CHAPTER

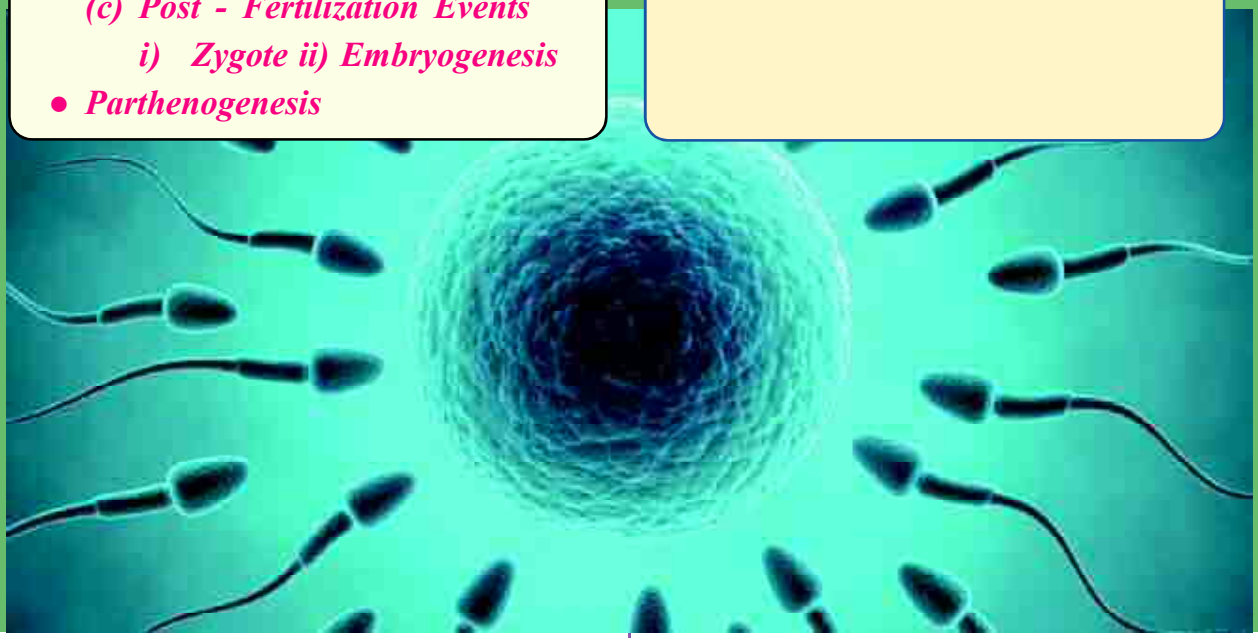
1

REPRODUCTION IN ORGANISMS

CONTENTS

NEET SYLLABUS :

- *Reproduction in organisms: Reproduction, a characteristic feature of all organisms for continuation of species;*
- *Modes of reproduction – Asexual and sexual; Asexual reproduction;*
- *Modes-Binary fission, sporulation, budding, gemmule, fragmentation; vegetative propagation in plants.*



About Panchanan Maheshwari (1904-1966):

- Born in November 1904 in Jaipur (Rajasthan). Panchanan Maheshwari rose to become one of the most distinguished botanists not only of india but of the entire world. he moved to Allahabad for higher education where he obtained his D.Sc.
- During his college days, he was inspired by Dr. W Dudgeon, an American missionary teacher, to develop interest in Botany and especially morphology.
- His teacher once expressed that if his student progresses ahead of him, it will give him a great satisfaction. These words encouraged Panchanan to equire what he could do for his teacher in return.
- He worked on embryological aspects and popularised the use of embryological characters in taxonomy.
- He established the Department of Botany, University of Delhi as an important centre of research in embryology and tissue culture.
- He also emphasised the need for initiation of work on artifical culture of immature embryos.These days, tissue culture has become a landmark in science.
- His work on test tube fertilisation and intra-ovarian pollination won worldwide acclaim.
- He was honoured with fellowship of Royal Society of London (FRS), Indian National Science Academy and several other institutions of excellence.
- He encouraged general education and made a significant contribution to school education by his leadership in bringing out the very first text books of Biology for Higher Secondary Schools published by NCERT in 1964.

INTRODUCTION

Recall that the molecules of nucleic acids are self-duplicating; the cells divide by mitosis or meiosis. At the individual level, organisms employ a wide range of methods for reproduction. Acellular (single-celled) protist animals reproduce by a relatively simple method, whereas multicellular animals reproduce by complex methods. In this chapter, we will be familiarised with the major types of reproduction in animals. This will be followed by a description of phases in life cycle of an organism. Finally, the events of sexual reproduction, leading to the formation of the embryo and its subsequent development into a young individual.

REPRODUCTION:

* Biology in essence is the story of life on earth. While individual organisms die without fail, species continue to live through millions of years unless threatened by natural or anthropogenic extinction.
* Reproduction becomes a vital process without which species cannot survive for long. Each individual leaves its progeny by asexual or sexual means.
* Sexual mode of reproduction enables creation of new variants,so that survival advantage is enhanced.

* Each and every organism can live only for a certain period of time. The period from the birth to the natural death of an organism represents its life span

* **Death of every individual organism is a certainity i.e. no individual is immortal except single-celled organisms**

* Life spans of different organisms range from few days to a few thousand years. For most other organisms, the life span lies between these two extreme ranges. **Interestingly, life spans of organisms are not necessarily correlated with their sizes. For example:**

  (a) The life span of **Crow is 15 years** and that of a **Parrot is 140 years** even though both do not vary much in their sizes.

Table : Life Spans of Some Living Beings

Organism (Animals)	Maximum Life span
Butterfly	1-2 weeks
Fruit fly	30 days
Crow	15 years
Cow	20-25 years
Dog	20-30 years
Horse	60 years
Crocodile	60 years
Elephant	60-90 years
Parrot	140 years
Tortoise	100-150 years

Organism (Plants)	Maximum Life span
Rice plant	3-4 months
Rose Bush	5-7 years
Banana	25 years
Banyan Tree	200-300 years

  (b) Mango tree has a **much shorter life span** than the Peepal tree. **Death of every individual organism is a certainty i.e. no individual is immortal except single-celled organisms.**

* If one thinks about this reality, we can wonder how many vast number of plant and animal species have existed on earth for several thousand number of years.

* The **process that ensures their continuity generation after generation is reproduction.** Genetic variations are created and inherited during reproduction.

* **Reproduction is defined as a biological process in which an organism gives rise to young ones (offspring) similar to itself. An offspring grows, matures and in turn produce new offspring, it thus creates a cycle of birth, growth and death.**

Types of Reproduction

Organisms reproduce by three fundamental methods:

(1) **Asexual**
(2) **Vegetative**
(3) **Sexual**

* Asexual (vegetative) as well as sexual modes of reproduction are exhibited by the higher plants and only sexual mode of reproduction is present in most of the animals.

* While in animals and other simple organisms the term **asexual** is used unambiguously, in plants, the term **vegetative** reproduction is frequently used.
* In vegetative reproduction, the offspring are produced from the somatic cells which may be from root, stem, leaf, or even buds of leaf and flower.
* When an organism is produced by a single parent it is called **asexual reproduction.**

  When an organism is produced by the participation of two parents (opposite sex) in the reproductive process and also involves fusion of male and female gametes, it is called **sexual reproduction**.

1. Asexual Reproduction

Characteristics of Asexual Reproduction

(i) A single parent is capable of producing an offspring.

(ii) Offspring produced are **identical to each other** and also to their parents. Such genetically and morphologically similar individuals are called **Clones.**

* **Asexual reproduction** is common among **single-celled organisms**, **in some plants and animals with relatively simple organization**. In **Protists and Monerans,** the organism or the parent cell divides into two to give rise to new individuals. Thus, **cell division is a mode of reproduction.**

Modes of Asexual Reproduction

* Asexual reproduction takes place in following ways:

1.1 Asexual Reproduction In Animals

➢ **A. Binary fission :**

The parent organism divides into two halves and each half forming an independent daughter organism. Binary fission involves mitosis.

Types of binary fission :

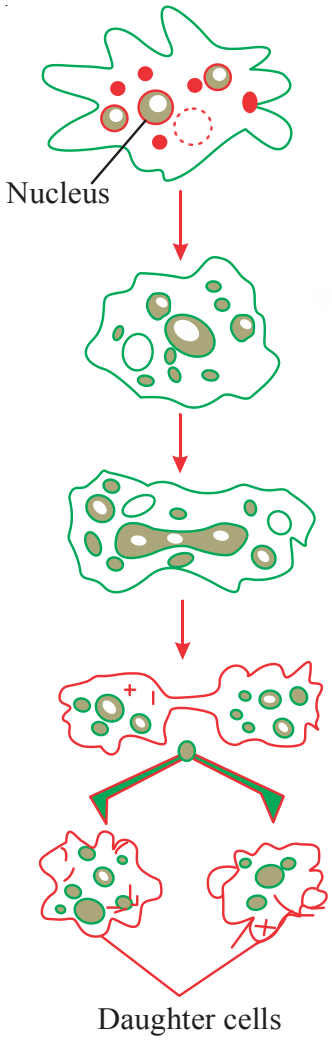
➢ **(i)** Irregular Binary Fission e.g., *Amoeba*.

➢ **(ii)** Logitudinal Binary Fission. The plane of division passes along the longitudinal axis of the body. e.g., *Euglena*.

➢ **(iii)** Transverse Binary Fission : The plane of division passes along the transverse axis of the body. e.g., *Paramecium,* Planaria.

➢ **B. Multiple fission :**

➢ Sometimes the nucleus divides several times by amitosis to produce many nuclei, without involving any cytokinesis. Later, each nucleus gathers a small amount of cytoplasm around it and the mother cell splits into many tiny daughter cells (e.g., *Amoeba*, *Plasmodium*, *Monocystis*, etc.). In course of time, each of these daughter cells starts a free life and transforms into an adult individual. This kind of fission is called multiple fission.

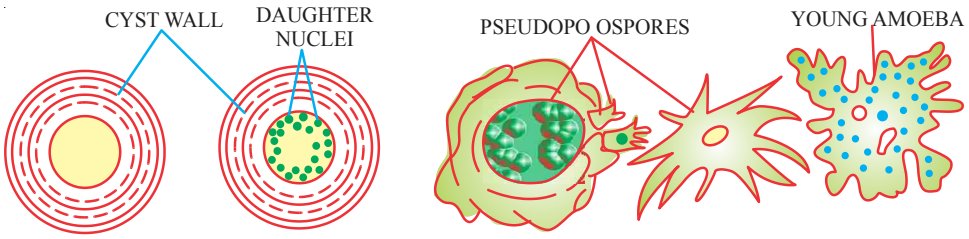


Irregular binary fission - ***Amoeba***

➢ **C. Sporulation**

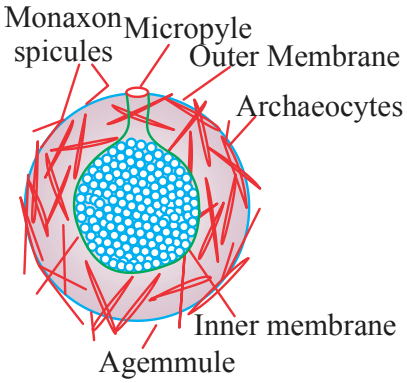
➢ In response to unfavourable living condition, an *Amoeba* withdraws its pseudopodia and secretes a three-layered hard covering or cyst around itself. This phenomenon is termed as encystation. During favourable condition, the encysted *Amoeba* divides by multiple fission and produces many minute amoebae 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.**

➢ Acellular protists like sporozoans (e.g., *Monocystis*, *Plasmodium*, etc.) typically exhibit sporulation in their life cycles.

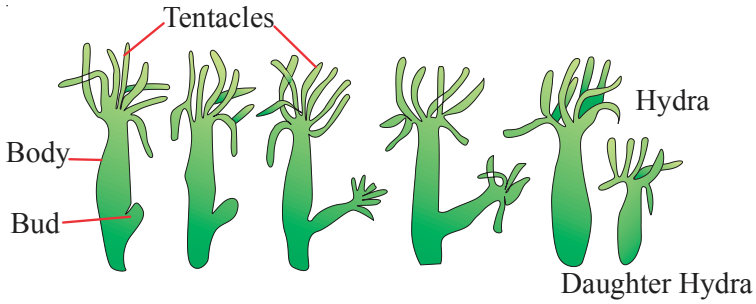


➢ **D. Budding :**

➢ (a) **Endogenous budding (Gemmulation):** In fresh water sponges and a few marine sponges gemmules (internal buds) are formed. Each gemmule has the mass of archaeocytes surrounded by protective covering to tide over seasonal drought or adverse environmental conditions. Gemmule formation is also called internal budding. Sponges have a great power of regeneration.



(a) Gemmulation



(b) Budding in *Hydra*

➢ (b) **Exogenous budding** - Initially, a small outgrowth of the parent's body develops into a miniature individual. It then separates from the mother to lead a free life (e.g., *Hydra*). This type of budding is recognised as exogenous budding.

➢ **Budding in Yeast : In yeast,** the division is unequal and a small **bud** is produced that remains attached initially to the parent body. Later, on the bud gets separated and matures into new yeast organism. Sometimes, yeast may bear many buds which may further bear daughter buds. This budding stage in yeast resembles with a genus *Torula*. Therefore, this condition is called **torula** stage and the process is known as **torulation.**

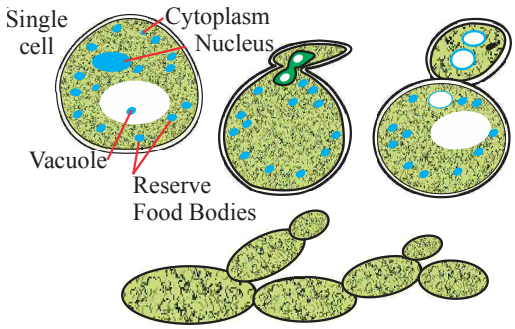


Fig. Budding in Yeast

➢ (A) **Zoospores:** The zoospores are special kind of motile and flagellated spores produced inside the **zoosporangia**. They are generally naked (without cell wall). The flagella help to swim in aquatic habitat for proper dispersal. The reproduction by zoospores occurs in some lower fungi and it is the most common mode of asexual reproduction in algae. eg: Phycomycetes (e.g., *Saprolegnia, Albugo, Phytophthora,* etc.) and some algae (e.g., *Chlamydomonas, Ulothrix*).

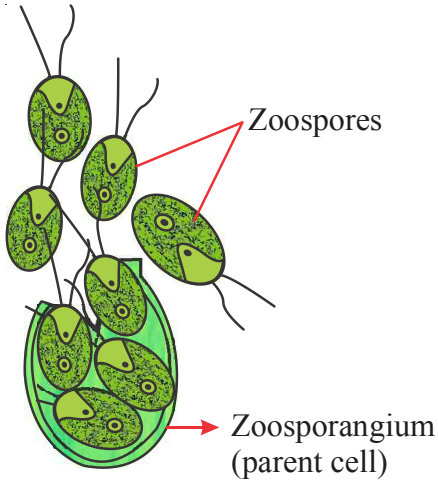


Fig. Zoospores of *Chlamydomonas*

➢ (B) **Conidia:** These are non-motile spores produced singly or in chains by constriction at the tip on lateral side of special hyphal branches, called **conidiophores.** They are produced exogenously, dispersed by wind and germinate directly by giving out germ tubes. Example – *Penicillium*

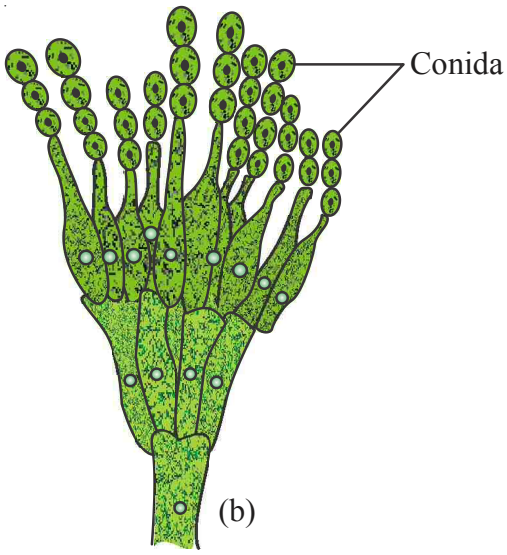


Fig. Conidia of *Penicillium*

TABLE : Differences Between Asexual and Sexual Reproduction

Differences between Asexual and Sexual Reproduction		
	Asexual Reproduction	*Sexual Reproduction*
1	It occurs in lower invertebrates and lower chordates and plants with simple organisations.	It occurs almost in all types of animals and mostly in higher plants.
2	It is always uniparental.	It is usually biparental.
3	Gametes are not formed.	Gametes are always formed.
4	No fertilization	Fertiliztion takes place.
5	It involves only mitosis.	It involves both meiosis and mitosis.
6	Daughter organisms are genetically identical to the parent.	Daughter organisms genetically differ from the parents.
7	Multiplication occurs rapidly.	Multiplication is not so rapid as in asexual reproduction.
8	Since there is no variation, so it does not contribute to evolution of the species	Since there are variations, so it contributes to evolution of the species.

* 2. Vegetative Reproduction

Vegetative Reproduction is the formation of new plants from vegetative units such as buds, tubers, rhizomes etc. These vegetative units are called vegetative propagules.

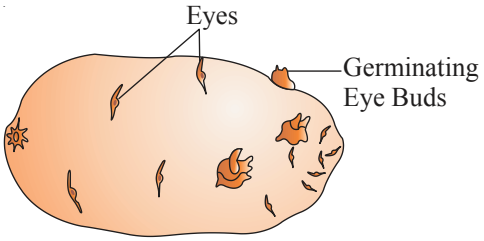
Characteristics of Vegetative Reproduction

(i) The formation of these structures does not involve two parents, the process involved is asexual.

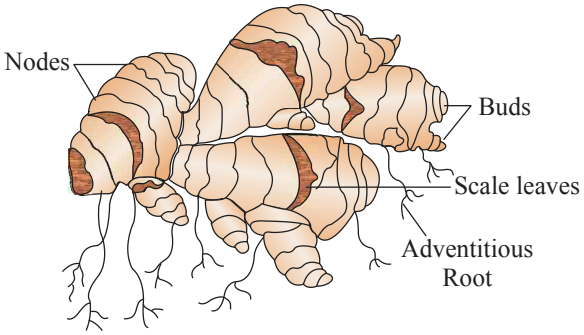
(ii) The method produces a large number of population of clones in shortest time.

(iii) It preserves purity, resistance and good qualities of race/variety indefinitely.

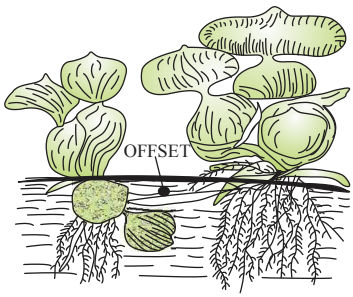
(iv) Crops remain true to their parent and mature early.



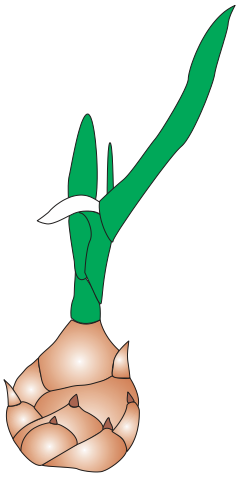
Tuber



Rhizome of ginger



Offset of pistia


Bulbil


Bryophyllum

* **Water hyacinth** *or* **"terror of Bengal"** *is the aquatic plant which is one of the most invading weeds found growing in the standing water. It takes oxygen from the water which causes death of fishes. This plant was introduced into India for its beautiful flowers and shape of leaves. It can propagate vegetatively at a fast rate and spread all over the water body in short time. It is very difficult to remove it from the water body.*

TEST YOUR I.Q.-1

INTRODUCTION

1. P Maheswari not initiated work on

(1) Artificial culture of immature embryos
(2) Test tube fertilization
(3) Intra- ovarian pollination
(4) Physio- chemical approach to study living organisms

2. Which of the following works of P. Maheswari won world wide acclaim?

(1) Artificial culture of immature embryos
(2) Use of embryological characters in Taxonomy
(3) Research on tissue culture
(4) Intra- ovarian pollination

3. Panchanan Maheshwari is not associated with the following works

(1) Use of embryological characters in Taxonomy
(2) Artificial culture of mature embryos
(3) Test tube fertilization
(4) Intra-ovarian pollination

4. P. Maheshwari popularized the use of these characters in plant taxonomy.

(1) Anatomical (2) embryological
(3) in vitro tissue culture (4) morphological

5. Life span of an organism usually include

(1) juvenility (2) maturity
(3) senescence and death
(4) all of the above

6. In animals, juvenile phase is followed by

(1) vegetative phase
(2) reproductive phase
(3) senescent phase (4) old age

7 **One of the most fundamental characterstics of life is**

(1) growth (2) movement
(3) reproduction (4) fragmentation

8. **Choose incorrect statement regarding the life span :**

(1) Banyan tree has shorter life span as compared to peepal tree.
(2) Life span represents time period between birth to natural death.
(3) Rose plant has 7 years life span.
(4) It is correlated with the size of the organisms

9. **Clones are prepared from**

(1) a single plant
(2) two different plants
(3) many different species
(4) many genera

10. **Find the correct statement from the following**

(1) A peepal tree has much shorter life span than mango tree
(2) All uniparental reproduction in plants are asexual reproductions only
(3) Liver worts & some fungi have some specialized structures for reproducation called gemmae
(4) Water hyacinth reproduces sexually by producing offsets

ASEXUAL REPRODUCTION

11. **Which one of the following statements is correct?**

(1) All the individuals of a species have exactly the same life span
(2) Smaller organisms always have shorter life span and vice versa
(3) Life span of an organism is the time period from its birth to its natural death
(4) No organism may have a life span of several hunadred years

12. **Single celled organisms are said to be immortal because**

(1) They grow indifinity in size
(2) They can tolerate any degree of change in temperature
(3) They can reproduce throughout their life span
(4) They continue to live as their daugher cells

13. **The term 'clone' cannot be applied to offspring formed by sexual reproduction because**

(1) Offspring do not possess exact copies of parental DNA
(2) DNA of only one parent is copied and passed on to the offspring
(3) Offspring are formed at different times
(4) DNA of parent and offspring are completely different

14. **Asexual reproduction is seen in members of kingdom**

(1) Monera (2) Plantae
(3) Animalia (4) All of these

15. **Choose the correct statement from amongst the following**

(1) Dioecious organisms are seen only in animals
(2) Dioecious organisms are seen only in plants
(3) Dioecious organisms are seen in both plants and animals
(4) Dioecious organisms are seen only in vertebrates

16. **Identify the incorrect statement**

(1) In asexual reproduction, the offspring produced are morphologically and genetically identical to the parent
(2) Zoospores are sexual reproductive structures
(3) In asexual reproduction, a single parent produces offspring with or without the formation of gametes
(4) Conidia are asexual structures in *Penicillium*

17. **There is no natural death in single celled organisms like Amoeba and bacteria because**
(1) They cannot reproduce sexually
(2) They reproduce by binary fission
(3) Parental body is distributed among the offspring
(4) They are microscopic

18. **There are various type of reproduction. The type of reproduction adopted by an organism depends**
(1) morphology of the organism
(2) the habitat and morphology of the organism
(3) morphology and physiology of the organism
(4) the organism's habitat, physiology and genetic make-up

19. **If the following options shown, two plants, in which new plantlets arise from the same organ?**
(1) *Dahlia* and ginger
(2) Potato and sweet potato
(3) *Dahlia* and rose
(4) Potato and sugarcane

20. **Which of the folloiwng cannot serve as a vegetative propagule?**
(1) A piece of potato tuber with eyes
(2) A middle piece of sugarcane internode
(3) A piece of ginger rhizome
(4) A marginal piece of Bryophyllum leaf

21. **Transverse binary fission occurs in**
(1) *Hydra* (2) *Euglena*
(3) *Paramecium* (4) *Amoeba*

22. **Which of the following animals is having longitudinal binary fission?**
(1) *Hydra* (2) *Euglena*
(3) *Paramecium* (4) *Plasmodium*

23. **Cell division itself is a type of reproduction in**
(1) *Euglena* (2) *Penicillium*
(3) *Rhizopus* (4) Liver worts

24. **Bulb helps the vegetative reproduction in**
(1) tomato (2) potato
(3) rye (4) onion

25. **Musa is propagated through its**
(1) tubers (2) bulbs
(3) seeds (4) rhizomes

26. **Which of the following is not an artificial method of vegetative reproduction ?**
(1) Cutting (2) Grafting
(3) Layering (4) Bulbils

27. **Ginger is multiplied vegetatively by means of**
(1) Bud (2) Tuber
(3) Corm (4) Rhizome

28. **In *Amorphophallus* and *Colocasia* vegetative reproduction is carried out through**
(1) rhizome (2) bulbils
(3) corms (4) offsets

29. **Which plant is generally called " Terror of Bengal"**
(1) Water lettuce (2) Water hyacinth
(3) *Hydrilla* (4) *Vallisneria*

30. **Vegetative propagation in sweet potato is by**
(1) stem (2) root
(3) leaf (4) flower

31. ***Hydra* reproduces by budding. This is an example of:**
(1) Regeneration (2) Parthenocarpy
(3) Asexual reproduction (4) Sexual

32. **Moneran that reproduce by binary fission is**
(1) *Euglena* (2) *E. coli*
(3) *Yeast* (4) Both (1) and (2)

33. **Swarm spores (Motile spores) are produced by**
(1) *Pencillium* (2) *Rhizopus*
(3) *Aspergillus* (4) *Chlamydomonas*

34. **In which of the following whole portion of the leaf blade regenerates a new individual?**
(1) Rose (2)Money plant
(3) Mango (4) *Kalanchoe*

35. **What is site of origin of the new plantlets in the plants multiplying by stems ?**
(1) nodes (2) internodes
(3) apex (4) base

36. **In *Bryophyllum* adventitious buds arise from the**
(1) notches present at margins of leaves
(2) notches present at base of leaves
(3) veins present at margins of leaves
(4) veins present on surface of leaves

37. **In grafting, scion belongs to**
(1) Plant having superior or desirable characters
(2) Plant having well developed root system
(3) Plant resistant to diseases
(4) Both (1) and (3)

38. **Stem cuttings are commonly used in propagation of**
(1) Mango (2) Cotton
(3) Rose (4) Agave

39. **Layering is used in vegetative propagation of**
(1) Jasmine (2) Rose
(3) Mango (4) Allthe above

40. **Grafting is employed for better and quicker yield of good varieties of**
(1) apple (2) *Citrus*
(3) mango (4) all of these

41. **Vegetative propagation through budding occurs in**
(1) Rose (2) *Agave*
(3) Yeast (4) Ginger

42. **A part of root of *Dalbergia* placed in the soil will**
(1) sprout
(2) decay
(3) develop underground complex
(4) grow depending upon availability of food

43. **'Terror of Bengal is not associated with this character**
(1) free floating hydrophyte
(2) most invasive weed of standing water
(3) It is an introduced plant
(4) it releases toxins to kill the fish

44. **The "Terror of Bengal " was introduced in India because of its**
(1) beautiful flowers, shape of leaves
(2) beautiful stem, size of leaves
(3) shape of root, size of stem
(4) beautiful leaves, shape of flower

45. **Find out the incorrect match**
(1) Non- motile spores-*Chlamydomonas*
(2) Terror of Bengal-Water hyacinth
(3) Sporangiospores-*Rhizopus*
(4) Conidia- *Penicillium*

46. **Specialised structures for reproduction via fragmentation in bryophytes are**
(1) suckers (2) offsets
(3) gemmae (4) spores

47. **Which of the following vegetative propagules are found in *Agave* and *Eichhornia* plants respectively?**
(1) bulbil and offset
(2) offset and sucker
(3) sucker and runner
(4) runner and Bulbil

48. **What is common in *Bryophyllum* and *Allium*?**
(1) Both are members of family liliaceae
(2) Both reproduce only sexually
(3) Both reproduce vegetatively
(4) Both lack heterospory

ANSWERS

1) 4	2) 4	3) 2	4) 2	5) 4	6) 2
7) 3	8) 4	9) 1	10) 3	11) 3	12) 4
13) 1	14) 4	15) 3	16) 2	17) 3	18) 4
19) 4	20) 2	21) 3	22) 2	23) 1	24) 4
25) 4	26) 4	27) 4	28) 3	29) 2	30) 2
31) 3	32) 2	33) 4	34) 4	35) 1	36) 1
37) 4	38) 3	39) 1	40) 4	41) 3	42) 1
43) 4	44) 1	45) 1	46) 3	47) 1	48) 3

3. SEXUAL REPRODUCTION

Meaning of Sexual Reproduction

It is the process of development of new individuals through the formation and fusion of male and female gametes. Sexual reproduction is also called **amphimixis.**

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.

Sexual reproduction involves four processes :

(i) formation of haploid cells, the **gametes,** by **gametogenesis** (meiosis)
(ii) fusion of the two gametes forming diploid cells, the **zygote** (fertilization)
(iii) repeated mitotic divisions of the zygotes to form embryos **(embryogenesis)**
(iv) growth of embryos into new individuals **(development).** Because there is fusion of male and female gametes, the offspring produced are not identical to their parents.

Phases in Life Cycle

There are three phases in an organism's life : juvenile phase, reproductive phase and senescent phase.

1. Juvenile phase/Vegetative phase

It is **prereproductive phase** in the life cycle of an individual. It is the *period of growth* between the birth of an individual upto reproductive maturity. This phase has different structures such as different shapes of leaves different colours of feathers of birds, Juvenile phase is known as **vegetative phase** in plants. This phase is of different durations in different organisms.

2. Reproductive phase

The organisms reproduce during this phase. Reproductive organs develop and mature during this period which is called **puberty.** Appearance of flowers in higher plants indicate sexual maturity. Sexually there are two types of flowering plants : monocarpic and polycarpic.

(i) **Monocarpic Plants.** These plants flower only once in their life. After flowering they produce fruits and die. All annual *(e.g.,* Wheat, Rice) and biennial plants *(e.g.,* Carrot, Radish) are monocarpic. A few perennial plants are also monocarpic. A few plants show unusual characters in bamboo species, *(e.g., Bambusa tulda)* flower only once in their life time, usually after 50-100 years. They produce large number of fruits and then die. *Strobilanthus kunthiana* (Neelakuranji) flowers once in 12 years. The last time this plant flowered during September-October 2006. It is found in hilly areas in Kerala, Karnataka and Tamil Nadu and attracted a large number of tourists. Thus reproductive phase is also of variable duration in different organisms.

(ii) **Polycarpic Plants.** These plants are perennial and flower repeatedly at intervals every year, *e.g.,* Apple, Mango, Orange, Grape vine. Very few perennial plants have flowers throughout the year *(e.g.,* China Rose — Shoe Flower).

Differences between Monocarpic Plants and Polycarpic Plants		
	Monocarpic Plants	*Polycarpic Plants*
1	Monocarpic plants flower only once in their life	Polycarpic plants flower every year in particular season.
2	These plants are generally anuual or biennial. Very few monocarpic fruits and perennial.	These plants are perennial.
3	Monocarpic plants die after flowering and fruiting.	Polycarpic plants do not die after flowering and fruiting.
4	**Examples :** Rice, Wheat, Radish, Carrot, Bamboo, etc.	**Examples :** Apple, Mango, Grape vine, Oranges, etc

On the basis of time of breeding, **animals** are of two types : seasonal breeders and continuous breeders.

* (i) **Seasonal Breeders.** They reproduce at particular period of the year such as frog, lizards, most birds, deer, etc.

* (ii) **Continuous Breeders.** These animals continue to breed throughout their sexual maturity. Examples are honey bee, queen, poultry, rabbit, mice, cattle, etc.

In females of placental mammals, there are cyclical changes in ovaries, accessory reproductive ducts and hormones during the reproductive phase. These are of two types. In primates (monkeys, apes and humans) such cyclical changes during reproductive phase is called **menstural cycle** whereas in non-primate mammals like cows, sheep, rats , deer, dogs, tiger, etc. such cyclical changes during reproduction are called **oestrous cycle.**

Differences between Menstrual and Oestrous Cycles		
	Menstrual Cycle	*Oestrous Cycle*
1	It occurs in primates (monkeys, apes and human beings) only.	It occurs in nonprimates such as cow, dogs, etc.
2	Blood flows in the last few days of this cycle.	Blood does not flow in this cycle.
3	The broken endometrium is passed out during menstruation.	The broken endometrium is reabsorbed.
4	Sex urge is not increased during menstruation.	Sex urge is increased during oestrous period.
5	Female does not permit copulation during menstrual phase of the cycle.	Femle permits copulation only during oestrous period.

3. Senescent phase (Senescence, Ageing)

It begins from the end of the reproductive phase. The terminal irreversible stage of ageing is called senescence. This is the last phase of life span, senescence ultimately leads to death.

In both plants and animals hormones are responsible for the change over from one phase to another. Hormones and certain environmental factors regulate the reproductive processes and the behaviour of the organisms.

Differences between Ageing and Senescence		
	Ageing	*Senescene*
1	Ageing is progressive deterioration in the body of the organisms. There is general decline is metabolic process.	The terminal irreversible stage of ageing is called senescence. In plants it is characterized by yellowing and leaf fall.
2	It is not essential that ageing starts at the end of reproductive phase.	Senescence (old age) starts at the end of reproductive phase.

* **Sexuality in Organisms.** In most primitive sexually reproducing organisms, there is no morphological or physiological difference in the functional gametes. The gametes belong to the same parent. Such organisms are called **homothallic,** *e.g., Mucor mucedo.* When the functional gametes belong to different parents as in *Rhizopus stolonifer,* and there is no morphological or physical difference, these organisms are called **heterothallic.**

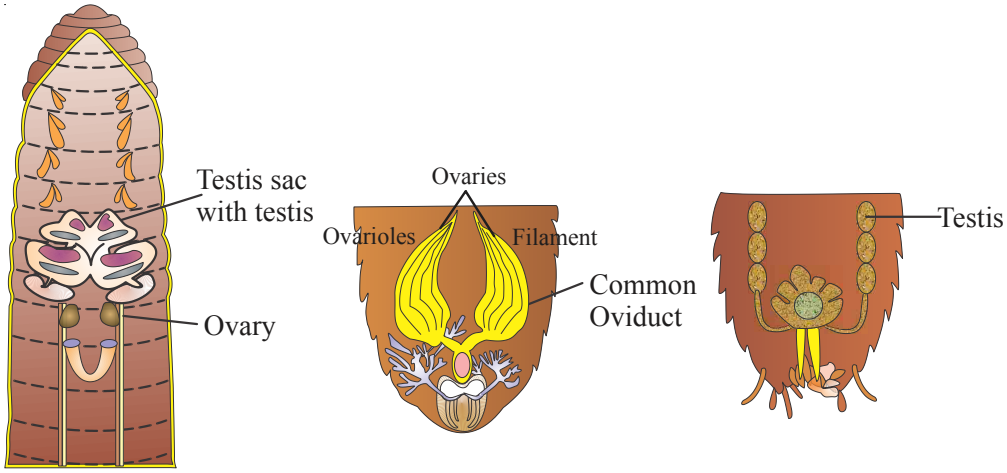


Fig Earthworm (Bisexual), Female Cockroach and Male Cockroach (Unisexual)

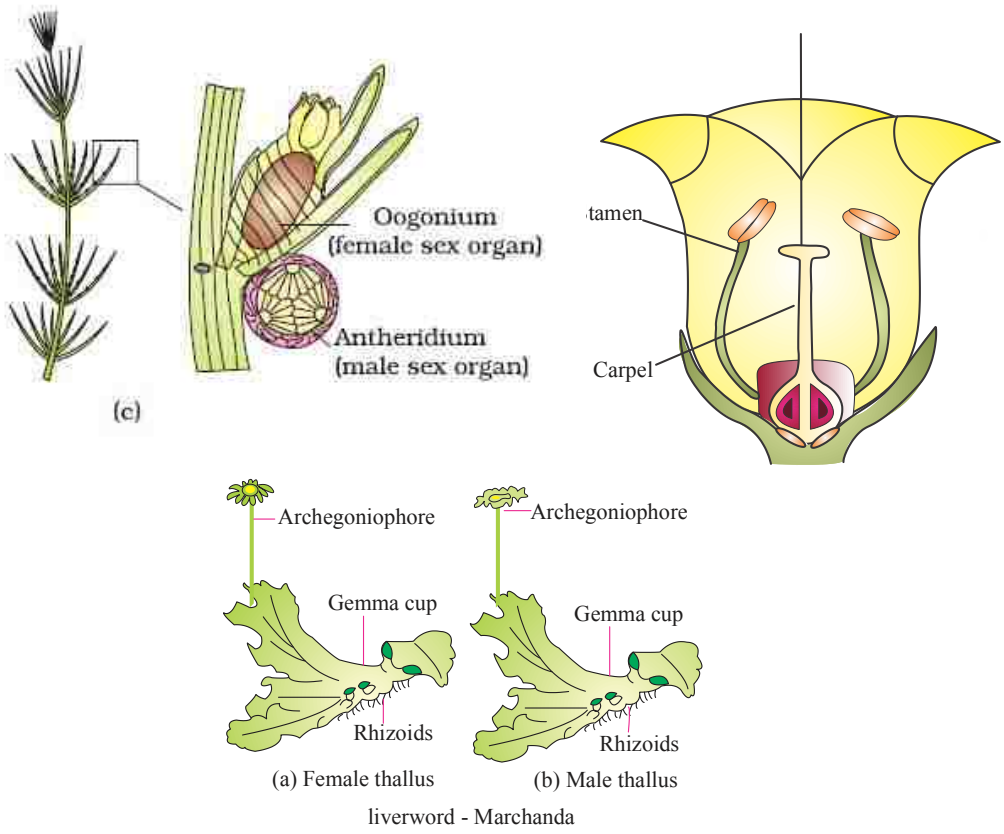


Fig : Diversity of sexuality in Organisms

In higher organisms, sex organs developed, and they became male and female organisms. In most flowering plants, both male and female sex organs (stamens and carpels) occur in the same flower. Such plants are called **hermaphrodite** or **bisexual,** *e.g.,* sweet potato. In some flowering plants, male flowers **(staminate flowers)** and female flowers **(pistillate flowers)** are borne on different plants. These plants are called **dioecious plants.** Plants are either male or female, *e.g.,* Date Palm and Papaya. When both male and female flowers are present on the same plants they are called **monoecious plants,** *e.g.,* Maize, coconut and Cucurbits. Lower plants are also monoecious and dioecious. *Chara* often bears both male **(antheridium)** and female **(oogonium)** sex organs. *Marchantia* a liverwort is dioecious. Here, the female plant bears archegonia over the **archegoniophore.** The male plant has **antheridia** over the **antheridiophore.**

Differences between Monoecious Plants and Dioecious Plants		
	Monoecious Plants	***Dioecious Plants***
1	Both male and female flowers are present on the same plant.	Male and female flower are present on different plants.
2	**Examples :** Maize, Coconut, Cucurbits and Pinus.	**Examples :** Date Palm and Papaya.

In some lower animals both male and female sex organs are present in the same individual, such animals are called **hermaphrodite, monoecious** or **bisexual,** *e.g.,* Tapeworm, Earthworm and Leech. Most of animals are **unisexual** or **dioecious** with distinct male and female individuals, *e.g., Ascaris,* Cockroach, Frog, Lizards, Birds and Mammals.

*Events in Sexual Reproduction

These events may be grouped into three stages : The **pre-fertilization, fertilization** and the **post-fertilization events.**

* 1. Pre-fertilization Events

These events of sexual reproduction are prior to the fusion (fertilization) of male and female gametes. These events are **gametogenesis** and **gamete transfer.**

(i) Gametogenesis (Gk. *gametos* = gamete, *genesis* = production)

The process of formation of two types of gametes—male and female is called gametogenesis. Gametes are haploid cells. In some algae, the two gametes are so similar in appearance that they are called **homogametes (isogametes)** *e.g., Cladophora, Ulothrix.* Therefore, it is not possible to differentiate them into male and female gametes. However, in most of sexually reproducing organisms the gametes are of two morphologically dissimilar types hence they are known as **heterogametes (anisogametes),** *e.g., Fucus* (a brown alga), humans. In these organisms the male gamete is called the **antherozooid** or **sperm** and the female gamete is known as the **egg** or **ovum**.

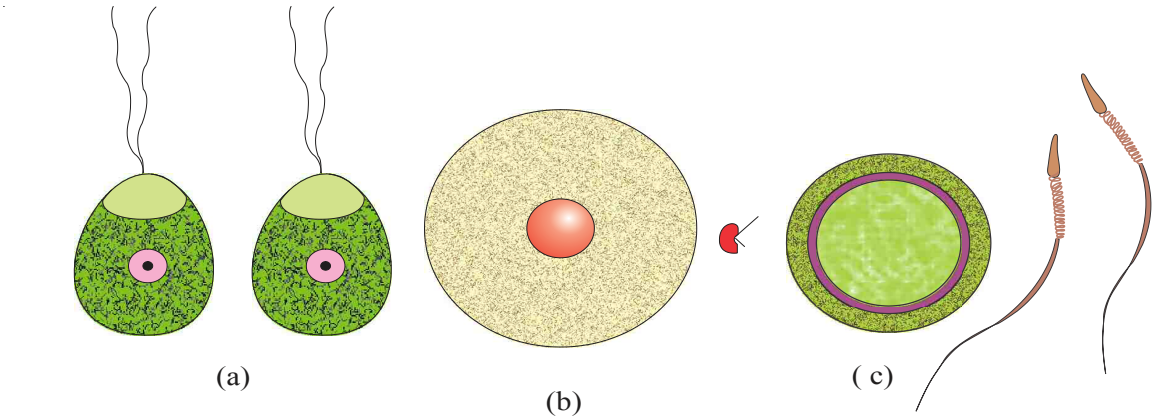


Fig. Types of gametes. (a) Isogametes of *Cladophora* (an alga). (b), Heterogametes of *Fucus* (an alga) and (c) Heterogametes of Human beings.

* **Cell Division During Gamete Formation.** Gametes are **haploid** whether the structures or cells producing them are haploid or diploid. The structure formed by the fusion of gametes is always diploid. It is due to **meiosis** which occurs in the life of all sexually reproducing organisms. Gamete producing cells which undergo meiosis are called **meiocytes** (gamete mother cells). The latter are diploid.

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
Housefly	12	6
Rat	42	21
Dog	78	39
Cat	38	19

Name of organism	*Chromosome number in meiocyte (2n)*	*Chromosome number in gamete (N)*
Fruitfly	8	4
Elephant	56	28
Apple	34	17
Rice	24	12
Maize	20	10
Potato	48	24
Butterfly	380	190
Onion	16	8
Ophioglossum (a fern)	1260	630

* **(ii) Gamete Transfer**

After the formation of male and female gametes, they must be brought together for fertilization. In most of organisms male gamete is motile and the female gamete is nonmotile. However, there are a few fungi and algae where both types of gametes are motile. A medium is needed through which male gametes move. In algae, bryophytes and pteriodophytes, water serves as the medium through which gamete transfer takes place. Since several male gametes fail to reach the female gametes, hence the male gametes are produced in large number, *i.e.,* several thousand times more than the female gametes.

➢ In flower bearing plants, pollen grains carry the male gametes which are produced in large number.

➢ The pollen grains are transferred to the stigma of the female organ (carpal) through the process of pollination. Transfer of pollen grains from the anther to the stigma is called **pollination.** Pollination is of two types. Self pollination and cross pollination. **Self pollination** is the transfer of the pollen grains from anther of a flower to the stigma of either the same flower or the stigma of another flower of the same plant or genetically similar plant. **Cross-pollination** is the transfer of pollen grains from anther of one flower to the stigma of a genetically different flower of other plant of the same species.

➢ **In unisexual animals,** male and female gametes are formed in different individuals, therefore, the organism must evolve a special mechanism for gamete transfer. Many animals have copulatory organs to transfer the male gametes. Transfer of gametes and coming together of gametes is essential for fertilization in sexual reproduction.

2. Fertilization

The **fertilization** is the complete and permanent fusion of two gametes from different parents or from the same parent to form a diploid **zygote.** This process is also called **syngamy.** Although the terms syngamy and fertilization are frequently used interchangeables. If syngamy does not occur, there would be no variations in the offspring.

* **Where does fertilization occur** ? Fertilization occurs either in external medium (water) or inside the body of the organism. Thus there are two types of gametic fusion namely external fertilization and internal fertilization.

* (i) **External Fertilization.** When fertilization occurs outside the body of the organism, this type of gametic fusion is called **external fertilization** or **external syngamy.** The external medium such as water is required for this type of fertilization. Thus in most aquatic organisms such as a majority of algae, fishes, and amphibians, external fertilization

occurs. Organisms exhibiting external fertilization produce a large number of gametes in water to enhance the chances of fertilization. This happens in bony fishes and frogs where a large number of offspring are produced. A major disadvantage of this type of fertilization is that the offspring are not protected from the predators and their survival is threatened upto adulthood.

* (ii) **Internal Fertilization.** When egg is formed inside the female body where it fuses with the male gamete, the process is called **internal fertilization** or **internal syngamy.** Many terrestrial organisms belonging to fungi, higher animals such as reptiles, birds and mammals and majority of bryophytes, pteridophytes, gymnosperms and angiosperms are the examples where internal fertilization occurs. Here male gamete is motile and has to reach the egg in order to fuse with it. The number of sperms produced is very large but there is reduction in the number of eggs produced. However, in seed plants, the non-motile male gametes are carried to the female gamete by pollen tubes.

Differences between External Fertilization and Internal Fertilization

	External Fertilization	*Internal Fertilization*
1	It occurs outside the body of the female.	It occurs inside the body of the female.
2	A large number of gametes are released in the surrounding medium (e.g., water) where fertilization takes place.	The number of gametes produced in less. The male gametes are deposited in the body of the female with the help of copulatory organ.
3	**Example :** Bony fish, Amphibians, most of Algae, etc.	**Examples :** Reptiles Birds, Mammals, Bryophytes and Tracheophytes (Pteridophytes, Gymnosperms, Angiosperms) etc.

* 3. Post Fertilization Events

Events in sexual reproduction after the fertilization (formation of zygote) are called post-fertilization events. These events may be described under two headings : zygote and embryogenesis.

➢ (i) Zygote

After fertilization a diploid zygote is formed in all sexually reproducing organisms. In external fertilization, zygote is formed in the external medium (usually water) whereas in internal fertilization, zygote is formed inside the body of the organism.

Differences between Zoospore and Zygote

	Zoorspore	*Zygote*
1	Zoospore is formed inside the zoosporangium.	It is formed by fusion of tow gametes.
2	It is usually flagellated and motile.	It is usually non-flagellated and non-motile or motile.
3	Zoospore is the result of asexual reproduction	It is the net result of sexal reproduction.
4	It is haploid or diploid.	It is always diploid.
5	Zoospore takes part in dispersal.	It has little role in dispersal.

* **(ii) Embryogenesis.**

The process of development of **embryo** from the zygote is called **embryogenesis.** During embryogenesis zygote undergoes **mitotic cell division** and **cell differentiation.** Cell division increases the number of cells in the developing embryo while cell differentiation helps to form specialised tissues and organs to form an organism.

Differences between Gametogenesis and Embryogenesis		
	Gametogenesis	*Embryogenesis*
1	It is the formation of haploid gametes.	It is the formation and development of a multicellular embryo from unicellular zygote.
2	It is of two types (a) spermatogenesis (formation of male gametes) and (b) Oogenesis (formation of female gamets).	It involves cell divison to increase the number of cells, cell growth and cell differentiation growth and cell differentiation (formation of different kinds of tissues).
3	Meiosis occurs during gametogenesis.	Mitosis occurs during embryogenesis.
4	It leads to fertilization.	It leads to organogenesis (organ formation).

Whether zygote development occurs inside the female body or outside the female body, the animals are grouped into following three categories.

Oviparous animals : These animals lay fertilized or unfertilized eggs. Many invertebrates, fishes and amphibians lay unfertilized eggs. Reptiles and birds lay fertilized eggs covered by hard calcareous shell (cleidoic eggs) in a safe place. After passing a variable incubation period, the young ones hatch out from the fertilized eggs. Prototherians or monotremes are egg laying mammals.

Viviparous animals : These animals give birth to young ones. Zygote develops into embryo inside uterus of mother and derives nutrition from maternal body through placenta. Eg. Eutherian mammals. (Humans, Monkeys, Elephants, Dogs etc.)

Ovoviviparous animals : Fertilized eggs hatch out in the reproductive tract of mother. Embryo is nourished by egg yolk and not from maternal body. The placenta is not formed. However mother's body does provide gas exchange. Eg. sharks - Dog fish (*Scoliodon*) some amphibians. development of the embryo inside the body without providing extra nourishment to the developing embryo as the placenta is absent. However, the female animals give birth to the young ones. Examples of ovoviviparous animals are sharks and rattle snakes.

Differences between Oviparous and Viviparous Animals		
	Oviparous Animals	*Viviparous Animals*
1	Females lay fertilized/unfertilized eggs.	Females give borth to young noes.
2	The development of zygote takes place outside the female's body.	The development of zygote takes place inside the female's body.
3	Females lay eggs in a safe place in the environment but the chance of ruvival are less.	Females deliver young ones and the chances of survival are more.
4	**Examples :** All birds, most reptiles and egg-laying mammals.	**Examples :** Mammals except Egg-laying, Mammals.

In **flowering plants,** the zygote is formed inside the ovule of the female sex organs. After fertilization, the sepals, petals and stamens of the flower become faded and fall off. The sepals remain attached in *Hibiscus.* However, the pistal remains attached to the plant.

Seed and Fruit Formation. In angiosperms double fertilization produces two structures — a diploid zygote (= oospore) and a triploid primary endosperm cell. Zygote forms the embryo. The triploid primary endosperm cell gives rise to a nutritive tissue called **endosperm.** Endosperm provides food to the growing embryo. The fertilized ovules mature and convert into **seeds.** The wall of the ovary forms the **pericarp** (fruit wall). The ripened ovary enclosing the seeds forms fruits. The pericarp protects the young seeds. After dispersal the seeds germinate to form new plants.

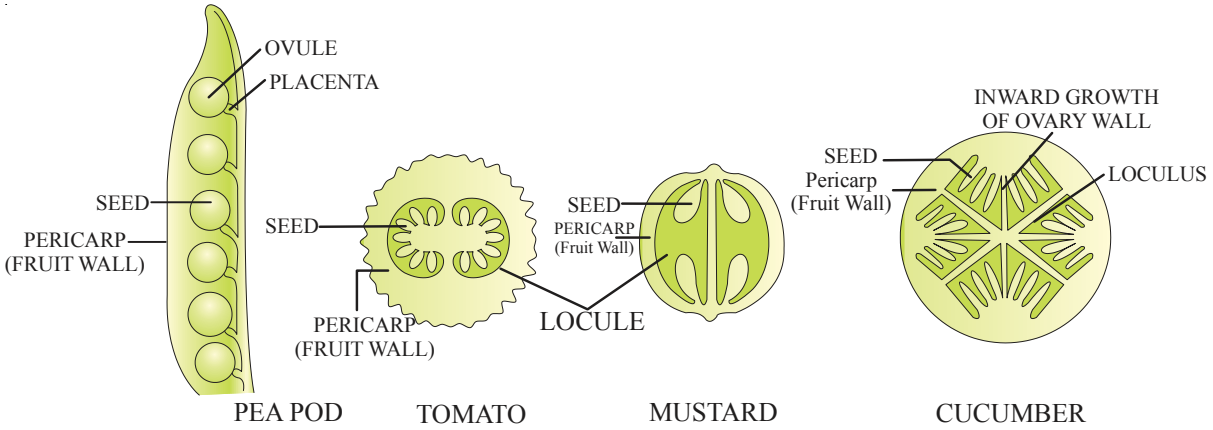


Fig. : A few kinds of fruits showing seeds and protective pericarp.

Maintenance of Chromosome Number

The reproductive units in sexual reproduction are the male and female gametes that are produced by testes and ovaries respectively. The gametes are haploid with only N chromosomes. Consequently the zygote resulting from fusion of two such haploid gametes becomes diploid with 2N chromosomes. The offspring that develops from the zygote is also diploid.

Sexual Reproduction

49. Which of the following groups formes only of the hermaphrodite organisms?

(1) Earthworm, tapeworm, housefly, frog
(2) Earthworm, tapeworm, sea horse, housefly
(3) Earthworm, leech, sponge, roundworm
(4) Earthworm, tapeworm, leech, sponge

50. It is observed that simple organisms like algae and fungi normally reproduce asexually but before the onset of adverse conditions they shift to sexual reproduction. It is so because, sexual reproduction

(1) saves time (2) is rapid
(3) produces variations (4) all of these

51. The growth phase of an organism before attaining sexual maturity is referred to as

(1) juvenile phase
(2) vegetative phase
(3) both '1' and '2'
(4) none of these

52. Clear cut vegetative, reproductive and senescent phases cannot be observed in
(1) annual plants
(2) perennial plants
(3) biennial plants
(4) ephemeral plants

53. *Strobilanthus kunthiana* differs from bamboo in
(1) being monocarpic
(2) duration of juvenile phase
(3) being polycarpic
(4) none of these

54. A multicellular, filamentous alga exhibits a type of sexual life cycle in which the meiotic division occurs after the formation of zygote.
The adult filament of this alga has
(1) haploid vegetative cells and diploid gametangia
(2) diploid vegetative cells and diploid gametangia
(3) diploid vegetative cells and haploid gametangia
(4) haploid vegetative cells and haploid gametangia

55. The number of chromosomes in the shoot tip cells of a maize plant is 20. The number of chromosomes in the microspore mother cells of the same plant shall be:
(1) 20 (2) 10 (3) 40 (4) 15

56. If a leaf cell of *Agave* has' x 'chromosomes then what will be the number of chromosomes in its egg cell?
(1) 2x (2) x/2 (3) x/4 (4) x

57. Identify the following perennial monocarpic plants
(1) agave,bamboo (2) rice,wheat
(3) agave,maize (4) maize,bamboo

58. Sexuality of *Chara,* papaya respectively
(1) both are monoecious
(2) monoecious, dioecious
(3) both are dioecious
(4) dioecious, monoecious

59. If a fungal thallus is undifferentiated as male and female reproductive structures, it willl be called
(1) heterothallic (2) homothallic
(3) dioecious (4) unioecious

60. In flowering plants both male and female gametes are nonmotile. The method to bring them together for fertilization is
(1) water (2) air
(3) pollination (4) apomixis

61. Oestrus cycle is absent in
(1) cows, sheep (2) sheep, rats
(3) rats, deers (4) monkeys, apes

62. A pair of monoecious plant are
(1) papaya and date palm
(2) papaya and coconut
(3) date palm and cucurbita
(4) cucurbits and coconuts

63. Which is not an examples of bisexual (hermaphrodites) animals ?
(1) Earthworms (2) Sponge
(3) Tapeworm and leech (4) Cockroach

64. The terms homothallic and monoecious are used to denote
(1) Bisexual condition (2) Unisexual condition
(3) Staminate flowers (4) Pistillate flowers

65. Which of the following plants is Dioecious?
(1) Papaya (2) Date palm
(3) Coconut (4) Both (1) and (2)

66. Non-motile male gametes are produced in
(1) *Zea* (2) *Pisum*
(3) *Hibiscus* (4) All of these

67. Algae having heterogametes are
(1) *Funaria* and *Pteris*
(2) liver worts
(3) *Chara* and *Fucus*
(4) *Chara* and *Marchantia*

68. Marine aquatic plants that produce hetero gametes is/are

(1) *Funaria* (2) *Fucus*

(3) *Cycas* (4) All

69. Which of the following sequences correctly represents the series of events that take place during sexual reproduction?

(1) Gametogenesis-gamete transfer-fertilisation-zygote formation - embryogenesis

(2) Gamete transfer-fertilisation Gametogenesis-zygote formation - embryogenesis

(3) Fertilisation-zygote formation-gamete transfer-Gametogenesis-embryogenesis

(4) Zygote formation-gamete transfer-embryogenesis - fertilisation - Gametogenesis

70. Perennial plants flower only once in their life time are

I) Rice II) Bamboo
III) Century plant IV) Carrot plant

(1) I, II and III (2) I, II, III and IV

(3) II only (4) II and III

71. Meiosis does not required during

(1) asexually reproducing diploid individuals

(2) sexually reproducing haploid individuals

(3) sexually reproducing diploid individuals

(4) all of these

72. Sexual reproduction is considered more beneficial than asexual reproduction because

(1) it is not affected by adverse environmental conditions

(2) fertilization is a chance factor

(3) is rapidly multiplies the population

(4) it assists in evolutioin by producing variations

73. Senescent phase of an organism's life span can be recognized by

(1) slow metabolism

(2) cessation of reproduction

(3) decreased immunity

(4) all of these

74. Birds in captivity (as in poultry farms) can be made to lay eggs

(1) throughout the year (2) seasonally

(3) once in their life time (4) everyday

75. Chromosome number in meiocyte of 'A' plant, chromosome number in gamete of 'B' plant are found in 1:1 ratio find out the A,B plants.

(1) A-potato, B-Rice

(2) A-rice, B-potato

(3) A-maize, B-rice

(4) A-apple ,B-onion

76. Identify ploidies of the following parts of a flowering plant such as Ovary, Anther, Egg, Pollen,Male gamete, Zygote respectively

(1) 2n,2n,n,n,n,2n (2) 2n,n,2n,2n,n,2n

(3) n,2n,2n,n,2n,n (4) 2n,2n,n,n,n,n

77. Sexual reproduction results in off spring that are not identical because it involves

(1) The production of gamete by meiosis

(2) The production of gamete by mitosis

(3) The fusion of male and female gametes

(4) The production of spores by meiosis

78. In both plants and animals_____ are responsible for the transitions between the three phases-juvenile, mature and old

(1) hormones (2) metabolism

(3) environmental factors

(4) behavioural expressions of organisms

PRE FERTILIZATION EVENTS

79. A diploid parent plant body produces_____gametes and a haploid parent plant body produces _____gametes
(1) diploid haploid
(2) haploid, diploid
(3) diploid, diploid
(4) haploid, haploid

80. In a monoecious plant:
(1) All stamens are fused to form one unit
(2) Male and female sex organs are on the same individual
(3) Male and female sex organs are on the different individuals
(4) Male and female gametes are of morphologically indistinct

81. Which of the following processes involves the transfer of male gametes in angiosperms
(1) Syngamy (2) Pollination
(3) Embroyogenesis (4) Parthenogenesis

82. In organism that exhibit the (i) life cycle, the adult is haploid and it forms haploid gametes through (ii) The information in which alternative completes the given statement?

	(i)	(ii)
(1)	haplontic	mitosis
(2)	haplontic	meiosis
(3)	diplontic	mitosis
(4)	diplontic	meiosis

83. Oogonium and archegonium are the female sex organs(gametangia) respectively in
(1) *Chara and Marchantia*
(2) maize and *Chara*
(3) papaya and date palm
(4) *Marchantia and Fucus*

84. The life-cycle of rockweed , a brown alga is
(1) Diplontic life cycle
(2) Diplohaplontic life cycle
(3) Haplontic life Mcycle
(4) Haplo diplontic life cycle

85. In monoecious algal plant *Chara* the male and female sex organs are called as
(1) antheridium and oogonium
(2) antheridium and carppogonium
(3) Antherozoid and egg cell
(4) antheridium and archegonium

86. List of monoecious plants among the following are
(1) *Chara*,coconut,*Cucurbita,*maize
(2) *Chara,Marchantia,*papaya,date palm
(3) maize, *Cucurbita, Cladophora*, date palm
(4) *Funaria,Cycas,Cucurbita*,papaya

87. Two unequal lengthed flagellae are arranged at lateral side of male gamete in
(1) *Cladophora* (2) *Pteris*
(3) *Funaria* (4) *Fucus*

88. In angiospermic plant life cycle sporophytic generation begins and ends with respectively
(1) spore mother cell, Zygote
(2) zygote,spore mother cell
(3) gametes, Zygote (4) zygote,gamete

89. Find the wrong one
(1) an alga with isogametes is *Cladophora*
(2) an alga with heterogametes is *Fucus*
(3) a monoecious alga is *Chara*
(4) a monoecious bryophyte is *Marchantia*

90. Find out mis match
(1) Date palm exhibits dioecious condition
(2) cucurbits exhibit monoecious condition
(3) *Chara* exhibit dioecious condition
(4) cocos exhibit monoecious condition

FERTILIZATION

91. Zygote is resulted by the process of:
(1) isogamy (2) syngamy
(3) anisogamy (4) monogamy

92. External fertilisation is absent in
(1) bony fishes (2) reptiles
(3) frogs (4) majority of algae

93. Fusion of two dissimilar gametes is known as
(1) Allogamy (2) Anisogamy
(3) Autogamy (4) Dichogamy

94. Upon fertilization, which structure develops from ovary?

(1) Testa (2) Tegmen

(3) Fruit (4) Perisperm

95. Select the incorrect statements about external fertilization

(1) organisms showing external fertilization produce a large number of male gametes only

(2) external fertilization is very uncertain and requires synchrony between release of male and female gametes

(3) it is replaced by internal ferilization in higher organisms as it wastes energy and requires external medium like water

(4) it occurs in most of the fishes and amphibians

96. Find out the mismatch

(1) Internal fertilization-Bryophytes, Pteridophytes

(2) Internal fertilization- amphibians,fishes

(3) Internal fertilization- gymnosperms, angiosperms

(4) Internal fertilization- Red algae

97. Identify the incorrect statements

(1) In embryophytes,fertilization is internal

(2) All gymnosperms exhibit siphanogamy only.

(3) All angiosperms are siphonogamous

(4) Bryophytes and pteriodophytes are zooidogamous

POST FERTILIZATION EVENTS

98. Zygote in sexually reproducing organisms

(1) is a vital link ensuring continuity of species from one generation to the other

(2) it undergoes mitosis in organisms with haplontic life cycle to form embryo

(3) it is the first cell of gametophytic phase

(4) it is the last cell of sporophytic phase

99. Which of the following is a post-fertilization event in flowering plants?

(1) Transfer of pollen grains

(2) Embryo development

(3) formation of flower

(4) formation of pollen grains

100. If a leaf cell of *Agave* has 'x' chromosomes then what will be the number of chromo somes in a cell of its bulbil?

(1) 2x (2) x/2 (3) x/4 (4) x

101. *Spirogyra* is a sexually reproducing alga in which vegetative thallus is haploid. In *Spirogyra*, meiosis

(1) never occurs

(2) occurs at time of gamete production

(3) occurs after fertilization

(4) occurs during vegetive growth

102. In maize, a meiocyte has 20 chromosomes, what will be the number of chromosomes in its somatic cell?

(1) 40 (2) 30 (3) 20 (4) 10

103. Development of new individual from female gamete without fertilization is termed as

(1) syngamy (2) embryogenesis

(3) oogamy (4) parthenogenesis

104. Zygote of an organism developed after syngamy undergoes meiosis to form haploid spores, which divide mitotically and form the gametophyte. The organism must have_____life cycle

(1) haplontic (2) diplontic

(3) haplodiplontic (4) either (1) or (3)

105. Apogamy is

(1) reproduction of virus

(2) development of bacteria

(3) failure of fusion of gametes

(4) loss of function of reproduction

106. Why sometimes, even diploid offspring is produced through parthenogenesis?

(1) When offspring is produced through fertilisation of diploid egg cell

(2) When offspring is produced with out fertilisation of haploid egg cell

(3) When offspring is produced through fertilisation of haploid egg cell

(4) When offspring is produced with out fertilisation of diploid egg cell

107. Which of the following statements is incorrect about post fetilization events in plants?

(1) ovary grows, enlarges, and ripens to be come a fruit.

(2) Fruit develops a thick protective wall, called pericarp

(3) Zygote divides several times to form an embryo, enclosed in the seed

(4) petals of the flower grow and form a part of the fruit after fertilization.

108. Which of the following is a post-fertilization event in flowering plant

(1) Transfer of gametes

(2) Endosperm development

(3) formation of flower

(4) germination of pollen grains

ANSWERS

49) 4	50) 3	51) 3	52) 2	53) 2	54) 4
55) 1	56) 2	57) 1	58) 2	59) 2	60) 3
61) 4	62) 4	63) 4	64) 1	65) 4	66) 4
67) 3	68) 2	69) 1	70) 4	71) 1	72) 4
73) 4	74) 1	75) 2	76) 1	77) 3	78) 1
79) 4	80) 2	81) 2	82) 1	83) 1	84) 1
85) 1	86) 1	87) 4	88) 2	89) 4	90) 3
91) 2	92) 2	93) 2	94) 3	95) 1	96) 2
97) 2	98) 1	99) 2	100) 4	101) 3	102) 3
103) 4	104) 1	105) 3	106) 4	107) 4	108) 2

EXERCISE-I

1. Arrange the following in their ascending chronological order of life spans : (i) Banana (ii) Rose (iii) Rice (iv) Peepal tree (v) Banyan tree

(1) (i), (ii), (iii), (iv), (v)

(2) (ii), (iii), (i), (iv), (v)

(3) (iii), (ii), (i), (v), (iv)

(4) (iv), (iii), (i), (ii), (v)

2. Choose the correct ascending sequence of the following plants with respect to their life span

(A) *Wolffia* (B) *Daucus*

(C) *Rosa* (D) *Oryza*

(E) *Osmunda* (F) *Musa*

(G) *Ficus* (H) moss plant

(1) G, E, C, F, B, D, H, A

(2) A, H, D, B, F, C, E, G

(3) A, H, B, D, F, C, G, E

(4) A, H, D, B, C, F, E, G

3. Match column I with column II and select the correct option

Column-I	Column-II
A. Eyes	1. *Zingiber*
B. Rhizome	2. *Bryophyllum*
C. Bulbil	3. *Eichhornia*
D. Leaf buds	4. *Solanum*
E. Offset	5. *Agave*

(1) A-4, B-3, C-5, D-1, E-2

(2) A-5, B-3, C-2, D-4, E-1

(3) A-2, B-5, C-4, D-1, E-3

(4) A-4, B-1, C-5, D-2, E-3

4. Match the vegetative propgules listed under column I with the plants given under column- II and choose the appropriate option from the given choices

Column-I	Column-II
A. Rhizome	1. *Agave*
B. Offset	2. *Bryophyllum*
C. Sucker	3. Ginger
D. Leaf buds	4. *Chrysanthemum*
	5. *Eichhornia*

(1) A-3, B-5, C-4, D-2
(2) A-3, B-4, C-1, D-2
(3) A-2, B-1, C-5, D-4
(4) A-4, B-5, C-2, D-2

5. Match column I with column II and select the correct option

Column-I	Column-II
A. Runners	1. *Allium*
B. Suckers	2. Grass
C. Offsets	3. *Mentha*
D. Bulbs	4. Strawberry
E. Stolons	5 *Pistia*

(1) A-5, B-3, C-2, D-4, E-1
(2) A-2, B-5, C-4, D-1, E-3
(3) A-2, B-3, C-4, D-5, E-1
(4) A-2, B-3, C-5, D-1, E-4

6. Match column I with column II and select the correct option

Column-I	Column-II
A. Zoospores	1. *Rhizopus*
B. Conidia	2. Sponge
C. Buds	3. *Penicillium*
D. Gemmules	4. *Hydra*
E. Sporagiospores	5. *Chlamydomonas*

(1) A-3, B-4, C-5, D-3, E-2
(2) A-5, B-3, C-4, D-2, E-1
(3) A-2, B-5, C-4, D-1, E-3
(4) A-5, B-3, C-4, D-1, E-2

7. Select the mismatched pair of organism and its mode of multiplication

Organism	Mode of multiplication
(1) *Agave, Oxalis*	Bulbils
(2) *Amoeba,Paramecium*	Binary fission
(3) *Chlamydomonas, Ulothrix*	Sporangiospores
(4) *Adiantum caudatum*	Adventitiousbuds presents at leaf tips

8. Identify the incorrect statement

I. In budding the division is unequal
II. Binary fission is a mode of asexual reproduction found in both prokaryotes and some Eukaryotes
III. The type of reproduction involving single parent is always asexual.
IV. Meiosis is absent in haploid organisms.

(1) I, II, IV (2) II, III
(3) III, IV (4) III only

9. Further development of the zygote depends on

A. Type of life cycle of organism
B. Environment to which it is exposed
C. Type of fertilization through which it is formed

(1) A, B and C (2) A and B only
(3) A and C only (4) B and C only

10. Find the number of plants with both male and female flowers on the same plant.

i. Cocos	*ii. Cucurbita*
iii. Zea	*iv. Carica*
v. Phoenix	*vi. Colocasia*
vii. Helianthus	*viii.Euphorbia*
ix. Ficus	*x. Chara*
xi. Hibiscus	*xii. Datura*

(1) 6 (2) 7
(3) 8 (4) 5

11. Find the incorrect statement from the following with regard to maize plant

I. It is a monoecious plant with bisexual flowers

II. It has both fibrous and adventitious roots

III. seed coat and fruit wall remain fused in its fruits

IV. feathery stigmas are seen in its gynoecium.

(1) I only (2) all except II

(3) all except III (4) I, II.III, IV

12. Read the following statements about the reproductive cycles in mammals and select the correct ones

i. Oestrous cycle occurs in primate mammals

ii. In species with oestrous cycle, females are generally sexually active during estrous phase

iii. Both the cycle show monthly recurrence

(1) i and ii (2) ii and iii

(3) ii only (4) i, ii and iii

13. Read the following statements and select the correct option

Statement -I : Unisexual flowers are either staminate flowers or pistillate flowers

Statement-II: Both monoecious and dioecious plnat has unisexual flowers

(1) both statements I and II are correct

(2) both statements I and II are incorrect

(3) statements I is correct and statement II is incorrect

(4) statements II is correct and statement I is incorrect

14. Which of the following statements is not correct regarding sexuality in organisms?

(1) When both male and female flowers are presents on the same plants, the condition is said to be monoecious and is present in cucurbits and coconuts

(2) When both male and female flowers are present on the separate plants the condition is said to be dioecious and is present in papaya and date palms

(3) In earthworms both male and female sex organs are present in the same individual and therefore, self fertilization occurs in earthworms

(4) Cockroaches are dioecious animals and exhibit sexual dimorphism

15. Match column I with column II and select the correct option

Column-I	Column-II
A. Bisexual flower	1. *Chara*
B. Bisexual animal	2. *Pheretima*
C. Unisexual animal	3. *Marchantia*
D. Monoecious	4. *Ipomoea*
E. Dioecious plant	5. *Periplaneta*

(1) A-3, B-2, C-2, D-1, E-4

(2) A-4, B-3, C-2, D-5, E-1

(3) A-2, B-5, C-4, D-1, E-3

(4) A-4, B-2, C-5, D-1, E-3

16. Match the following :

Organism	Chromosomes in a gamete
(A) Maize	(i) 24
(B) Onion	(ii) 17
(C) Apple	(iii) 8
(D) Potato	(iv) 10

(1) A (i), B (iii), C (ii), D (iv)

(2) A (iv), B (i), C (iii), D (ii)

(3) A (ii), B (iii), C (i), D (iv)

(4) A (iv), B (iii), C (ii) D (i)

17. Regarding chara, incorrect statements are

I) A multicellular green alga

II) Sex organs are multicellular

III) Male and female flowers develop on the same plant - monoecious

IV) Antheridium lies below the level of the archegonium

(1) III and IV (2) II and III

(3) I and IV (4) III only

18. Choose the correct statements. In relation to gametes

I) They may be produced from either haploid or diploid parents
II) They are produced by meiosis only
III) They can be produced by mitosis
IV) They can be produced by mitosis(or) meiosis

(1) III only (2) II only
(3) I, III and IV (4) I, II, III and IV

19. What is the ratio of monoecious and dioecious plants in the following examples____ Pinus, chara, papaya, castor, marchantia, maize, cycas

(1) 3 : 4 (2) 2 : 5
(3) 4 : 3 (4) 3 : 4

20. Given below area a few statements related to external fertilisation. Choose the correct statements.

i. The male and female gametes are formed and released simultaneously
ii. Only a few gametes are released into the medium.
iii. Water is the medium in a majority of organisms exhibiting external fertilisation
iv. Offspring formed as a result of external fertilisation have better chance of survival than those formed inside an organism

(1) iii and iv (2) i and iii
(3) ii and iv (4) i and iv

21. The statements given below describe certain features that are observed in the pistil of flowers.

i. Pistil may have many carpels.
ii. Each carpel may have more than one ovule..
iii. Each carpel has only one ovule
iv. Pistil have only one carpel

Choose the statements that are true from the options below:

(1) i and ii (2) i and iii
(3) ii and iv (4) iii and iv

22. Which of the following situations correctly describe the similarity between an an giosperm egg and a human egg?

i. Eggs of both are formed only once in a lifetime.
ii. Both the angiosperm egg and human egg are stationary.
iii. Both the angiosperm egg and human egg are motile transported.
iv. Syngamy in both results in the formation of a zygote.

Choose the correct answer from the options given below:

(1) ii and iv (2) iv only
(3) iii and iv (4) i and iv

23. Appearance of vegetative propagules from the nodes of plants such as sugarcane and ginger is mainly because:

(1) Nodes have meristematic cells
(2) Nodes are located near the soil.
(3) Nodes are shorter than internodes.
(4) Nodes have non-photosynthetic cells.

24. Which of the following statements, support the view that elaborate sexual reproductive process appeared much later in the organic evolution.

i. Lower groups of organisms have simpler body design.
ii. Asexual reproduction is common in lower groups.
iii. Asexual reproduction in common in higher groups of organism.
iv. The high incidence of sexual reproduction occurs in angiosperms and vertebrates.

Choose the correct answer from the options given below:

(1) i,ii and iii (2) i, iii and iv
(3) i,ii and iv (4) ii, iii and iv

25. Offspring formed by sexual reproduction exhibit more variation than those formed by asexual reproduction because:
(1) Sexual reproduction is a lengthy process.
(2) Gametes of parents have qualitatively different genetic composition.
(3) Genetic material comes from parents of two diffent species
(4) Greater amount of DNA is involved in sexual reproduction

26. Read the folloiwng statements about 'Terror of Bengal' and select the correct ones
i. Terror of Bengal is the name given to water hyacinth *(Eichhornia)*
ii. *Eichhornia* was introduced in the india due to its asethetic value
iii. *Eichhornia* drains oxygen from the water which leads to death of fishes
(1) i and ii (2) i and iii
(3) ii and iii (4) i, ii and iii

27. Read the following statements and select the correct option.
Statement-I : In gymnosperms, endosperm is formed before fertilization and is haploid
Statement-II: In angiosperms, endosperm is formed after fertilization and is diploid
(1) both statements I and II are correct
(2) both statements I and II are incorrect
(3) statements I is correct and statement II is incorrect
(4) statements II is correct and statement I is incorrect

28. A few statements with regard to sexual reproduction are given below
i. sexual reproduction does not always require two individuals
ii. sexual reproductin generally involves gametic fusion
iii. meiosis never occurs during sexual reproduction
iv. external ferilisation is a rule during sexual reproduction
Choose the correct statements from the options below
(1) i and iv (2) i and ii
(3) ii and iii (4) i and iv

29. Read the following statements about asexual reproduction and select the correct ones
i. It involves a single parent
ii. It is slower than sexual reproduction
iii. It produces progeny that are genetically identical with the parent but not with one another
iv. The progeny of asexual reproduction can be termed as clones
(1) i and ii (2) ii and iii
(3) i and iv (4) i, iii and iv

30. *Amoeba* and Yeast reproduce asexually by fission and budding respectively, because they are
(1) Microscopic organisms
(2) Heterotrophic organisms
(3) Unicellular organisms
(4) Uninucleate organisms

31. Match Column-I with Column-II and select the correct option from the codes gives below

Column-I	Column-II
A. Sponge	i. Tuber
B. Yeast	ii. Offset
C Potato	iii. Gemmules
D. Water hyacinth	iv. Budding

(1) A-iv, B-i, C-ii, D-iii (2) A-iii, B-i, C-iv, D-ii
(3) A-iii, B-iv, C-i, D-ii (4) A-iv, B-ii, C-i, D-iii

32. Read the following statements and select the correct ones
i. Conidia are the asexual propagules restricted to kingdom fungi
ii. A piece of potato tuber having at least one eye (or node) is capable of giving rise to a new plant
iii. Ginger propagates vegetatively with the help of its underground roots
iv. Fleshy buds which take part in vegetative propagation are called bulbils, present in *Dioscorea, Agave* etc
(1) ii and iii (2) i and iv
(3) ii and iv (4) i, ii and iii

33. **Which of the following is pollinated by water?**
(1) *Zostera* (2) *Yucca*
(3) *Oxalis* (4) *Commelina*

34. **The number of chromosomes in the meiocytes (2n) of Rice, Maize, Potato respectively**
(1) 24, 48, 20 (2) 20, 24, 48
(3) 24, 20, 48 (4) 24, 20, 34

35. **Read the following statements and selected the correct option.**
Statement -I : Many plants are propagated vegetatively even though they bear seeds
Statement -II: Sweet potatoes multiply vegetatively by root tubers
(1) both statements I and II are incorrect
(2) both statements I and II are correct
(3) statements I is correct and statement II is incorrect
(4) statements II is correct and statement I is incorrect

36. **A few statements describing certain features of reproduction are given below:**
i. **Gametic fusion takes place**
ii. **Transfer of genetic material takes place**
iii. **Reduction division takes place**
iv. **Progeny have some resemblance with parents**
Select the options that are true for both asexual and sexual reproduction from the options given below:
(1) i and ii (2) ii and iii
(3) ii and iv (4) i and iii

37. **The male gametes of rice plant have 12 chromosomes in their nucleus. The chromosome number in the female gamete, zygote and the cell of the seedling will be, respectively:**
(1) 12,24,12 (2) 24,12,12
(3) 12,24,24 (4) 24,12,24

38. **Which one of the following is an incorrect combination of organism with its chromosome numbers in meiocyte and in gamete?**

	Name of organism	chromosome number	
		meiocyte	gamete
(1)	Onion	24	12
(2)	Ophioglossum	1260	630
(3)	Human beings	46	23
(4)	Fruitfly	8	4

ANSWERS

1.(3)	2.(4)	3.(4)	4.(1)	5.(4)	6. (2)
7.(3)	8.(3)	9.(2)	10.(2)	11.(1)	12.(3)
13.(1)	14.(3)	15.(4)	16.(4)	17.(1)	18.(3)
19.(3)	20.(2)	21.(1)	22.(2)	23. (1)	24.(3)
25.(2)	26.(4)	27.(3)	28.(2)	29.(3)	30.(3)
31.(3)	32.(3)	33.(1)	34.(3)	35.(2)	36.(3)
37.(3)	38.(1)				

EXERCISE-II

1. **Binary fission is a form of:** DPMT 2007
(1) asexual reproductioon
(2) sexual reproduction
(3) both of these (4) none of these

2. **Which of the following animals is having longitudinal binary fission** KPMT 2007
(1) Euglena (2) Paramoecium
(3) Amoeba (4) Hydra

3. **The living organisms can be unexceptionally distinguished from the non-living things on the basis of their ability for** CBSE-PMT 2007
(1) Size of organism
(2) growth and movement
(3) responsiveness to touch
(4) interaction with environment and progressive evolution

4. **Apogamy is** CMC 2008
(1) reproduction of virus
(2) development of bacteria
(3) failure of fusion of gametes
(4) loss of function of reproduction

5. **Parthenogenesis is a type of** PBPMP 2008
(1) budding (2) regeneration
(3) sexual reproduction
(4) asexual reproduction

6. **Why sometimes, even dipliod offspring is produced through parthenogenesis?** GCET 2008
(1) When offspring is produced through fertilisation of diploid egg cell
(2) When offspring is produced without fertilisation of haploid egg cell
(3) when offspring is produced through fertilisation of haploid egg cell
(4) when offspring is produced without fertilisation of diploid egg cell

7. **Monocarpic plant** ORISSA JEE 2009
(1) flowers twice in every year
(2) bears only one type of flower
(3) flowers once in every year
(4) dies after flowering once in its life cycle

8. **Hydra reproduces by budding. This is an example of:** ORISSA JEE 2009
(1) Regeneration (2) Parthenocarpy
(3) Asexual reproduction
(4) sexual reproduction

9. **Vegetative propagation in mint occurs by** CBSE PMT 2009
(1) offset (2) rhizome
(3) sucker (4) runner

10. **Match the items in Column I with Column II and choose the correct option** KERALA PMT 2009

Column I	Column II
A. Binary fission	1. Algae
B. Zoospore	2. *Amoeba*
C. Conidium	3. *Hydra*
D. Budding	4. *Penicillium*
E. Gemmules	5. Sponge

(1) A-1, B-4, C-5, D-3, E-2
(2) A-2, B-1, C-4, D-3, E-5
(3) A-2, B-4, C-3, D-5, E-1
(4) A-1, B-4, C-3, D-2, E-5

11. **Asexual reproduction in fungi takes place by** ORISSA JEE 2010
(1) endospore (2) gametangia
(3) exospores (4) conidiospore

12. **Which of the following is pollinated by water?** KERALA PMT 2010
(1) *Zostera* (2) *Yucca*
(3) *Oxalis* (4) *Commelina*

13. **Non-motile male gametes are produces in** CPMT 2010
(1) *Zea* (2) *Pisum*
(3) *Hibiscus* (4) all of these

14. **The "eyes" of the potato tuber are** AIPMT PRELIMS 2011
(1) root buds (2) flower buds
(3) shoot buds (4) axillary buds

15. **A clone is** KERALA CET 2011
(1) a group of genetically similar organisms produced through asexual reproduction
(2) a group of genetically similar organisms produced through sexual reproduction
(3) a group of genetically dissimilar organisms produced as a result of sexual reproduction
(4) a group of genetically dissimilar organisms produced as a result of sexual reproduction

16. **The eyes of potato tubers help in:** KERALA CET 2011
(1) Sexual reproduction
(2) Asexual reproduction
(3) Vegetative reproduction (4) Both (1) and (2)

17. **Which of the following is correctly matched?** AIPMT 2012
(1) Onion - Bulb
(2) Ginger - Sucker
(3) Yeast - Zoospores
(4) *Chlamydomonas* - Conidia

18. **Isogamous condition with non-flagellated gametes is found in:** NEET 2013
(1) *Volvox* (2) *Fucus*
(3) *Spirogyra* (4) *Chlamydomonas*

19. **Product of sexual reproduction generally generates** NEET 2013
(1) Large biomass
(2) Prolonged dormancy
(3) Longer viability of seeds
(4) New genetic combination leading to variation

20. **Which one of the following shows isogamy with non-flagellated gametes?** AIPMT 2014
(1) *Ulothrix* (2) *Spirogyra*
(3) *Sargassum* (4) *Ectocarpus*

21. **In ginger, vegetative propagation occurs through:** AIPMT 2015
(1) Offsets (2) Bulbils
(3) Rhizome (4) Runners

22. **Banana is an example of** WB JEE 2015
(1) apomixis (2) polyembryony
(3) parthenocarpy (4) parthenogenesis

23. **Which one of the following generates new genetic recombinations leading to variation?** NEET 2016
(1) Nucellar polymbryony
(2) Vegetative reproduction
(3) Sexual reproduction
(4) Parthenogenesis

24. **Which one of the following statements in not correct?** NEET 2016
(1) In potato, banana and ginger, the plantlets arise from the internodes present in the modified stem
(2) Water hyacinth growing in the standing water, drains oxygen from water that leads to the death of fishes
(3) Offspring produced by the asexual reproduction are called clone
(4) Microscopic, motile asexual reproductive structures are called zoospores

('Assertion' and Reason type Questions)

The following questions consist of two statements each :

Assertion (A) and Reason (R), To answer these questions mark the correct alternative as directed below.

1) If both A and R are true and R is the correct explanation of A.

2) If both A and R are true but R is not the correct explanation of A

3) If A is true but R is false

4) If A is false but R is true

25. **A :** At the end of juvenility, the organism develops the capacity to reproduce.
R : It represents the time period between the first and next flowering in plants.

26. **A :** Reproduction is a biological process of giving rise to young ones.
R : Reproduction increases population and maintains the continuity of species.

27. **A :** Endogamy is common in majority of animals.
R : Fusing gametes are quite different and develop from the different individuals.

28. **A :** The higher organisms must evolve a special mechanism for gamete transfer.
R : Male and female gametes are formed in different individuals.They are dioecious

29. **A :** Air layering does not produce a composite plant.
R : Stock and scion are fused to form a composite plant during grafting.

30. **A :** Most of the species of Chara are monoecious but show cross fertilization.
R: The plant body shows protandrous condition.Protanderous ? Male part develops earlier than female part

31. **A :** Multiplication occurs rapidly with equal rate in apomixis as well as in amphimixis.

R : Both types shows mitotic as well as meiotic division.Apomixis show only mitotic division

32. **A :** Fucus, a brown alga shows oogamy.

R : Female gamete is quite large as compare to male gamete.

33. **A :** Runner, tuber, sucker, offset etc. are vegetative propagules.

R : Two parents are involved in the formation of these structure.Tuber, Runner, Suckers are vegetative propgule so it uniparental.

34. **A :** Cereals are monocarpic plants.

R : They have distinct juvenile, reproductive and senescent phases.

ANSWERS

1. (1)	2. (1)	3. (4)	4. (3)	5. (4)	6.(4)
7. (4)	8. (3)	9. (3)	10. (2)	11.(4)	12.(1)
13.(4)	14.(4)	15.(1)	16.(3)	17.(1)	18.(3)
19.(4)	20.(2)	21.(3)	22.(3)	23.(3)	24.(1)

ASSERTION' AND REASON TYPE

25.(3)	26.(2)	27.(4)	28.(1)	29.(2)	30.(1)
31.(4)	32.(1)	33.(3)	34.(2)