1 REPRODUCTION IN ORGANISMS

BASIC CONCEPTS

1. Life Span

- The period from birth to the natural death of an organism represents its life span.
- Life span of an organism may vary from species to species. Death of every organism is certain.

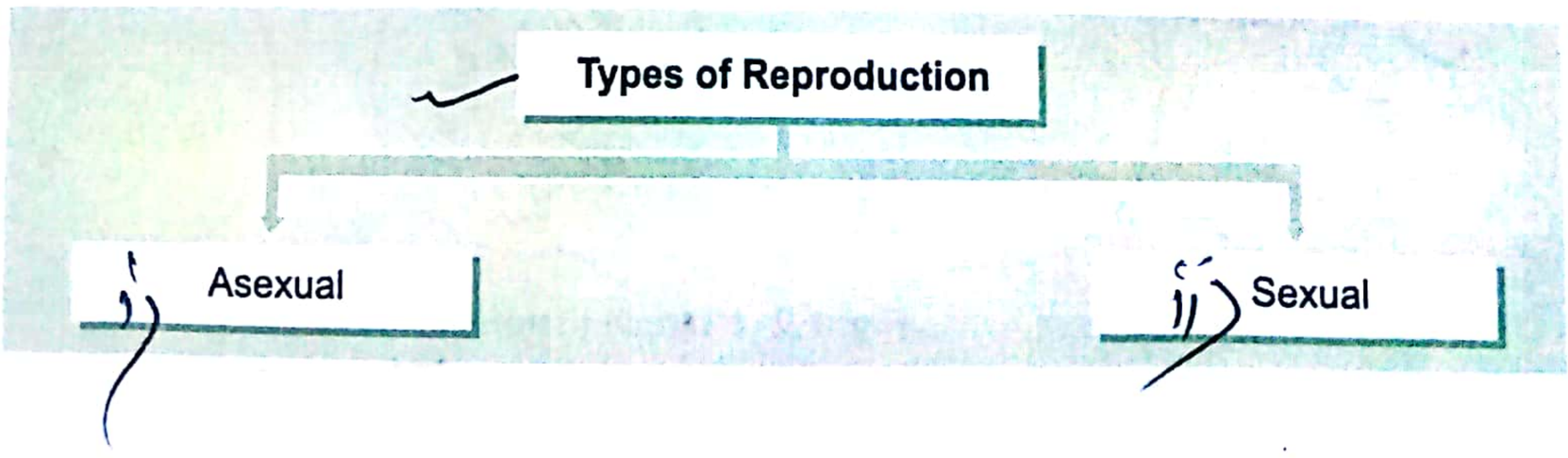
S. No.	Organism	Life span
(i)	Banyan tree	200 years
(ii)	Tortoise	100–150 years
(iii)	Parrot	140 years
(iv)	Man	100 years
(v)	Crocodile	60 years
(vi)	Crow	15 years
(vii)	Wheat plant	6 months
(viii)	Butterfly	1–2 weeks
(ix)	Mayfly	1 day

2. Reproduction

- Reproduction is a biological process by which an organism produces another organism (offspring) similar to itself.

Function/Importance

- Reproduction is necessary for the continuity of the species.
- Sexual reproduction is responsible for variation in a population and its inheritance to future generations.



S. No.	Asexual reproduction	Sexual reproduction
(i)	Asexual reproduction does not involve formation or fusion of gametes.	Sexual reproduction involves formation and fusion of gametes.
(ii)	The offsprings formed by asexual reproduction are genetically identical to the parent and are referred to as clones.	The offsprings are not identical to the parents or to each other hence, it leads to variation in a population.
(iii)	It is a simple and fast process.	It is an elaborate, complex and slow process.
(iv)	It involves only mitosis.	It involves meiosis.
(v)	It is always uniparental (single parent).	It is usually biparental (two parents).
(vi)	It does not play important role in evolution process.	It plays a vital role in evolution process.
(vii)	It is common among single-celled organisms, and in plants and animals with relatively simple organisation.	It is common in higher animals with complex organisation.

3. Asexual Reproduction

- Uniparental with or without gamete formation.
- Offsprings are exact copies or clones of each other and the parent.
- Mitosis is the essential mode of asexual reproduction.

Types of Asexual Reproduction

Fission | Fragmentation | Budding | Regeneration | Spore formation | Vegetative propagation

(*i*) **Fission:** The splitting of parental cell into two or more daughter cells.

(*a*) **Binary fission:** The splitting of a parental cell into two equal daughter cells, each of which rapidly grows into an adult is called binary fission. It occurs in single-celled animals like bacteria and protozoans (*e.g.*, *Amoeba, Paramecium*). It can be simple or irregular, longitudinal, oblique or transverse, depending on the plane of division.

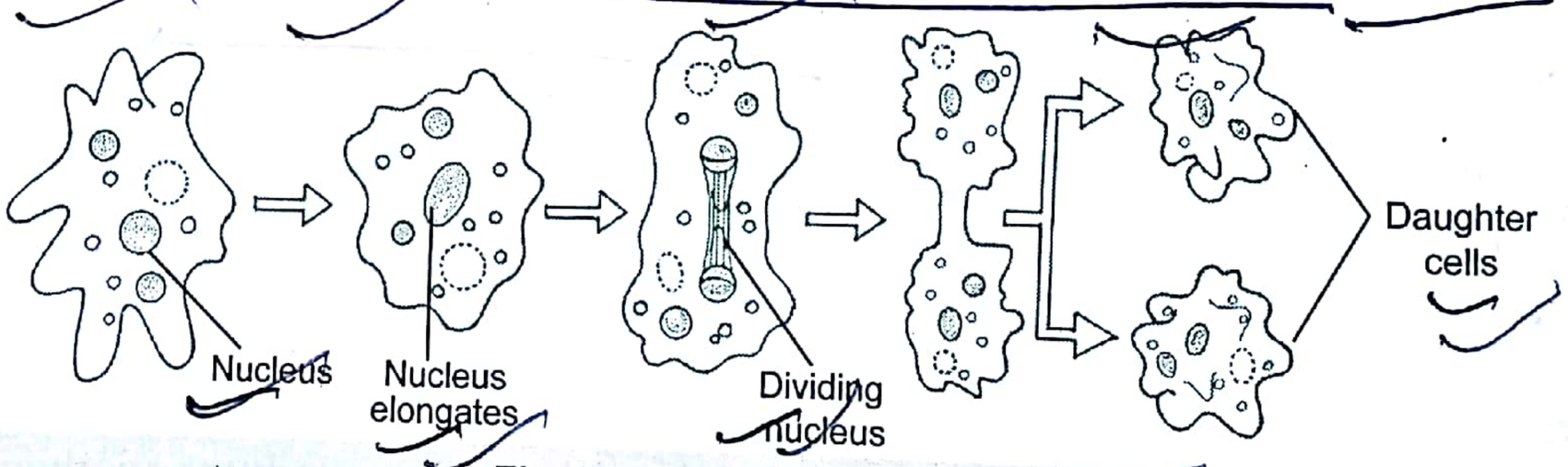


Fig. 1.1 Binary fission in *Amoeba*

(*b*) **Multiple fission:** The splitting of a parent cell into numerous daughter cells, each of which grow into an adult is called multiple fission, *e.g.*, *Plasmodium*.

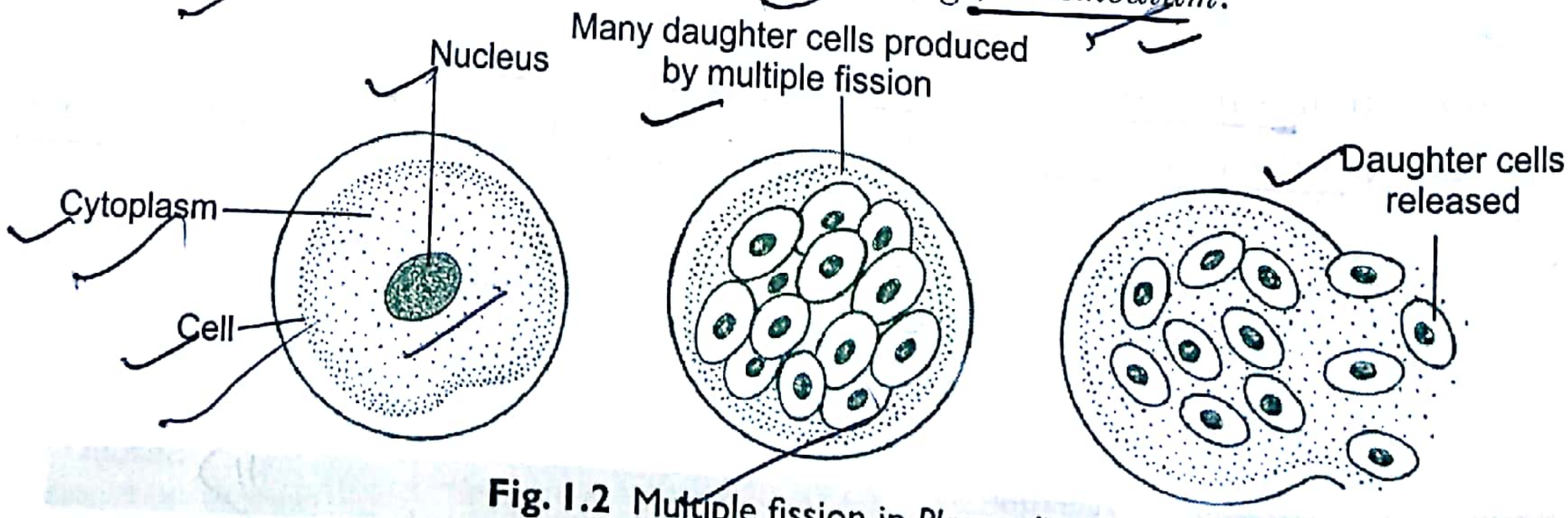


Fig. 1.2 Multiple fission in *Plasmodium*

- **Sporulation:** During unfavourable conditions, organisms like *Amoeba* cover themselves with a three-layered hard covering or cyst. This is called **encystation**. On return of favourable conditions, it divides by multiple fission within the cyst and produces many *Amoebae*. The cyst bursts and spores are liberated to develop into adults. This is called sporulation.

(*ii*) **Fragmentation:** It is a mode of asexual reproduction in which the parental body breaks into two or more fragments and each fragment grows into a new individual, *e.g.*, *Spirogyra*.

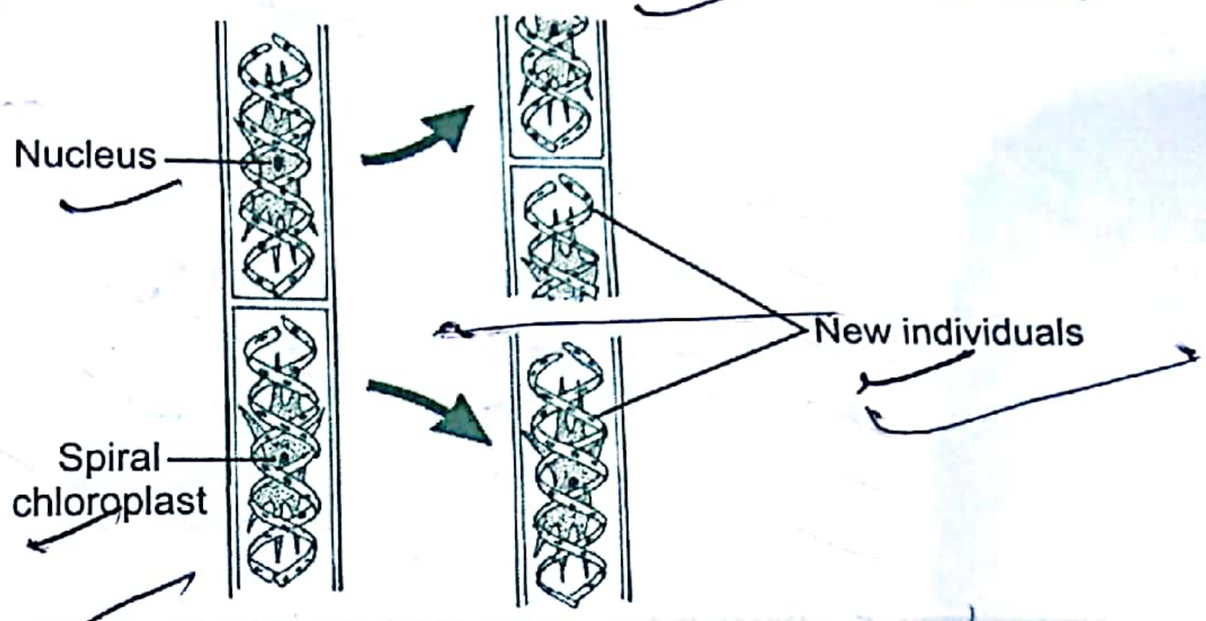


Fig. 1.3 Fragmentation in *Spirogyra*

(*iii*) **Budding:** It is a mode of asexual reproduction in which one or more outgrowths (buds) are produced which initially remain attached to the parent cell and eventually get separated from it to grow into a new individual, *e.g.*, yeast.

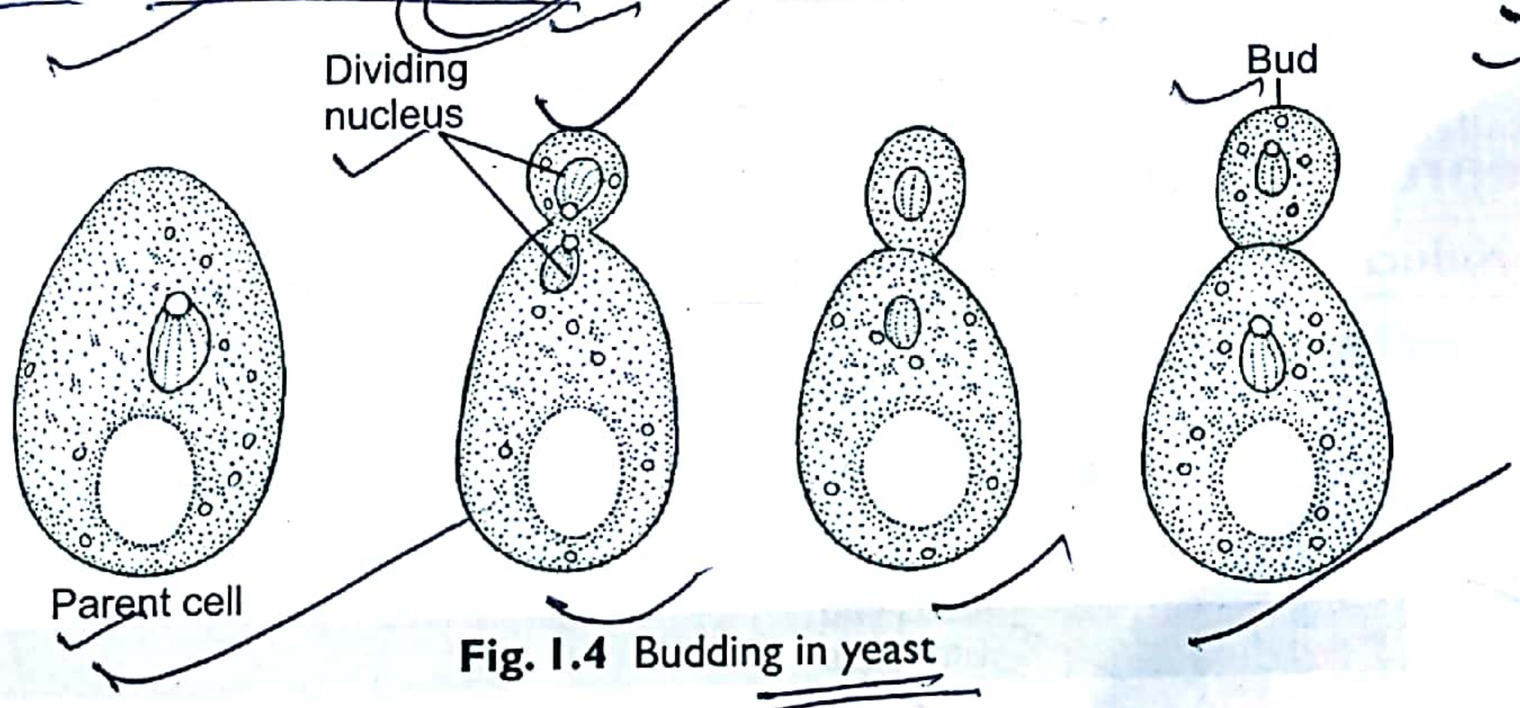
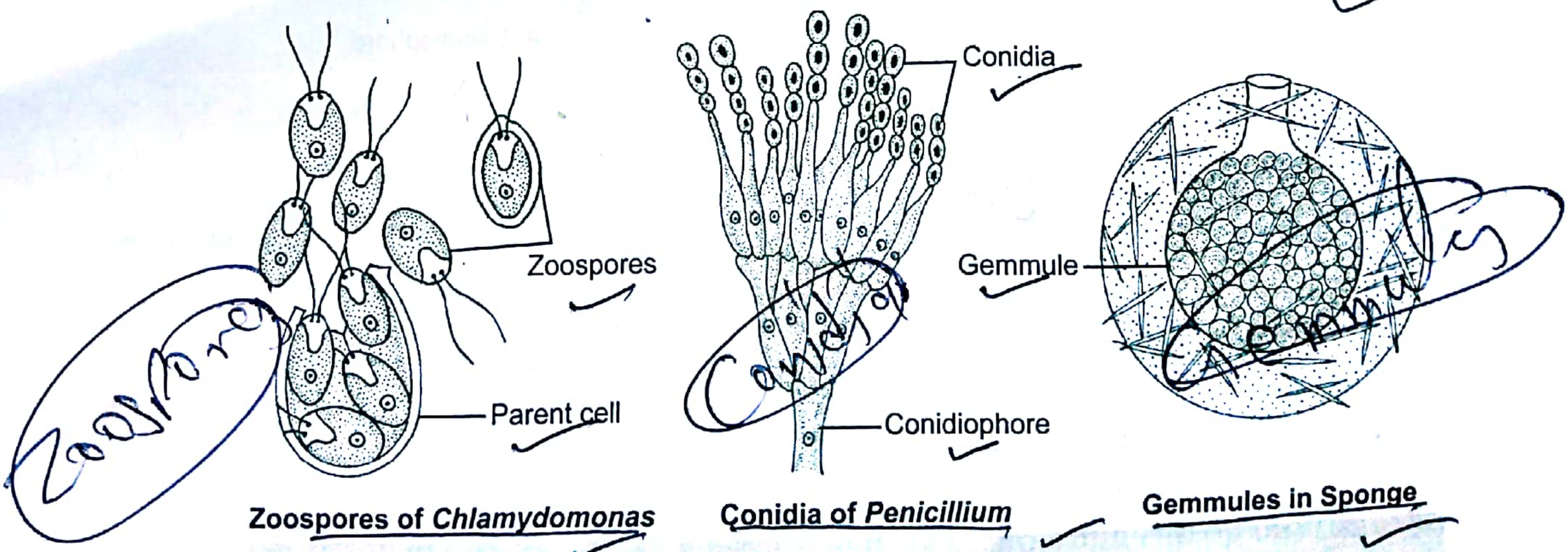


Fig. 1.4 Budding in yeast

(*iv*) **Regeneration:** It is a mode of asexual reproduction in which the missing parts of an organism is repaired by proliferation of cells, *e.g.*, *Planaria*.

(*v*) **Spore formation:**

- **Zoospores:** These are endogenously produced unicellular, naked and motile spores with one or two flagella. Zoospores are produced in a sac-like structure called **zoosporangium**, *e.g.*, *Chlamydomonas*.
- **Conidia:** Asexual non-motile spores cut off externally either singly (*e.g.*, *Phytophthora*) or in chains (*e.g.*, *Penicillium*) from the tip of a special hyphae called **conidiophore**.
- **Gemmules:** Internal asexual reproductive units or buds are called gemmules, *e.g.*, sponges. These develop within the parental body and are released during germination.



Zoospores of *Chlamydomonas* **Conidia of *Penicillium*** **Gemmules in Sponge**

Fig. 1.5 Spore formation

(vi) **Vegetative propagation:** It is a mode of reproduction in which new plants are formed from vegetative parts (vegetative propagules) of the plant like root, stem, etc. It is very common in higher angiosperms.

Following are some units of vegetative propagation:

- Bulbil ⟶ *Agave*
- Bulbs ⟶ Onion, Garlic
- Eyes ⟶ Potato
- Leaf buds ⟶ *Bryophyllum*
- Offset ⟶ Hyacinth and *Pistia*
- Rhizome ⟶ Ginger
- Runner ⟶ *Oxalis*
- Sucker ⟶ Mint

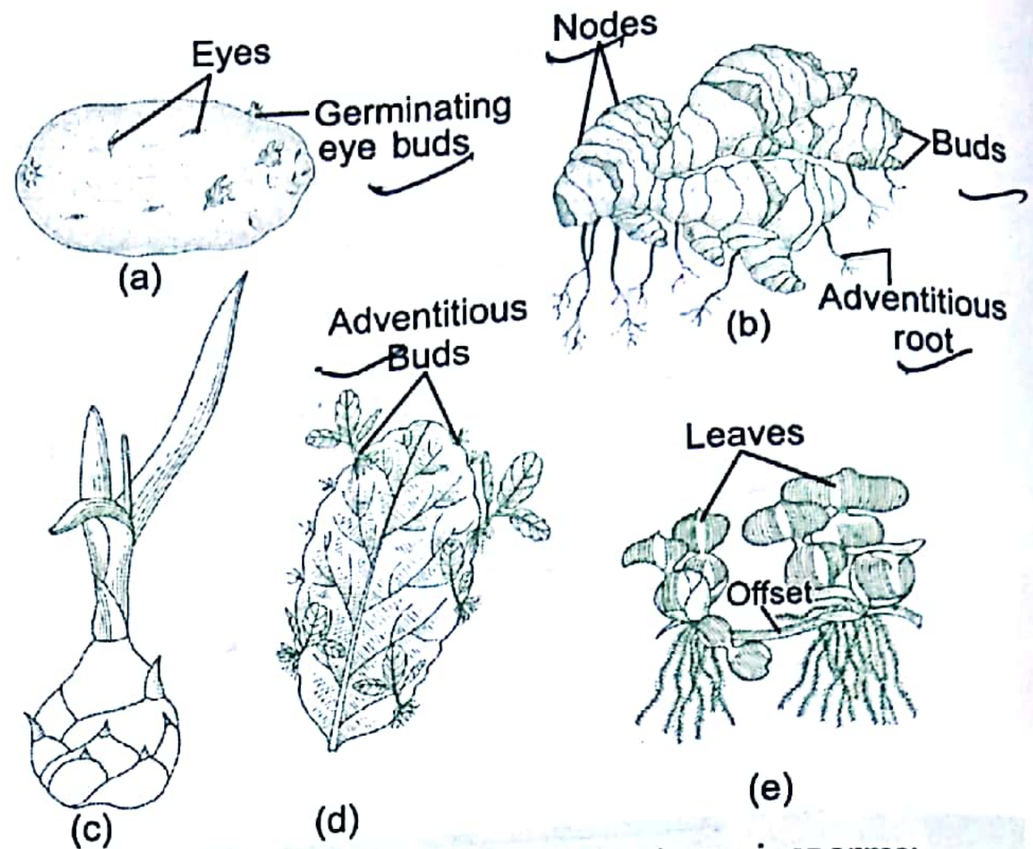


Fig. 1.6 Vegetative propagules in angiosperms: (a) Potato tuber; (b) Rhizome of ginger; (c) Bulbil of *Agave*; (d) Leaf buds of *Bryophyllum*; (e) Offset of water hyacinth

4. Sexual Reproduction

- Sexual reproduction involves the fusion of male and female gametes to form a zygote.

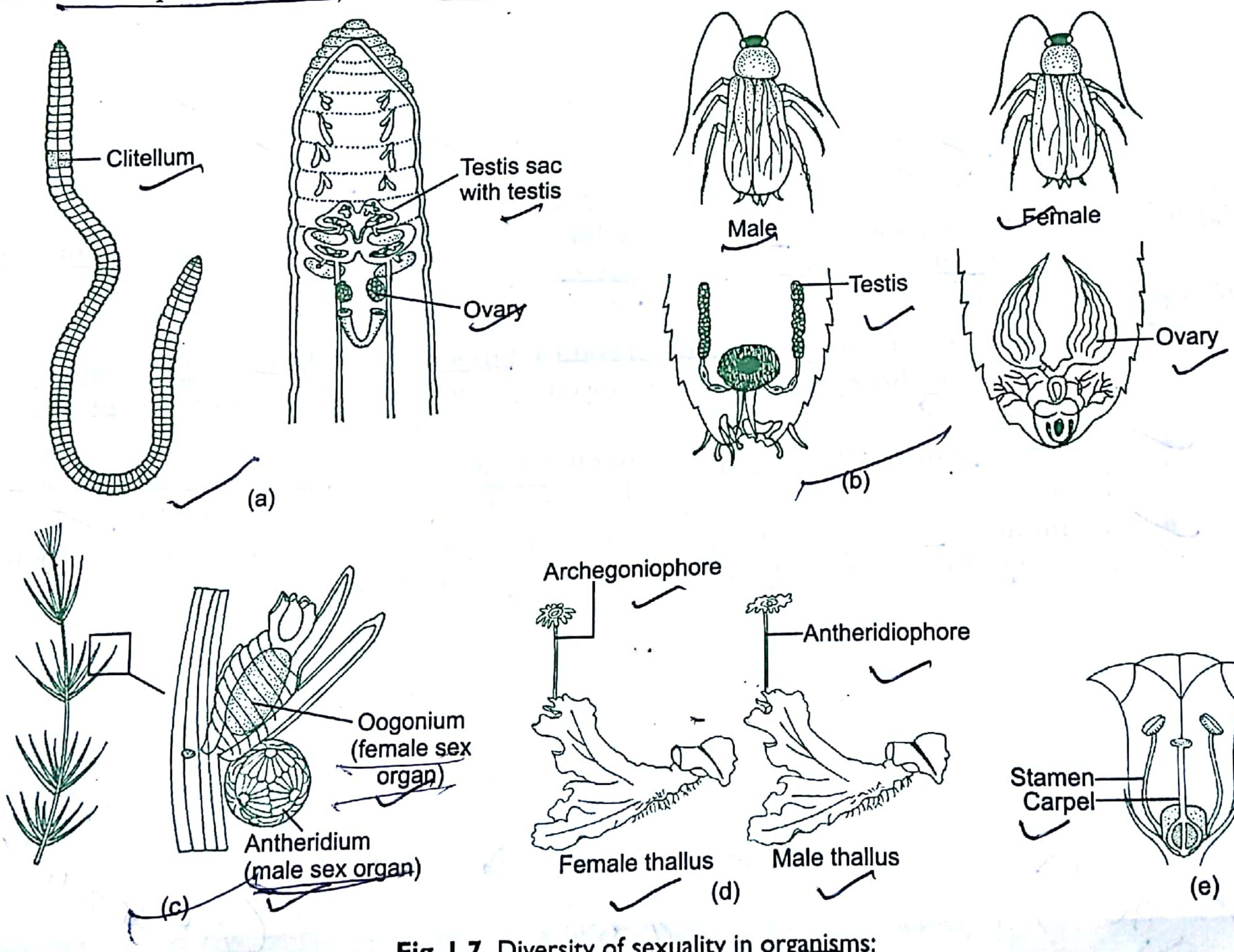


Fig. 1.7 Diversity of sexuality in organisms: (a) Bisexual animal (Earthworm); (b) Unisexual animal (Cockroach); (c) Monoecious plant (*Chara*); (d) Dioecious plant (*Marchantia*); (e) Bisexual flower (sweet potato)

- All organisms go through a phase to attain the stage of growth and maturity in their life, before they can reproduce sexually. This phase is called **juvenile phase**.

- Juvenile phase in plants is called **vegetative phase**.
- In non-primates (cows, sheep and dogs), the female reproductive cycle is called **oestrus cycle**.
- In primates (monkey, apes and humans), the female reproductive cycle is called **menstrual cycle**.

5. Events in Sexual Reproduction

- Events in sexual reproduction may be grouped into three distinct stages as follows:
  (i) Pre-fertilisation (ii) Fertilisation (also known as syngamy) (iii) Post-fertilisation.

(i) Pre-fertilisation

- This includes formation of gametes (**gametogenesis**) and their transfer.

(a) Gametogenesis

- It involves formation of two haploid reproductive units called gametes.
- The formation of male gamete or male reproductive unit is called **spermatogenesis**.
- The formation of female gamete or female reproductive unit is called **oogenesis**.
- When male and female gametes are similar in appearance and it is not possible to differentiate between them, they are called **homogametes** or **isogametes**.
- When the male and female gametes are morphologically distinct, they are called **heterogametes**.
- Among heterogametes, the male reproductive unit is called **antherozoid** or **sperm** and female reproductive unit is called **egg** or **ovum**.
- A single organism bearing both male and female sex gametes is called **homothallic** or **monoecious**, *e.g.*, coconut.
- Organisms in which different individuals carry male and female gametes are called **heterothallic** or **dioecious**, *e.g.*, papaya.
- Unisexual male flowers bearing stamens are called **staminate** flowers.
- Unisexual female flowers bearing pistils are called **pistillate** flowers.
- The animals bearing both the sexes are called **hermaphrodites**, *e.g.*, earthworm, sponge, tapeworm and leech.

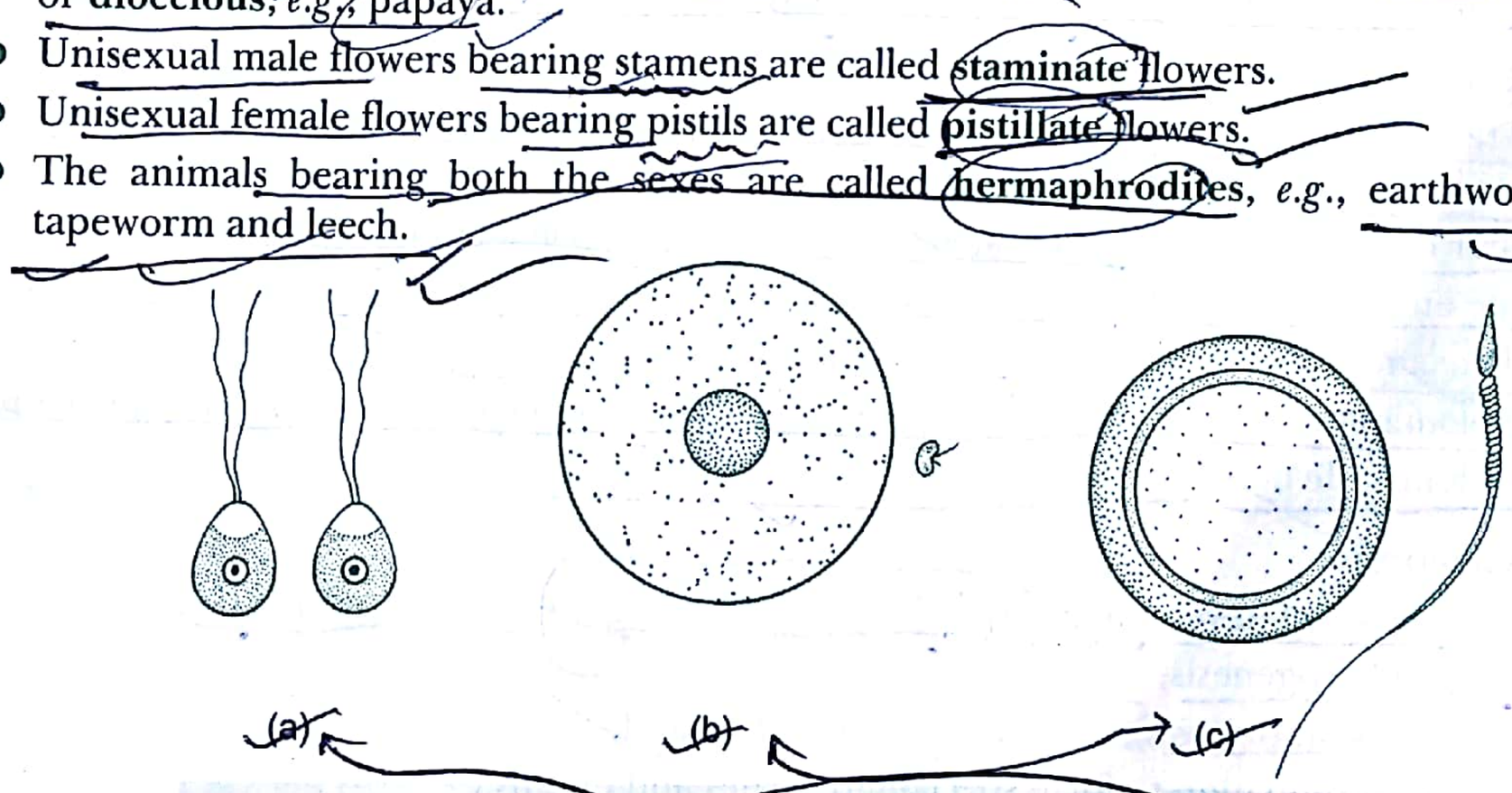


Fig. 1.8 Types of gametes: (a) Isogametes of *Cladophora* (an alga); (b) Heterogametes of *Fucus* (an alga); (c) Heterogametes of *Homo sapiens* (human beings)

Cell division during gamete formation

- Gametes are always haploid.
- Haploid organisms produce gametes by mitotic division. Diploid organisms undergo meiosis of specialised cells called **meiocytes** (gamete mother cell) to form gametes.
- At the end of both divisions, only one set of chromosomes get incorporated into each gamete.

(b) Gamete transfer

- After gamete formation, male and female gametes must be physically brought together to facilitate fusion (**fertilisation**).

- *Male* gametes are usually motile whereas female gametes are static.
- *In lower* plants like some algae and fungi, both male and female gametes are motile.
- In simple plants like algae, bryophytes and pteridophytes, water acts as the medium for gamete transfer.
- In angiosperms, the pollen grains are transferred from anther of one flower to the stigma of another flower. This is called **pollination**.

(ii) Fertilisation or syngamy

- It is the fusion of male and female gametes to form a diploid cell called **zygote**.
- The phenomenon of development of female gamete directly into an individual without fertilisation is called **parthenogenesis**, *e.g.*, rotifers, honeybees, lizards and birds.
- Fertilisation is of two types, *i.e.*, external fertilisation and internal fertilisation.

S. No.	External fertilisation	Internal fertilisation
(*i*)	When fusion of gametes occurs outside the body of an organism, it is called external fertilisation.	When fusion of gametes occurs inside the body of an organism, it is called internal fertilisation.
(*ii*)	Large number of both male and female gametes are released into the surrounding medium (*e.g.*, water) in order to enhance chances of syngamy.	The number of sperms produced are very large and number of eggs produced are less.
(*iii*)	The offsprings are extremely vulnerable to predators, threatening their survival.	The offsprings are well protected comparatively.
(*iv*)	Examples: Bony fishes, frogs and majority of algae.	Examples: Birds, mammals, etc.

(iii) Post-fertilisation events

These include development of zygote and embryo after fertilisation.

(a) Zygote development

- In external fertilisation, zygote is formed in the external medium, whereas in internal fertilisation, zygote is formed inside the body of the organism.
- Further development of zygote depends upon the life cycle and environment.
- Zygote ensures continuity of species between organisms of one generation and the next.
- In algae and fungi, the zygote develops a thick wall to resist dessication and damage.
- In haplontic life cycle, the zygote undergoes reductional division (meiosis) to form a haploid organism.
- In diplontic life cycle, the zygote undergoes mitotic division.

(b) Embryogenesis

- The processes of development of embryo from the zygote is called **embryogenesis**.
- During embryogenesis, zygote undergoes
  (*i*) cell division (mitosis) to increase cell number, and,
  (*ii*) cell differentiation to form specialised tissues and organs.
- Based on whether the zygote develops outside the body of female parent or inside, animals can be classified into **oviparous** and **viviparous**, respectively.

S. No.	Oviparous animals	Viviparous animals
(*i*)	Oviparous animals lay fertilised eggs.	Viviparous animals give birth to young ones.
(*ii*)	The fertilised eggs have calcareous shell and young ones hatch out after a period of incubation.	The fertilised egg (zygote) has no shell and develops into a young one inside the body of the female organism.
(*iii*)	Chances of survival of young one is less as the female lays egg in the environment.	Chances of survival of young one is more because of proper embryonic care and protection inside the mother's body.
(*iv*)	For example, reptiles, birds, etc.	For example, majority of mammals including humans.

- In flowering plants, the zygote is formed inside the ovule, where the zygote develops into an embryo.

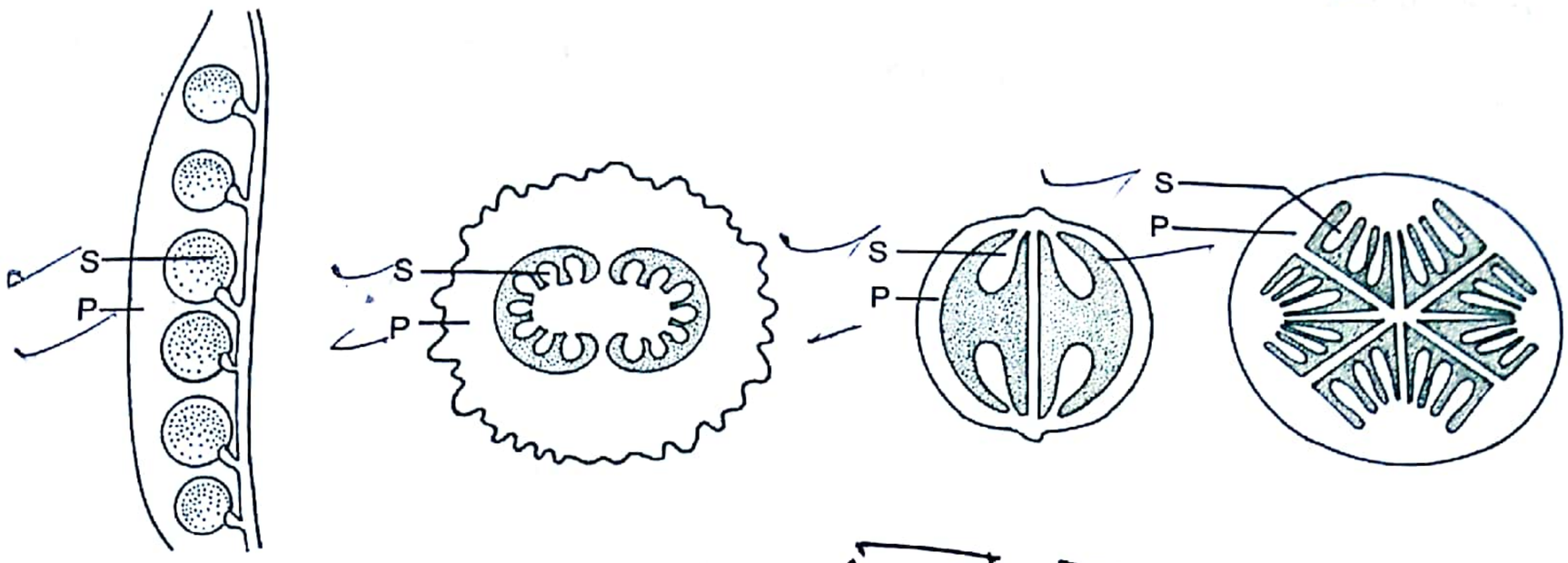


Fig. 1.9 A few kinds of fruit showing seeds (S) and protective pericarp (P)

- The fertilised ovule develops into **seed** and ovary develops into **fruit**.
- The seed after dispersal in favourable condition germinates to produce new plants.
- The outermost protective covering of fruit is called **pericarp** or fruit wall.

NCERT QUESTIONS

Q. 1. Why is reproduction essential for organisms?

Ans. Reproduction is essential

(*i*) for multiplication and maintaining the identity of a species;

(*ii*) to introduce variation among the individuals of a species;

(*iii*) to maintain and to inherit the genetic constitution or genetic make-up.

Q. 2. Which is a better mode of reproduction: sexual or asexual? Why?

Ans. Sexual mode of reproduction is better because it is biparental reproduction and introduces variation among offsprings and their parents (in a population) due to crossing over and recombination during gamete formation by meiosis.

Q. 3. Why is the offspring formed by asexual reproduction referred to as clone?

[CBSE (AI) 2010]

Ans. In asexual reproduction, the offspring is morphologically and genetically identical to the parent and to each other. Hence it is called clone.

Q. 4. Offspring formed due to sexual reproduction have better chances of survival. Why? Is this statement always true?

Ans. Offspring formed due to sexual reproduction have better chances of survival because:

(*i*) the offspring retains its hybrid vigour which may adapt better with the changing environment.

(*ii*) genetic variation is introduced among the offsprings, which increases the range of tolerance or biological tolerance.

(*iii*) sexual reproduction occurs in adverse conditions in lower plant kingdom, so sexual spores survive in adverse conditions.

Sexual reproduction may not always show better chances of survival because the offspring may be inferior to the parents.

2 SEXUAL REPRODUCTION IN FLOWERING PLANTS

BASIC CONCEPTS

1. Flower

- The sexual reproductive part of angiosperms is called **flower**. It develops after the completion of vegetative phase.
- The branch of ornamental horticulture concerned with growing and marketing of ornamental flowers is called **floriculture**.

2. Parts of Flower

- In a flower, four different sets of whorls or floral members are attached to a central axis called **thalamus**.
- The outermost and the first accessory whorl is of sepals and is called **calyx**.
- The second accessory whorl is of petals and is called **corolla**.
- Next to the corolla, is the male reproductive whorl of stamens called **androecium**.
- The female reproductive whorl is of carpels and is called **gynoecium** or **pistil**.

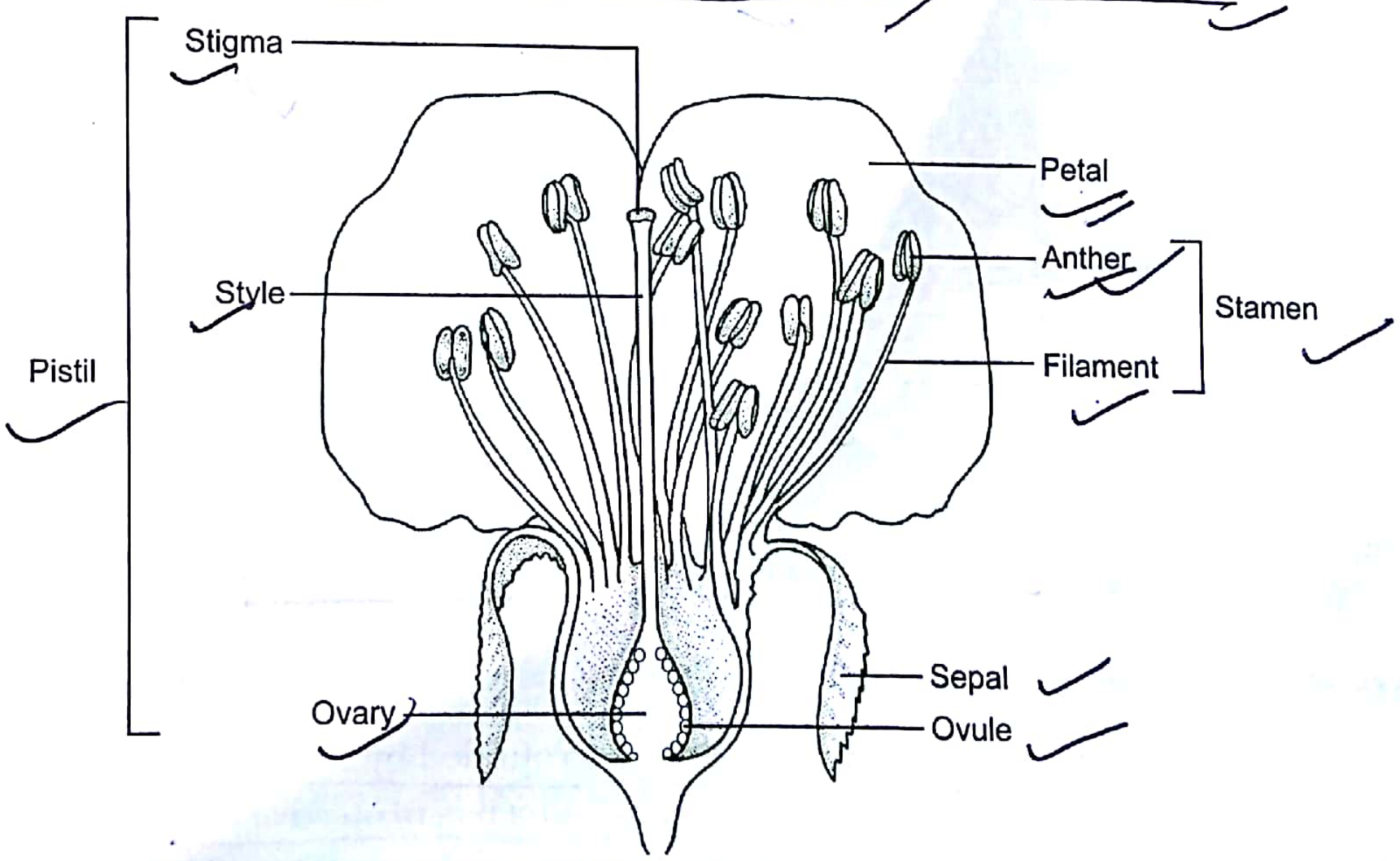


Fig. 2.1 A diagrammatic representation of L.S. of a flower

3. Functions of Floral Members

- **Calyx**
  - (*i*) Its main function is to protect the flower in bud condition. It is smaller than the petals in size.
  - (*ii*) When green, it is photosynthetic in nature.
  - (*iii*) When coloured, it attracts insects for pollination.
- **Corolla**
  - (*i*) It provides colour and scent to attract pollinators.
  - (*ii*) Sometimes the base of corolla bears some secretory glands and secretes nectar.
  - (*iii*) They also provide protection to the plant.
- **Androecium:** Its main function is the production of microspores, *i.e.*, pollen grains containing male gametes within the anther lobe.
- **Gynoecium:** The function of gynoecium is the production of megaspores, fruits and seeds.

4. Male Reproductive Unit

- **Stamen** is the male reproductive unit and consists of the following two parts:
  - (*i*) A long and slender stalk called **filament** which may be joined or free.
  - (*ii*) A bilobed terminal structure called **anther**.

Structure of Anther

- It is composed of two anther sacs or lobes separated by a tissue called connective tissue.
- The anther is bilobed and each lobe or sac consists of two theca separated by a septum.
- The anther is a tetragonal (four-sided) structure, consisting of four microsporangia, two in each of the lobes.
- Microsporangia develop further and get transformed into pollen sacs.

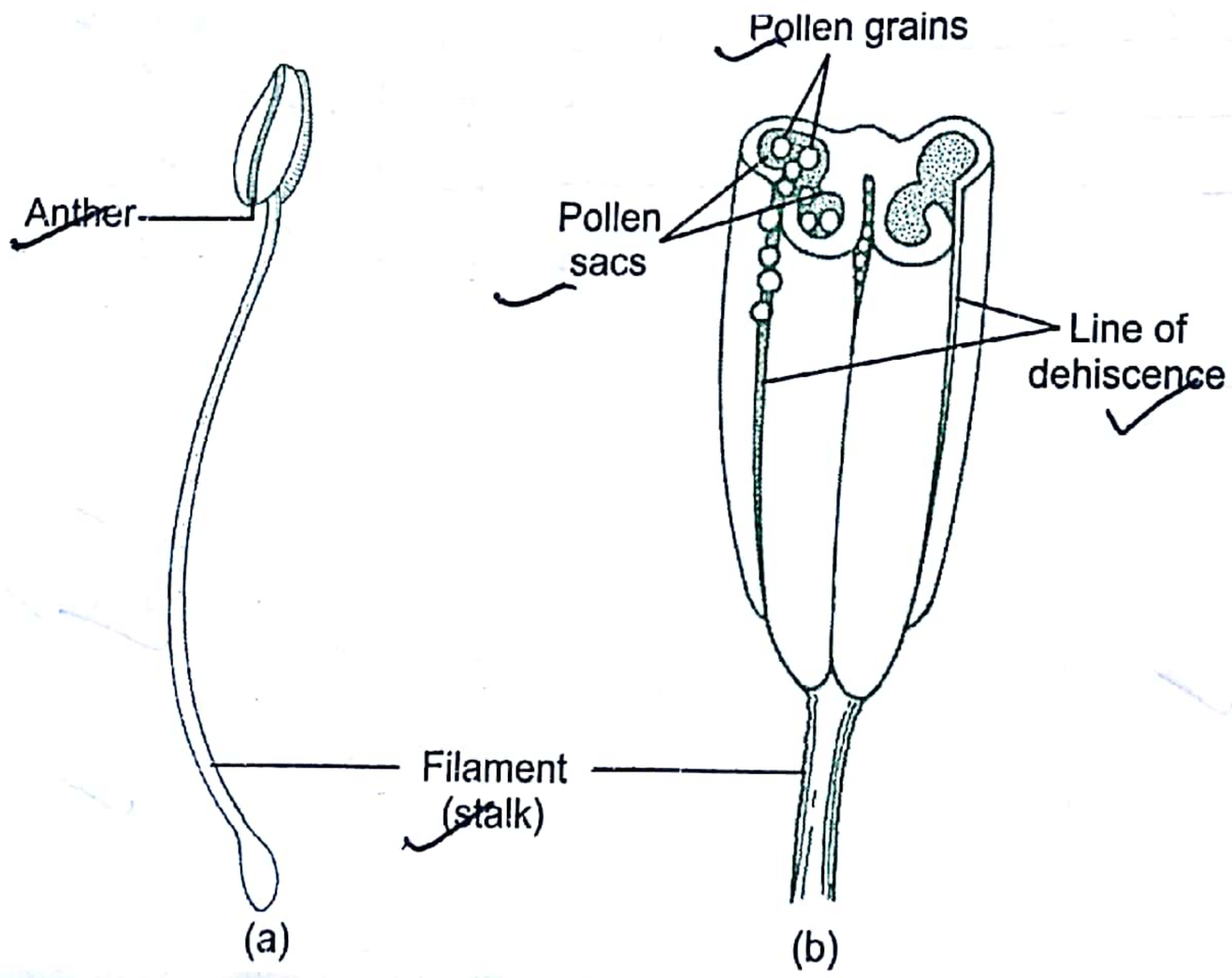


Fig. 2.2 (a) A typical stamen; (b) Transverse section of an anther

Structure of Microsporangium

- A typical microsporangium appears circular and is surrounded by four walls:
  - (*i*) **Epidermis:** It is the outermost single layer of cell which is protective in nature.
  - (*ii*) **Endothecium:** It is the second layer with thick cells, help in dehiscence and is protective in nature.

(*iii*) **Middle layer:** It is the third layer composed of 1–3 layers of cells, help in dehiscence and is protective in nature.

(*iv*) **Tapetum:** It is the fourth and innermost layer of cell with dense cytoplasm and many nuclei. It provides nourishment to the developing pollen grains.

- The centre of each microsporangium is filled with closely arranged similar cells called **sporogenous cells.**
- At maturity, pollen sac is formed by fusion of two microsporangium in each lobe.

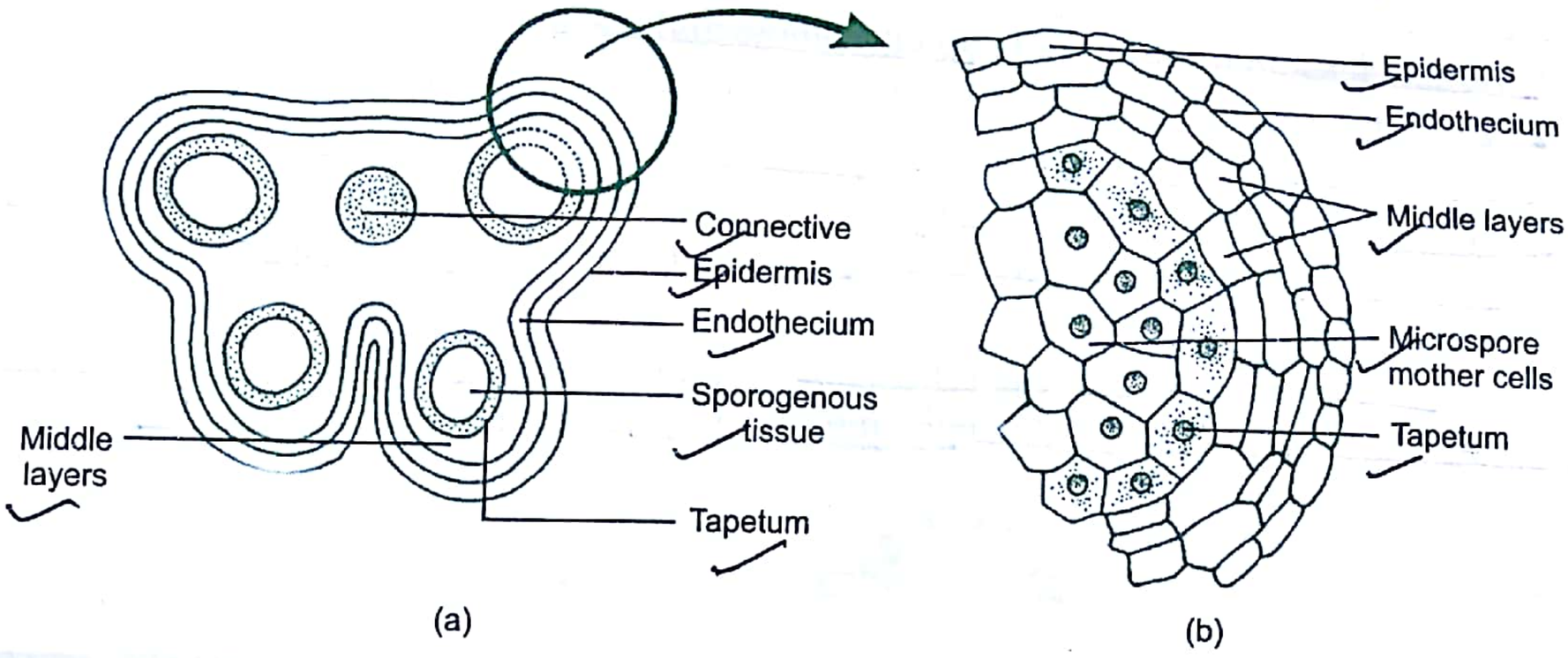


Fig. 2.3 (a) Transverse section of a young anther;
(b) Enlarged view of one microsporangium showing wall layers

Microsporogenesis

- The process of formation of microspore from a pollen mother cell by meiosis is called **microsporogenesis.**

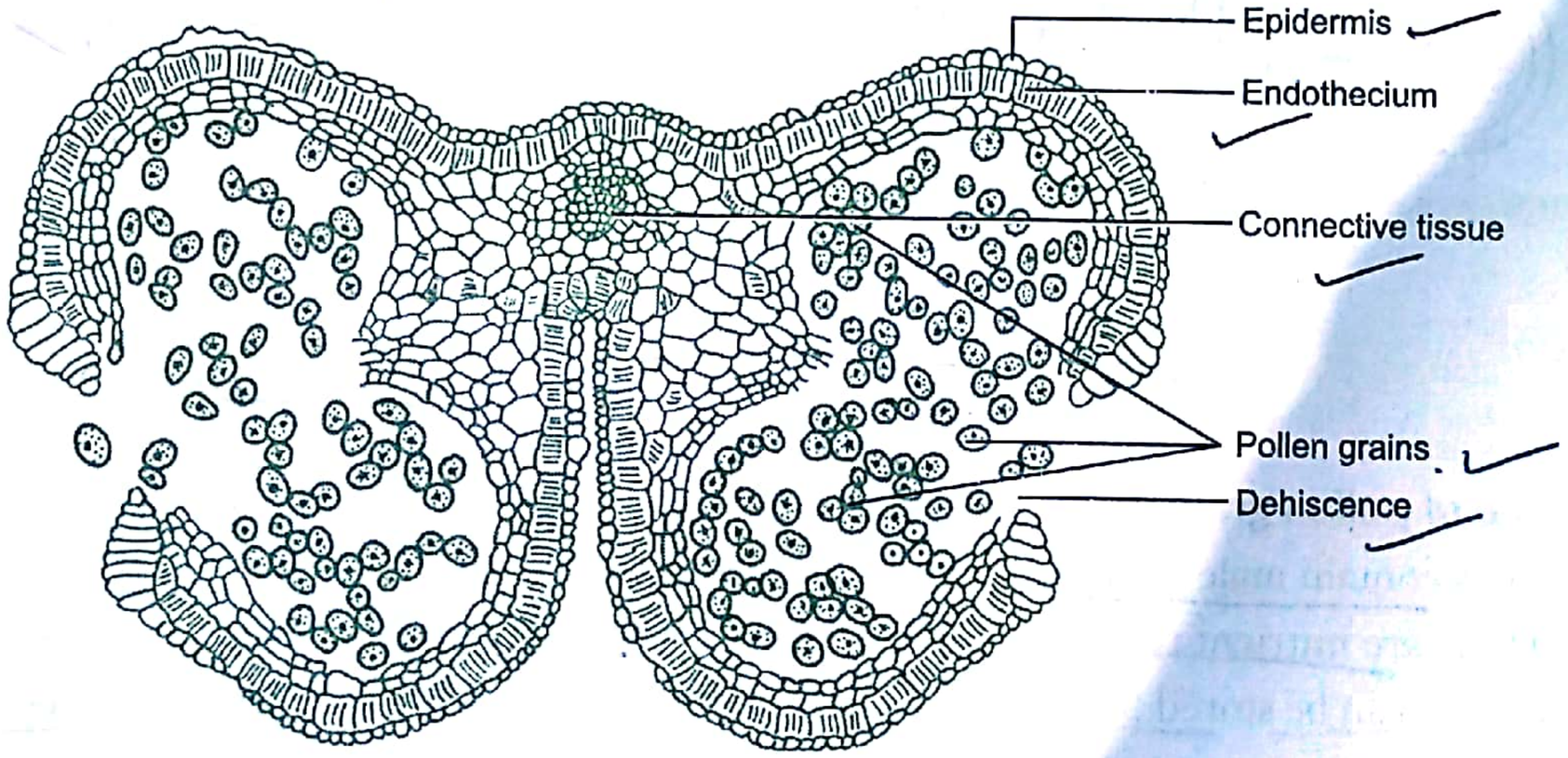


Fig. 2.4 T.S. of mature dehisced anther with pollen grains

- Each cell of the sporogenous tissue in a microsporangium acts as a potential pollen mother cell (PMC) or **microspore mother cell.**
- PMC undergoes meiotic divisions to form cluster of four cells called **microspore tetrad.**
- On maturity, the anther dehydrates and the microspores separate from each other to form pollen grains.

Pollen Grains

- They develop from PMC by meiotic division.
- They represent the male gametophyte.
- Pollen grains are generally spherical in structure.
- They possess two prominent layered walls—outer exine and inner intine.
- The exine is a hard layer made of sporopollenin which is one of the most resistant organic material present in nature.
- The inner thin layer of intine is made up of cellulose and pectin.
- The exine has an aperture where sporopollenin is absent, called **germ pore**.
- The newly differentiated pollen grain has a central nucleus and dense cytoplasm.
- The protoplast mitotically divides into two unequal cells—bigger vegetative cell which is rich in food reserve and smaller spindle-shaped generative cell with dense cytoplasm and a nucleus. This is called **2-celled stage**.
- In majority angiosperms, pollens are released in this 2-celled stage, whereas in other species, the generative cell divides into 2 male gametes and thus pollen is said to be in 3-celled stage.

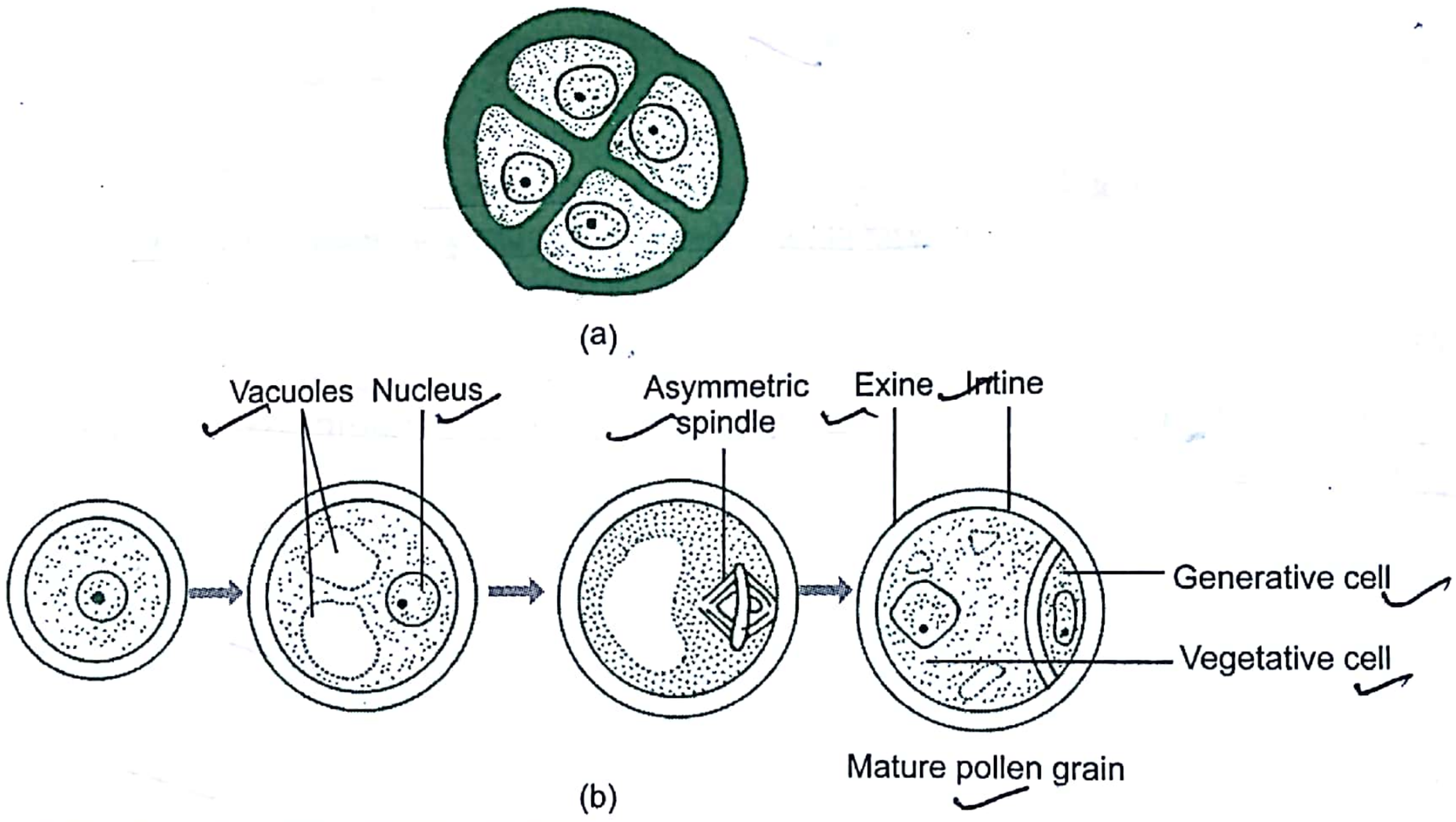


Fig. 2.5 (a) Enlarged view of a pollen grain tetrad;
(b) Stages of a microspore maturing into a pollen grain

Importance of pollen grains

- They contain male gametes for sexual reproduction.
- These are nutrient rich and thus are taken as food supplements.
- Pollens can be stored for years in liquid nitrogen at –196°C, to be used later in crop breeding programmes.

5. Female Reproductive Unit

- The pistil or gynoecium represents the female reproductive unit of a flower.
- The gynoecium may have single pistil (called **monocarpellary**), more than two pistils (called **multicarpellary**), fused pistils (called **syncarpous**) or free pistils (called **apocarpous**).

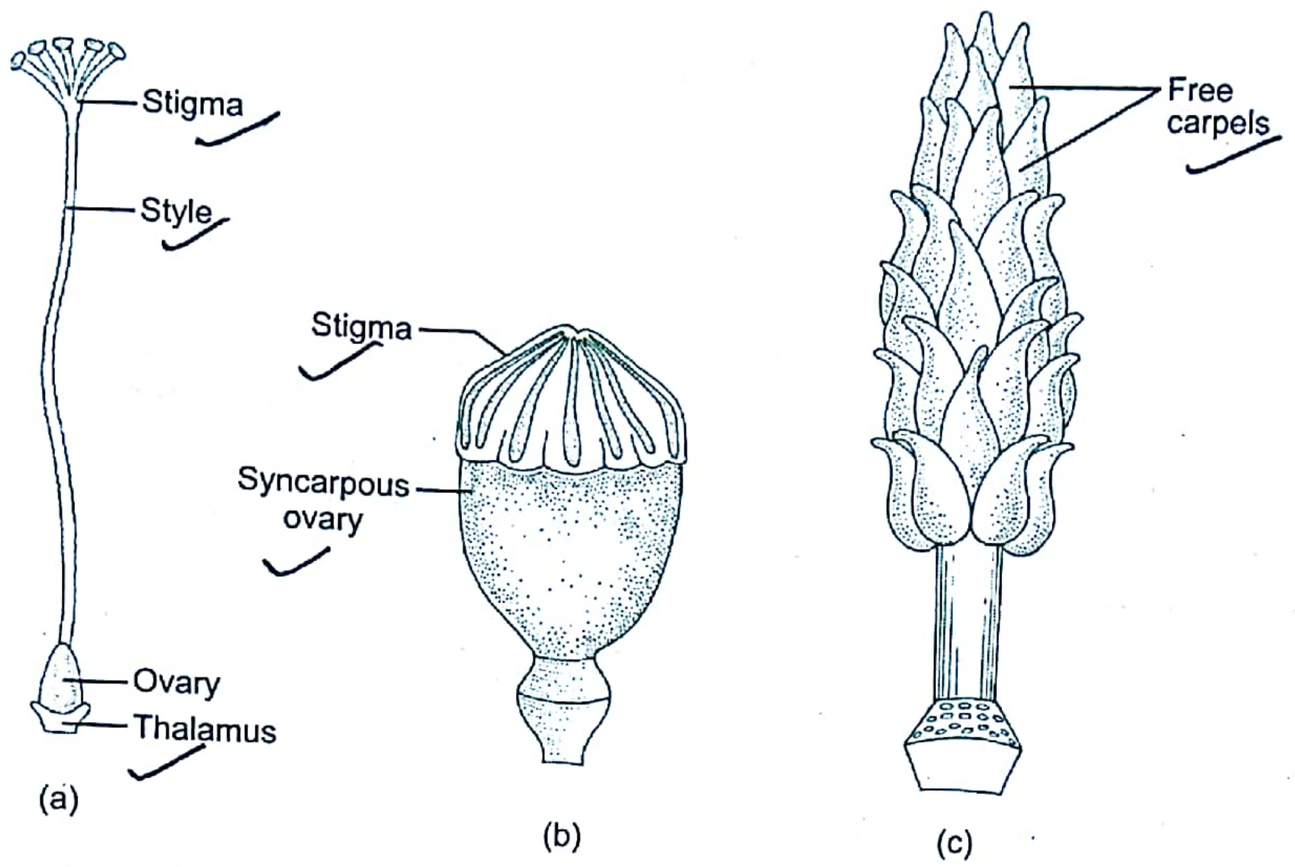


Fig. 2.6 (a) Pistil of *Hibiscus*; (b) Multicarpellary, syncarpous pistil of *Papaver*; (c) A multicarpellary, apocarpous gynoecium of *Michelia*

- A pistil has following three major parts:

S. No.	Parts	Functions
(i)	**Stigma**	It receives the pollen grains. It has sticky surface and pollen grains get stuck to it during pollination.
(ii)	**Style**	It is an elongated slender part beneath the stigma, that connects the stigma with ovary. It holds the stigma to receive the pollen grains. It is through the style that the pollen tube grows and reaches the ovule.
(iii)	**Ovary**	It is the basal swollen part of pistil that contains ovules and eggs.

- Inside the ovary there is a compartment called ovarian cavity or locule separated by septum.
- Placenta is the tissue in ovarian cavity from where ovule or **megasporangium** arise.

Structure of Megasporangium (Ovule)

- The ovule is stalked and is attached to the placenta by means of a stalk called **funicle**.
- The junction between an ovule and a funicle is called **hilum**. Sometimes, the funicle extends beyond the hilum to form a ridge called **raphae**.

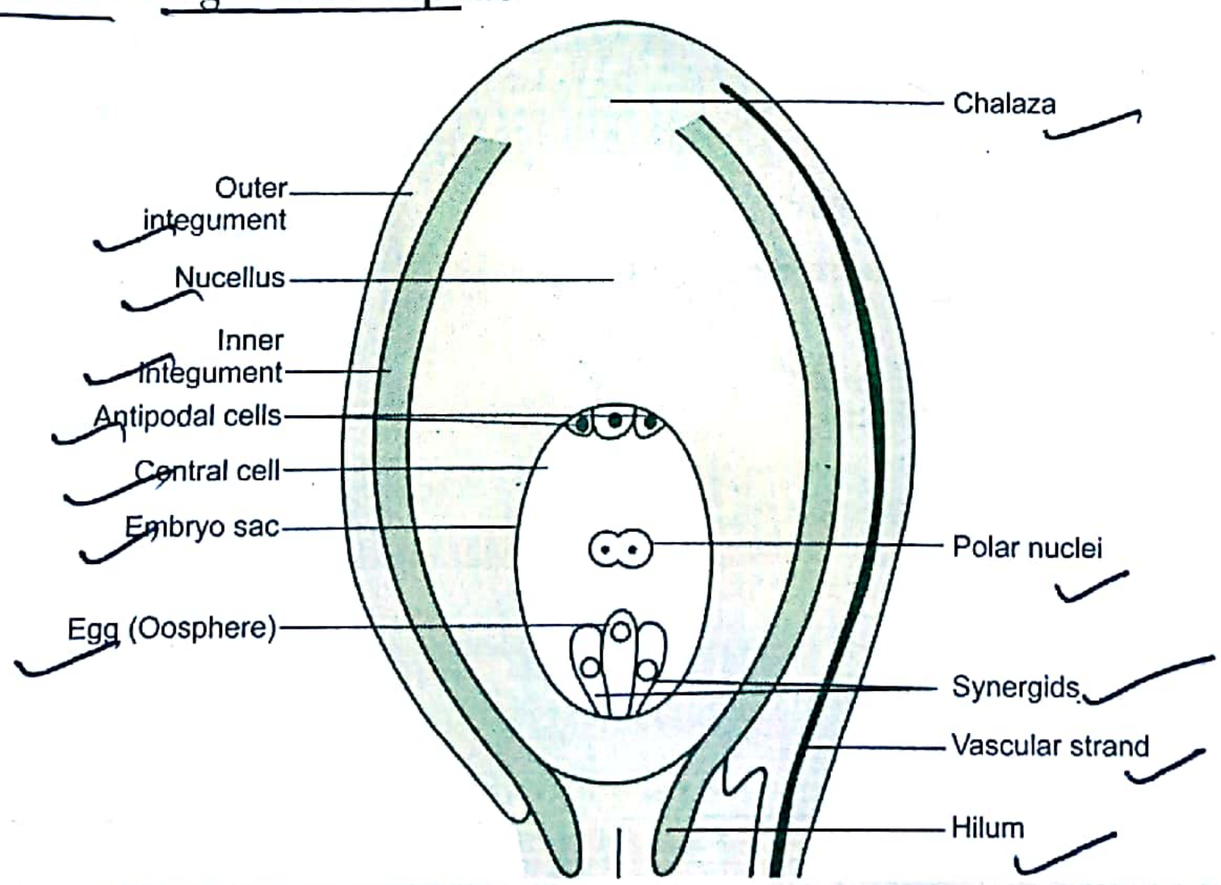


Fig. 2.7 A diagrammatic view of a typical anatropous ovule

- The ovule is surrounded by one or two protective multicellular **integuments.**
- Integument encircles the ovule entirely except at the tip, resulting in a small opening called **micropyle.**
- The basal part of an ovule opposite to micropyle is called **chalaza.**
- The cells with high or abundant reserve food material enclosed within integument is called **nucellus.**
- The female gametophyte located within the nucellus is called an **embryo sac.**

Megasporogenesis

- The process of formation of haploid megaspores from the diploid megaspore mother cell (MMC) is called **megasporogenesis.**
- In the micropylar region, the nucellus contains cells with dense cytoplasm and prominent nucleus which is differentiated into a single megaspore mother cell (MMC).
- Megaspore mother cell is diploid and undergoes meiosis.
- MMC first divides transversely into two cells called **dyad.**
- These two cells again divide transversely, as a result a linear row of four haploid cells is produced which is called **megaspore tetrad** or **linear tetrad.**
- Out of these four megaspores, only one remains functional while the other three degenerate.
- The one functional megaspore develops into the female gametophyte or **embryo sac.** This is called **monosporic development.**

Megagametogenesis

- The formation of female gametophyte (embryo sac) is called **megagametogenesis.**

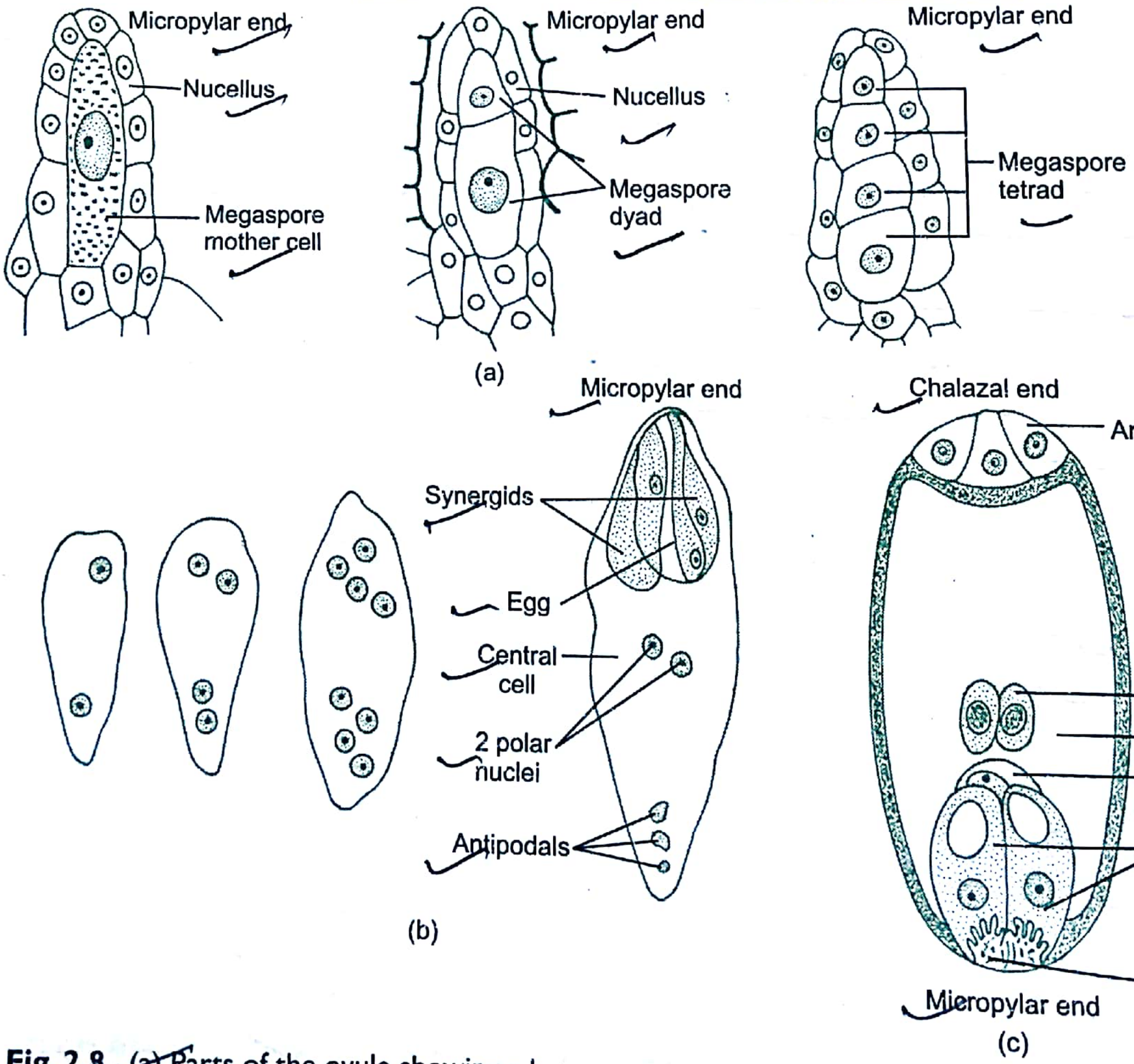


Fig. 2.8 (a) Parts of the ovule showing a large megaspore mother cell, a dyad and a tetrad of megaspores; (b) 2, 4 and 8-nucleate stages of embryo sac and a mature embryo sac; (c) A diagrammatic representation of the mature embryo sac

(*i*) Megaspore is the first cell of the female gametophyte.

(*ii*) The megaspore increases in size and its nucleus divides mitotically into two nuclei which move apart to opposite poles. Thus, a 2-nucleate embryo sac is formed.

(*iii*) The two daughter nuclei undergo another mitotic division giving rise to the 4-nucleate stage.

(*iv*) The third mitotic division gives rise to 8-nucleate 7-celled embryo sac.

(*v*) The central cell contains 2 nuclei known as polar nuclei.

(*vi*) The three nuclei at the micropylar region form the egg apparatus.

(*vii*) In the egg apparatus, the middle cell is the largest and is called **oosphere/egg/ovum**, while other two naked cells adjoining the egg cell are called **synergids**.

(*viii*) The three nuclei at the chalazal end are surrounded by cytoplasm and cellular wall. These are called **antipodal cells**.

(*ix*) The above mentioned method of female gametophyte formation is known as normal **8-nucleate type**, because 8 nuclei contribute in the formation of gametophyte. It is very common among angiosperms.

6. Pollination

- The transfer of pollen grains from anther and their deposition over stigma of the pistil is termed as **pollination**. Depending upon sources of pollen grains, pollination is of three types.

Pollination

(i) Autogamy	(ii) Geitonogamy	(iii) Xenogamy/Allogamy
The transfer of pollen grains is from anther to stigma of the same flower, *e.g.*, pea, rice, wheat, etc. It is self-pollination.	The transfer of pollen grains is from anther of one flower to the stigma of another flower of same plant, *e.g.*, *Cucurbita*.	The transfer of pollen grains is from anther of one flower to stigma of another flower of different plant, *e.g.*, papaya, maize.

Contrivances or Devices for Self-pollination (Autogamy)

- Cross-pollination can be prevented by exhibiting

(*i*) **Cleistogamous flowers:** These are bisexual closed flowers which never open and the anthers dehisce inside these closed flowers, *e.g.*, *Commelina*.

(*ii*) **Homogamy:** It is the condition of the maturity of anther and stigma at the same time, *e.g.*, *Catharanthus* (*Vinca*).

(*iii*) Close association between anther and stigma, *e.g.*, *Mirabilis*.

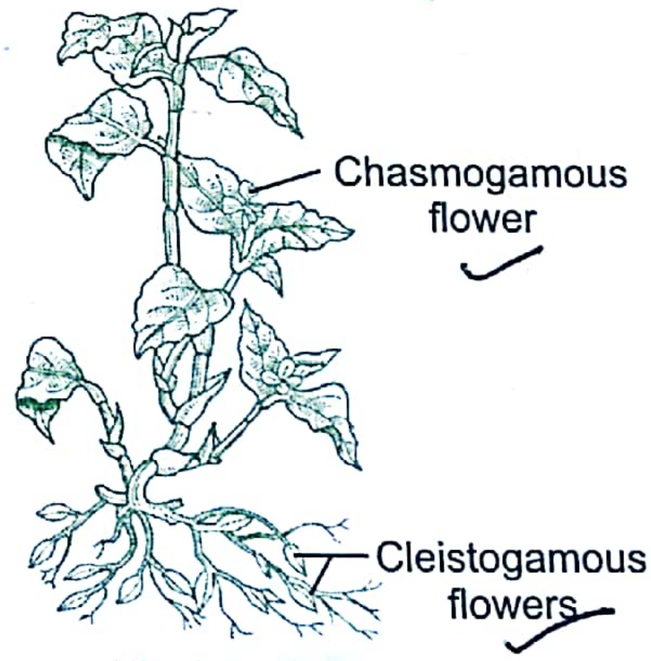


Fig. 2.9 Chasmogamous and cleistogamous flowers

Contrivances or Devices for Cross-pollination (Xenogamy/Allogamy)

- Self-pollination can be prevented by exhibiting

(*i*) **Unisexuality:** Male and female flowers are present on different plants.

(*ii*) **Dichogamy:** The condition in which the stamens and stigma of a bisexual flower mature at different times.

(*iii*) **Protandry:** This is the condition where anthers mature earlier than the stigma and release pollens.

(*iv*) **Protogyny:** This is the condition where the stigma matures earlier than the anther.

(*v*) **Self-sterility or self-incompatibility:** It is a genetic mechanism that prevents self-pollination.

(*vi*) **Chasmogamous flowers:** These are open flowers with exposed stamens and stigma which facilitate cross-pollination.

- The form of pollination in which wind distributes the pollens is called **anemophily**.
- Pollen grains are light in weight, non-sticky, dry and winged.
- Stamens are well-exposed for easy dispersal of pollen grains in the wind.
- The stigma is sticky, large and feathery to trap pollen grains floating in the air.
- Numerous flowers are packed together to form inflorescence.

Adaptation for Insect Pollination/Entomophily

- The form of pollination in which insects distribute pollens is called **entomophily**.
- Flowers are large, sticky and brightly coloured.
- They have honey and nectar glands, which are highly fragrant to attract insects.
- The pollen grain surface is sticky due to exine layer and stigma is sticky due to mucilaginous secretion.
- The flowers offer floral rewards like nectar and pollen grains for pollination to insects.
- In some species, floral rewards provide safe place to lay eggs, *e.g.*, *Amorphophallus*.
- The flower sometimes secrete foul odour to attract insects like flies and beetles.

7. Pollen – Pistil Interaction

- All the events from pollen deposition on the stigma until the entry of the pollen tubes into the ovule are together called **pollen–pistil interactions**.
- It is a dynamic process involving pollen recognition by stigma/pistil for compatible pollen.
- Incompatible pollens or sterile pollens are rejected by the pistil and do not allow growth of pollen tube.
- Compatible pollens are encouraged by pistil for growth and development of pollen tubes.
- The pollen tube grows through stigma and style to reach the ovary.
- It then enters the ovule through micropyle and reaches the synergids, guided by filiform apparatus.

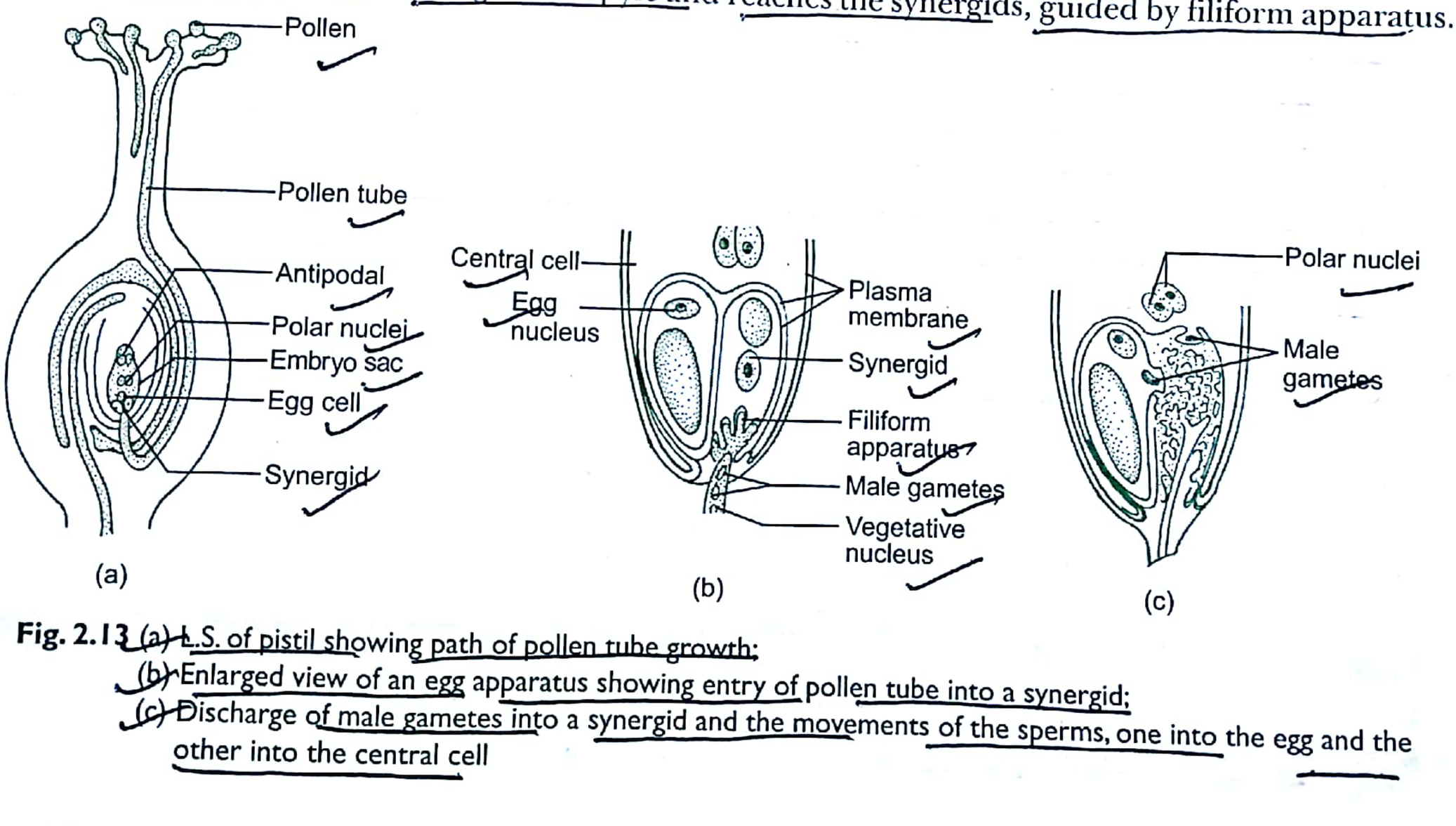


Fig. 2.13 (a) L.S. of pistil showing path of pollen tube growth;
(b) Enlarged view of an egg apparatus showing entry of pollen tube into a synergid;
(c) Discharge of male gametes into a synergid and the movements of the sperms, one into the egg and the other into the central cell

8. Artificial Hybridisation

- Commonly used technique in plant breeding programmes to obtain desirable characters.
- Anthers are removed from the bisexual flowers using forceps. This is **emasculation** and is done before the anther dehisces.
- The emasculated flower is covered with a paper bag to prevent contamination from unwanted pollens. This is called **bagging**.