (offspring) similar to itself. The offspring grow, mature and in turn produce **new offspring.** Thus, there is a cycle of birth, growth and death.
- **Reproduction enables the continuity of the species, generation after generation.**
- **The organism's habitat, its internal physiology and several other factors are collectively responsible for how it reproduces.**
- Based on whether there is participation of one organism or two in the process of reproduction, it is of two types – (A) Asexual Reproduction (B) Sexual Reproduction
- When offspring is produced by a single parent with or **without the involvement of gamete formation,** the reproduction is **asexual**. When two parents (opposite sex) participate in the reproductive process and also involve fusion of male and female gametes, it is called **sexual reproduction**.

(A) ASEXUAL REPRODUCTION :

- In this method, a single individual (parent) is capable of producing offspring. As a result, the offspring that are produced are not only identical to one another but are also exact copies of their parent.
- The term **clone** is used to **morphologically and genetically similar individuals**
- Asexual reproduction is common among single-celled organisms, and in plants and animals with relatively simple organisations. In **Protists** and **Monerans**, the organism or the parent cell divides by mitosis into two to give rise to new individuals.
- Many single-celled organisms reproduce by binary fission, where a cell divides into two halves and each rapidly grows into an adult (e.g., *Amoeba*, *Paramoecium*).
- In yeast, the division is unequal and small buds are produced that remain attached initially to the parent cell which, eventually gets separated and mature into new yeast organisms (cells).
- Under unfavourable condition the *Amoeba* withdraws its pseudopodia and secretes a three-layered hard covering or cyst around itself. This phenomenon is termed as **encystation**. When favourable conditions return, the encysted ***Amoeba*** divides by multiple fission and produces many minute amoeba or pseudopodiospores; the cyst wall bursts out, and the spores are liberated in the surrounding medium to grow up into many amoebae. This phenomenon is known as **sporulation**.

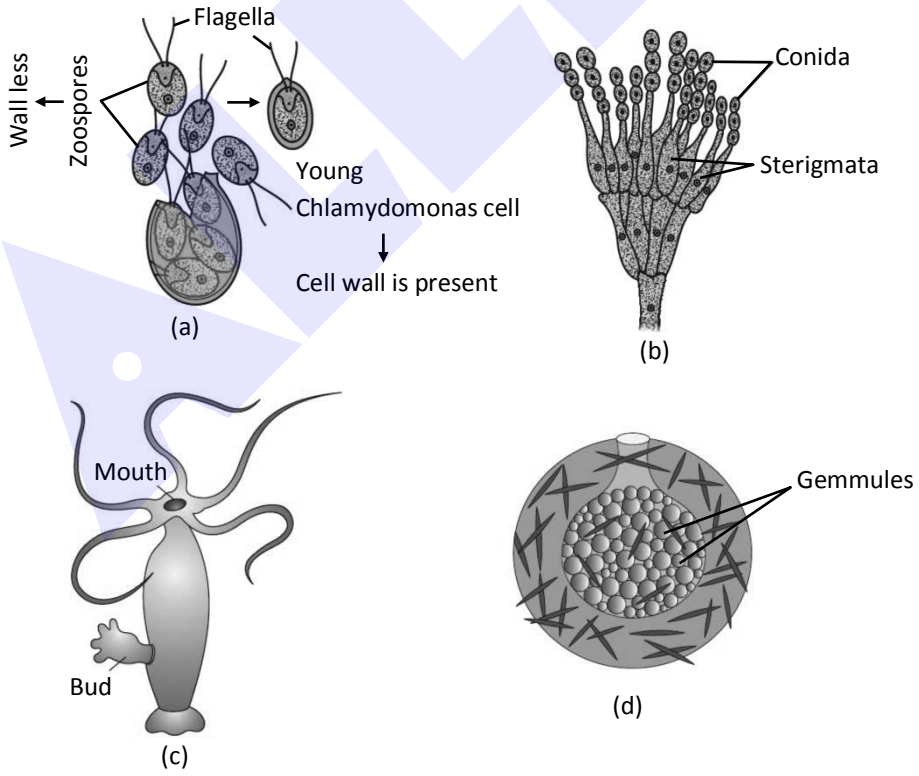


NCERT XII Page No. 5, Figure No. 1.2 (a) (Budding in yeast)

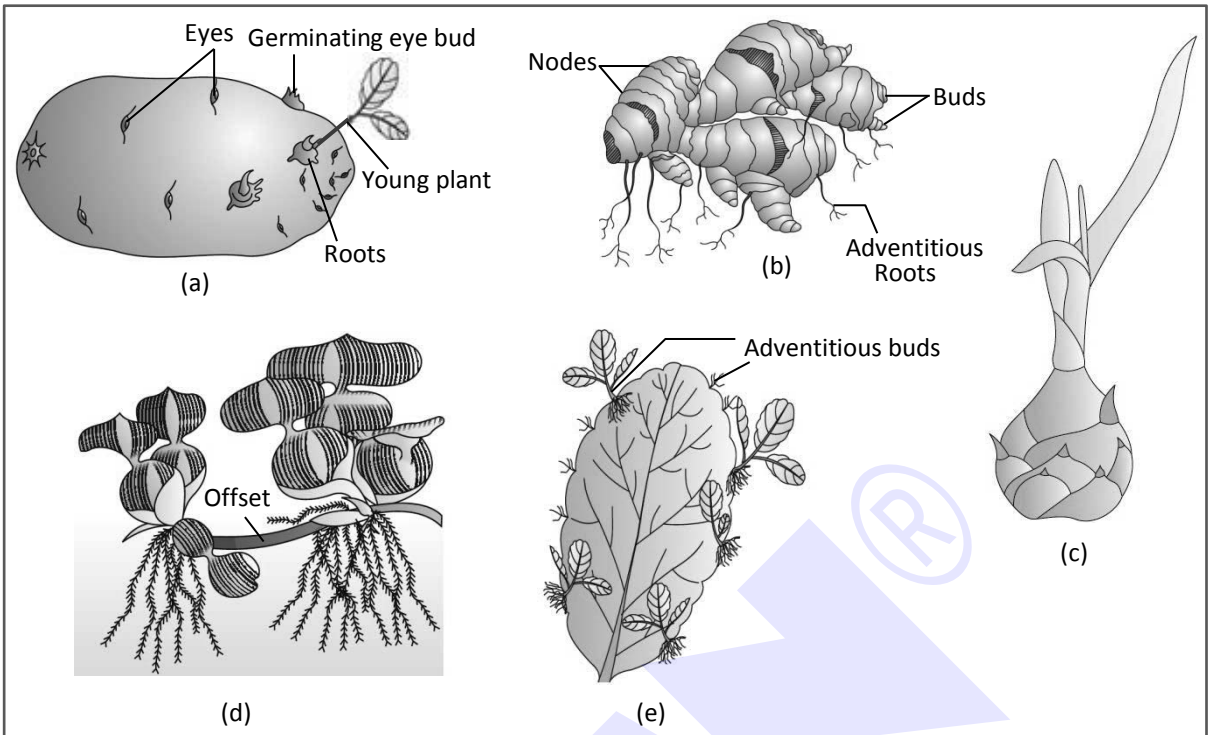


NCERT XII Page No. 5, Figure No. 1.2 (b) (Binary fission in *Amoeba*)

- Member of kingdom fungi and algae reproduce through special asexual reproductive structures called zoospores. Zoospores are usually microscopic and motile structures.
- Conidia (*Penicillum*) buds (*Hydra*) and gemmules (sponge) are other common asexual reproductive structures.



NCERT XII Page No. 6, Figure No. 1.3 Asexual reproductive structures: (a) Zoospores of *Chlamydomonas*; (b) Conidia of *Penicillium*; (c) Buds in *Hydra*; (d) Gemmules in sponge



Vegetative propagules in angiosperms: (a) Eyes of potato; (b) Rhizome of ginger; (c) Bulbil of *Agave*; (d) Offset of water hyacinth (*Eichhornia*); (e) Leaf buds of *Bryophyllum*;

NCERT XII Page No. 7, Figure No. 1.4

- Is vegetative reproduction also a type of asexual reproduction? Answer **will be yes.**
- Is the term clone applicable to the offspring formed by vegetative reproduction? Answer **will be yes.**
- While in animals and other simple organisms the term asexual is used **unambiguously,** in plants, the term vegetative reproduction is frequently used.
- In plants, the units of vegetative propagation such as **runner, rhizome, sucker, tuber, offset, bulb** are all capable of giving rise to new offspring. These structures are called **vegetative propagules.** Obviously, since the formation of these structures does not involve two parents, the process involved is asexual.

In some organisms, if the body breaks into distinct pieces (fragments) each fragment grows into an adult capable of producing offspring (e.g., *Hydra*). This is also a mode of asexual reproduction called fragmentation/**regeneration**.

- **'Water hyacinth'** (Terror of Bengal) which is one of the most **invasive weeds** found growing wherever there is **standing water.** It drains oxygen from the water, which leads to death of fishes.
- This plant was introduced in India because of its **beautiful flowers** and **shape of leaves.** Since it can propagate vegetatively at a phenomenal rate and spread all over the water body in a short period of time, it is very difficult to get rid off them.

Name of plant	Vegetative propagules
Potato	Eyes (buds) of stem tuber
Sugarcane	Stem
Banana & ginger	Rhizome

Note :-

(i) In banana & ginger, new plantlets arise from the nodes present in the modified stems.

(ii) In *Bryophyllum*, adventitious buds arise from the notches present at margins of leaves.

- It is interesting to note that asexual reproduction is the common method of reproduction in organisms that have a relatively simple organisation, like algae and fungi and that they shift to sexual method of reproduction just before the onset of adverse conditions.
- Asexual (vegetative) as well as sexual modes of reproduction are exhibited by the higher plants. Only sexual mode of reproduction is present in most of the animals.

(B) SEXUAL REPRODUCTION :

- Sexual reproduction involves formation of the male and female gametes, either by the same individual or by different individuals of the opposite sex. These gametes fuse to form the zygote which develops to form the new organism. It is an **elaborate, complex** and **slow process** as **compared to asexual reproduction.**
- Because of the fusion of male and female gametes, sexual reproduction results in offspring that are not identical to the parents or amongst themselves.
- Plants, animals or fungi–show that though they differ so greatly in external morphology, internal structure and physiology, when it comes to sexual mode of reproduction, surprisingly, they share a similar pattern.
- All organisms have to reach a certain stage of growth and maturity in their life, before they can reproduce sexually. That period of growth is called the **Juvenile phase.** It is known as **vegetative phase** in plants. This phase is of variable durations in different organisms.
- In merigold, rice and wheat flowering started approximately after three months of vegetative phase while it started in mango and coconut approximately after 3 to 6 years of vegetative phase.
- In some plants, where flowering occurs more than once, what would you call the inter-flowering period – juvenile or mature? Answer will be **mature.**

- **Plants–the annual and biennial types, show clear cut vegetative, reproductive and senescent phases,** but **in the perennial species it is very difficult to clearly define these phases.**
- **Bamboo species flower only once** in their life time, **generally after 50-100 years,** produce large number of fruits and die.
- ***Strobilanthus kunthiana* (neelakuranji),** flowers **once in 12 years.** As many of you would know, this plant flowered during September-October 2006 and 2018. Its mass flowering transformed large tracks of hilly areas in **Kerala, Karnataka** and **Tamil Nadu** into blue stretches and attracted a large number of tourists.

- The end of **reproductive phase can be considered** as one of the **parameters of senescence or old age.** There are concomitant changes in the body (like slowing of metabolism, etc.) during this last phase of life span. Old age ultimately leads to death.
- In both plants and animals, **hormones are responsible for the transitions between the three phases.** Interaction between hormones and certain environmental factors regulate the reproductive processes and the associated behavioural expressions of organisms.

Events in sexual reproduction :

- After attainment of maturity, all sexually reproducing organisms exhibit events and processes that have remarkable fundamental similarity, even though the structures associated with sexual reproduction are indeed very different.
- The events of sexual reproduction though elaborate and complex, follow a regular sequence. Sexual reproduction is characterised by the fusion of the male and female gametes, the formation of zygote and embryogenesis.

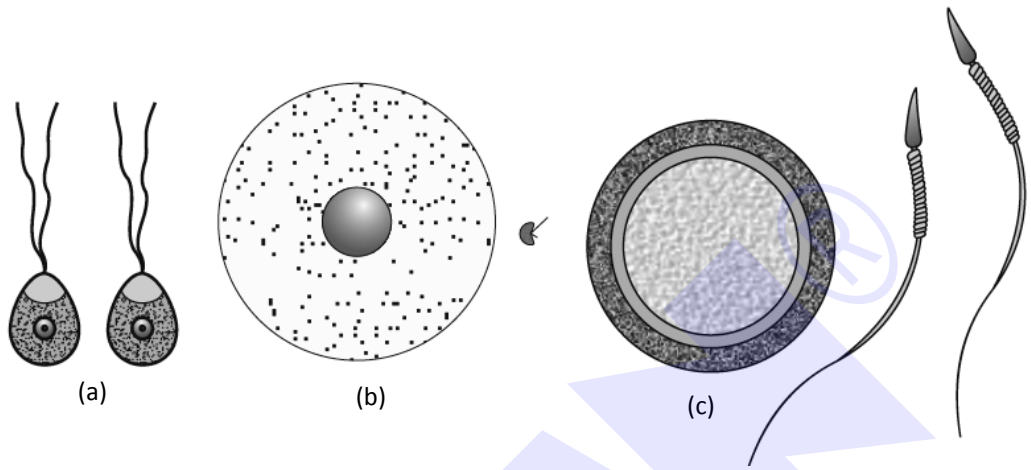
(i) PRE-FERTILISATION EVENTS < **Gametogenesis** / **Gamete transfer**

(a) Gametogenesis

Gametogenesis refers to the process of formation of the two types of gametes – male and female. **Gametes are haploid cells.**

- In some algae the two gametes are so similar in appearance that it is not possible to categorise them into male and female gametes. They are hence called **homogametes (isogametes). e.g. *Cladophora***

- In a majority of sexually reproducing organisms the gametes produced are of two morphologically distinct types **(heterogametes)**. In these organisms, male gametes are called antherozoids or sperm while female gemetes are called egg or ovum. e.g. *Fucus*, Homo sapiens



Types of gametes: (a) Isogametes of *Cladophora* (an alga); (b) Heterogametes of *Fucus* (an alga); (c) Heterogametes of *Homo sapiens* (Human beings)

NCERT XII Page No. 10, Figure No. 1.5

- Sexual reproduction in organisms generally involves the fusion of gametes from two different individuals. But **this is not always true.**
- In several fungi and plants, terms such as **homothallic** and **monoecious** are used to denote the **bisexual condition** and **heterothallic** and **dioecious** are the terms used to describe **unisexual condition.**
- In flowering plants, the unisexual **male flower is staminate,** i.e., bearing stamens, while the **female is pistillate** or bearing pistils.
- In some flowering plants, both male and female flowers may be present on the same individual **(monoecious)** or on separate individuals **(dioecious).**
- Some examples of **monoecious plants** are **cucurbits** and **coconuts** and of **dioecious plants** are **papaya** and **date palm.**

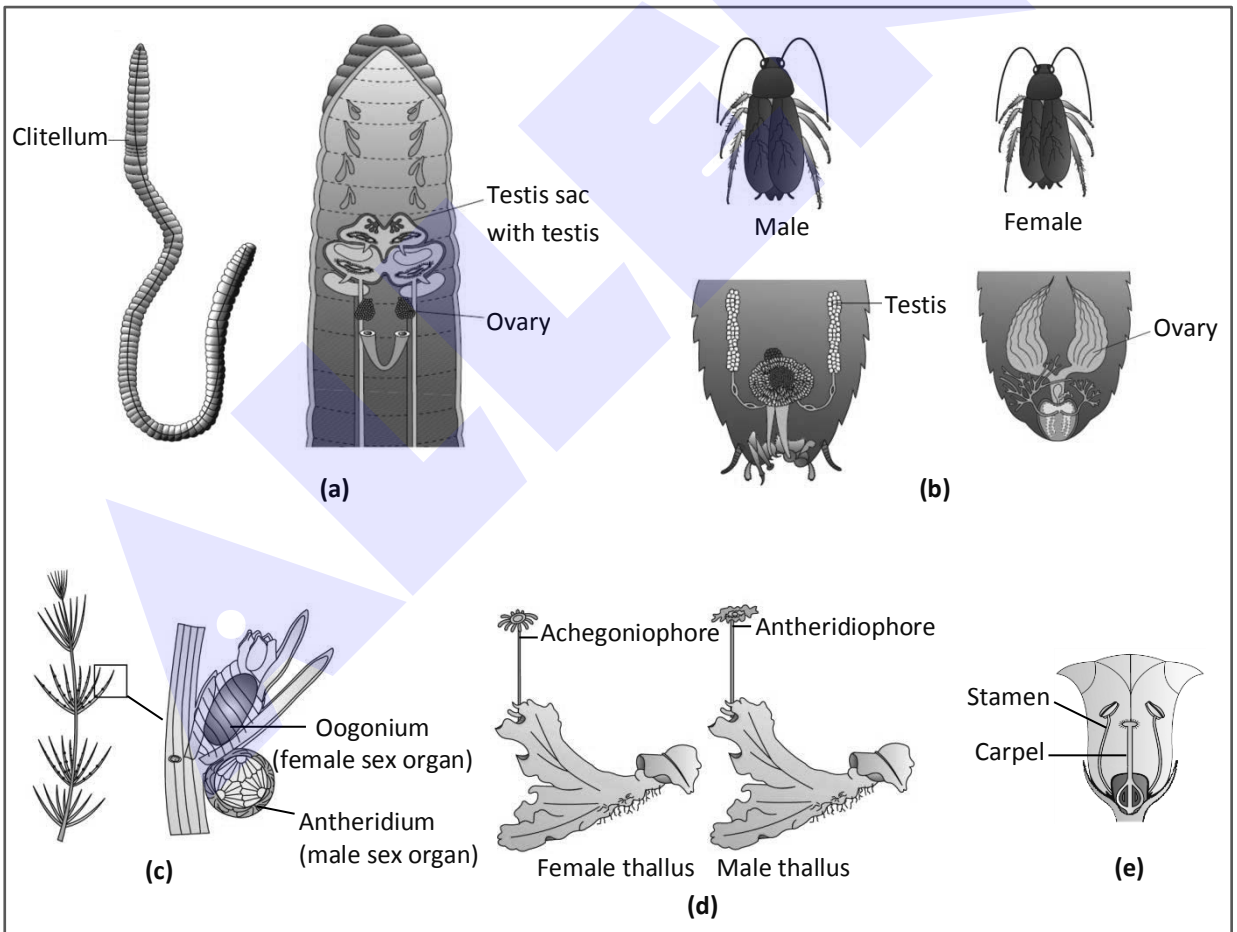
Unisexual animals eg : **Human,** Monkey, **Cockroach** etc.
Bisexual animals eg : **Sponges, tapeworm, earthworm, leech.**

- A haploid parent produces gametes by mitotic division.

Note :-

Meiosis never occurs in organisms that are haploid but Meiosis takes place in the life cycle of haploid organisms. Zygotic meiosis takes place in the life cycle of haploid algae and haploid protists whereas in life cycle of bryophytes meiosis takes place in spore mother cell of capsule.

- Several organisms belonging to monera, fungi, algae and bryophytes have **haploid** plant body, but in organisms belonging to pteridophytes, gymnosperms, angiosperms and most of the animals including human beings, the parental body is **diploid.** It is obvious that meiosis, the reduction division, has to occur if a diploid body has to produce haploid gametes.
- In diploid organisms, specialised cells called meiocytes (gamete mother cell). At the end of meiosis, only one set of chromosomes gets incorporated into each gametes.



Diversity of sexuality in organisms (a) Bisexual animal (Earthworm); (b) Unisexual animal (Cockroach); (c) Monoecious plant (*Chara*); (d) Dioecious plant (*Marchantia*); (e) Bisexual flower (sweet potato)

NCERT XII Page No. 12, Figure No. 1.6

Table : Chromosome Numbers in Meiocytes (diploid, 2n) and Gametes (haploid, n) of Some Organisms.

Name of organism	Chromosome number in meiocyte (2n)	Chromosome number in gamete (n)
Human beings	46	23
House fly	12°	6
Rat	42	21
Dog	78	39
Cat	38	19
Fruit fly	8°	**4**
Ophioglossum (a fern)	1260	**630**
Apple	34	**17**
Rice	24	**12**
Maize	20	**10**
Potato	48	24
Butterfly	380	**190**
Onion	16	**8**

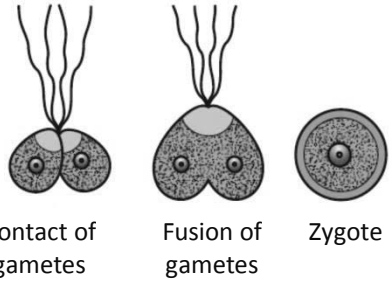
NCERT XII Page No. 13, Table No. 1.1

(b) Gamete transfer :

- In a **majority of organisms, male gamete is motile** and the **female gamete is stationary.**
- In **angiosperms** and in **red algae** both male and female gametes are non-motile.
- **Both angiosperm egg cell and human egg are non-motile but angiosperm cell is stationary while human egg is not stationary.**
- In several simple plants like **algae, bryophytes** and **pteridophytes,** water is the medium through which this gamete transfer takes place. A large number of the male gametes, however, fail to reach the female gametes. To compensate this loss of male gametes during transport, the number of male gametes produced is several thousand times the number of female gametes.
- In **bisexual, self-fertilising plants**, e.g., **peas,** transfer of pollen grains to the stigma is relatively easy as anthers and stigma are **located close to each other;** pollen **grains soon after they are shed, come in contact with the stigma.** But in cross pollinating plants (including **dioecious plants**), a specialised event called pollination facilitates transfer of pollen grains to the stigma. Pollen grains germinate on the stigma and the pollen tubes carrying the male gametes reach the ovule and discharge male gametes near the egg.

(ii) FERTILISATION EVENT/FERTILIZATION :

- The most vital event of sexual reproduction is perhaps the fusion of gametes. This process called **syngamy** results in the formation of a **diploid zygote.** The term fertilisation is also often used for this process. The terms **syngamy** and **fertilisation** are frequently used though, **interchangeably.**



(a) Homogametic contact in alga

NCERT XII Page No. 14, Figure No. 1.7

External Fertilisation :

- In most aquatic organisms, such as a majority of algae and fishes as well as amphibians, syngamy occurs in the external medium (water), i.e., outside the body of the organism. This type of gametic fusion is called **external fertilisation.**

Internal Fertilisation :

- In many terrestrial organisms, belonging to fungi, higher animals such as reptiles, birds, mammals and in a majority of plants (**bryophytes, pteridophytes, gymnosperms and angiosperms),** syngamy occurs inside the body of the organism, hence the process is called **internal fertilisation.** In **all these organisms, egg is formed inside the female body where they fuse with the male gamete.**
- In organisms (eg. bryophytes and pteriodphytes) exhibiting internal fertilisation, the male gamete is motile and has to reach the egg in order to fuse with it. In these even though the number of sperms produced is very large, there is a significant reduction in the number of eggs produced.
- **In seed plants, however, the non-motile male gametes are carried to non-motile female gamete by pollen tubes.**

Parthenogenesis :

- In some organisms like rotifers, honeybees and even some lizards and birds (turkey), the female gamete undergoes development to form new organisms without fertilisation. This phenomenon is called parthenogenesis.

(iii) POST FERTILIZATION EVENTS :

Events in sexual reproduction after the formation of zygote are called post fertilization events.

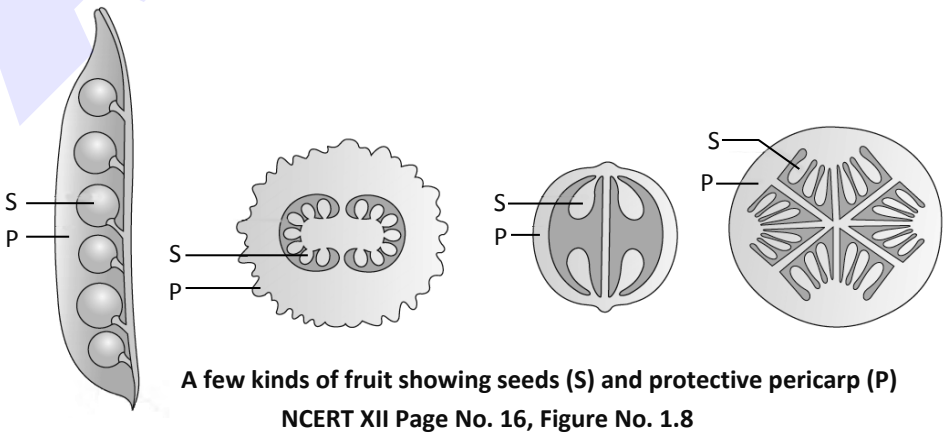
(a) The Zygote :-

- Formation of the diploid **zygote is universal** in all **sexually reproducing organisms.** In organisms with external fertilisation, zygote is formed in the external medium (usually water), whereas in those exhibiting internal fertilisation, zygote is formed inside the body of the organism.

- **In organisms belonging to fungi and algae, zygote develops a thick wall that is resistant to dessication and damage. It undergoes a period of rest before germination.**
- ***Zygote* is the vital link that ensures continuity of species between organisms of one generation and the next.**

(b) Embryogenesis :-

- **Embryogenesis refers to the process of development of embryo from the zygote.** During embryogenesis, zygote undergoes **cell division** (mitosis) and **cell differentiation.** While cell divisions increase the number of cells in the developing embryo; cell differentiation helps groups of cells to undergo certain modifications to form specialised tissues and organs to form an organism.
- Animals are categorised into **oviparous** and **viviparous** based on whether the development of the zygote takes place outside the body of the female parent or inside, i.e., whether they lay fertilised/unfertilised eggs or give birth to young ones.
- In **oviparous animals** like reptiles and birds, the fertilised eggs covered by hard calcareous shell are laid in a safe place in the environment; after a period of incubation young ones hatch out.
- In **viviparous animals** (majority of mammals including human beings), the zygote develops into a young one inside the body of the female organism. After attaining a certain stage of growth, the young ones are delivered out of the body of the female organism. Because of proper embryonic care and protection, the chances of survival of young ones is greater in viviparous organisms.
- In flowering plants, the **zygote is formed inside** the ovule. After fertilisation the sepals, petals and stamens of the flower wither and fall off. The **pistil however, remain attached to the plant.** The zygote develops into the embryo and the ovules develop into the seed. **The ovary develops into the fruit.**



A few kinds of fruit showing seeds (S) and protective pericarp (P)
NCERT XII Page No. 16, Figure No. 1.8

Special Points :

- In few fungi (*Synchytrium* & *Allomyces*) and algae (*Cladophora* & *Ulothrix*) fusing gametes are motile.
- Birds living in nature, lays eggs only seasonally. However, birds in captivity (as in poultry farms) can be made to lay eggs throughout the years by hormonal treatment. In this case, egg laying is not related to reproduction but is a commercial exploitation for human welfare.
- **During reproductive phase**, the females of placental mammals exhibit cyclical changes in the activities of ovaries and accessory ducts as well as secretion of hormones.
- In non-primate mammals like cows, sheeps, rats, deers, dogs, tigers, etc. such cyclical changes during reproduction are called ***Oestrus cycle*** where as in primates (monkeys, apes and humans) it is called ***menstrual cycle***.
- Many mammals, especially those living in natural, wild conditions exhibit such cycles only during favourable seasons in their reproductive phase and are therefore called seasonal breeders. Many other mammals are reproductively active throughout their reproductive phase and hence are called continuous breeders.

BEGINNER'S BOX — REPRODUCTION IN RGANISMS

1. Approximate life span of crocodile is :-

(1) 60 years (2) 140 years (3) 1-20 weeks (4) 15 years

2. Vegetative propagule in water hyacinth is:-

(1) Rhizome (2) Bulbil (3) Leaf bud (4) Offset

3. Which of the following are non-primates mammals :-

(1) Monkeys & apes (2) Apes & humans (3) Monkeys & human (4) Dogs & rats

4. Which of the following is unisexual animal ?

(1) Tapeworm (2) Cockroach (3) Earthworm (4) Leech

5. Number of chromosomes in gamete of onion is :-

(1) 12 (2) 10 (3) 34 (4) 8

BEGINNER'S BOX — ANSWERS KEY

Que.	1	2	3	4	5
Ans.	**1**	**4**	**4**	**2**	**4**

ESSENCE

- **Life span :** The period from birth to death is known as life span
- Life span of organisms are not necessarily correlated with size of organisms
- There is no natural death in unicellular organisms
- **Reproduction :** A biological process occurs only in living organisms.

Reproduction

Asexual reproduction
- Uniparental
- No Fusion of gametes
- Offsprings are genetically identical

Sexual reproduction
- Biparental (usually)
- Fusion of gametes occurs
- Offsprings show variations

Asexual Reproduction

by Zoospores | by Conidia | by Bud formation | by Gemmule

- **Vegetative Reproduction :** In plants, asexual reproduction is commonly called vegetative reproduction.

Vegetative Propagules

Runner | Rhizome | Sucker | Tuber | Offest | Bulb

Events in Sexual Reproduction

Pre-fertilization
- Gametogenesis
- Gamete transfer
  - Isogametes (Homogametes) e.g. *Cladophora*
  - Heterogametes e.g. *Fucus*

Fertilization
- Fusion of gametes and formation of zygote
  - External fertilization occurs in algae, fishes and amphibians
  - Internal fertilization occurs in few algae and from bryophytes to angiosperms

Post Fertilization
- Embryogenesis

- **Bisexual Animals :** Earthworm, leech, sponge, tapeworm etc.
- **Unisexual animals :** Cockroach, human etc.
- **Monoecious plants :** Chara, *cucurbita*, coconut etc.
- **Dioecious plants :** *Marchantia*, papaya, date palm etc.
- Plant body is haploid in organisms belonging to Monera, fungi, algae and bryophytes.
- Plant body is diploid in organisms belonging to pteridophytes, gymnosperms, angiosperms and most of the animals.
- In sweet potato flowers are bisexual
- In plants like tomato, brinjal etc. sepals remain attached to the fruit.