SECTION

4

REPRODUCTION IN PLANTS AND HUMANS

PROCESSES FOR LIVING

Essentials for survival

INTRODUCTION

This section explores the fascinating world of reproduction in both plants and humans. We will begin by examining the key parts of flowering plants and how they contribute to plant reproduction, including the differences between sexual and asexual reproduction and how seeds are dispersed. We'll then trace the life cycle of a flowering plant. Moving on to humans, we will identify the main parts of the male and female reproductive systems, describe the process of sexual reproduction, explain the menstrual cycle, and analyse its significance in human reproduction, including the role of hormones.

At the end of this section, you will be able to:

- Explain reproduction in plants
- Reproduction in animals
- Explain the female menstrual cycle and show how that can be used to address reproduction-related issues

KEY IDEAS:

- **Reproduction** is the process by which living organisms give rise to younger ones of their own kind. There are two types of reproduction: Sexual and Asexual.
- A flower is the reproductive structure of a flowering plant. The flower typically consists of four main parts, each of which plays its own role in reproduction.
- A **seed** is the mature ovule that contains the embryo, a food storage tissue called the endosperm, and a protective seed coat.
- **Fruits** develop from the ovary and surround and protect the seed(s).
- **Seed Dispersal:** The scattering of seed away from the parent plant. There are many methods of seed dispersal.

- Humans reproduce sexually, meaning that both male and female sex cells are involved in the production of offspring.
- **The Menstrual Cycle** refers to a natural monthly phenomenon experienced by women of reproductive age. This happens when an unfertilised egg is released from the ovaries and is discharged through the vagina as blood and mucus.

REPRODUCTION IN PLANTS

Today we're going to explore the fascinating topic of plant reproduction. Have you ever wondered how flowers are able to create new plants? It's a complex but beautiful process that we're going to dive into together.

Activity 4.1: What is reproduction?

Research and fill in the blanks below.

Learners, reproduction can take place in _____ or in humans/animals. Reproduction in plants is a fundamental biological process that allows plants to propagate and ensure the _____ of their species. Through these mechanisms, plants can produce _____, disperse their genetic material, and colonise new habitats.

There are two types of reproduction: _____ ***reproduction*** and _____ ***reproduction***.

Sexual Reproduction

Learners, just as we have a male and female coming together to reproduce, in plants sexual reproduction also involves a male and a female part coming together to reproduce offspring. Sexual reproduction in plants is, therefore, the process by which a male sex cell fuses with a female sex cell to form a zygote. These specialised reproductive cells are called gametes, which are involved in the fusion of genetic material. The key processes involved in sexual reproduction in plants are **pollination, fertilisation, seed production** and **dispersal, germination,** and subsequent **growth.**

In flowering plants, male and female reproductive structures can often be found in the same individual plant. The main organ of sexual reproduction is the **flower**. Let's take a closer look at the main components of a flower.

Activity 4.2

Using some real flower specimens (possibly gathered on a nature walk), such as ***hibiscus, bougainvillea, pride of Barbados and flamboyant***, perform a plant dissection. If you have time, you should compare the structure of one type of flower with another. Use the diagram below to identify the different parts of the flower, then use online resources (or any others that your teacher has provided) to research the function of the parts specified in Table 1.

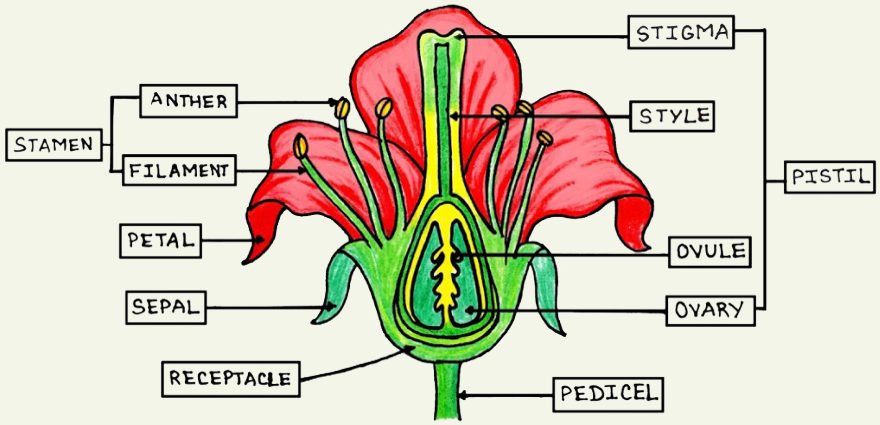


Fig. 4.1: Parts of a flower

Table 4.1

Part	Structure	Function
Sepals		
Petals		
Stamens		
Stigma		
Ovary		

So how do the pollen and ovules come together to create new seeds and offspring? This process is called pollination.

Pollination

When pollinators visit the flower to feed on its nectar, they inadvertently pick up pollen on their bodies. As they fly from bloom to bloom, they transfer this pollen to the receptive stigmas.

Once the pollen lands on the stigma, it grows a tiny tube that extends down through the style and into the ovary. The sperm cells within the pollen then fuse with the egg cells in the ovules, fertilising them. This fertilisation process forms seeds, which contain embryos that can germinate and grow into new plants.

Activity 4.3

Draw a diagram or storyboard showing the stages of sexual reproduction in plants. Research and discuss the descriptions and explanations that should be added to each stage of the diagram; **pollination, fertilisation, seed production** and **dispersal, germination,** and subsequent **growth.**

Agents of Pollination

Pollination requires some agents or vectors to help transfer pollen from one flower to another. The agents can be:

1. Insects (and other invertebrates)
2. Wind
3. Animals (bats, birds, mammals, birds, reptiles)
4. Water

Fig 4.2: Agents of pollination

NB: Insects and wind are the major agents of pollination.

Table 4.2: Characteristics/Adaptations of Insect and Wind-Pollinated Flowers Compared.

Insect-pollinated flowers	Wind pollinated flowers
Petals are brightly coloured to attract insects	Petals, if present, are dull in colour
Flowers are scented	Flowers are not scented
Have sticky stigma	Have feathery stigma
Have short and stout filaments	Have long filaments
Produces less pollen grains	Produce abundant pollen grains

See **Annex 4.2 – Further Information** for more detail on the advantages of wind and insect pollinators

Activity 4.4: Pollination Simulation Processes

Aim: To investigate the processes of pollination and the role of different pollination agents in the transfer of pollen grains

Materials needed:

- Mobile phone or other recording devices
- Flower models or dissected flowers
- Pens, pencils and paper
- Pollinator models (e.g. bee, butterfly and hummingbird)

Procedure:

1. Watch this video on pollination and discuss the key points before you start the activity below.

   Pollination Explained (youtube.com)

2. In groups of 3-4 people, produce a short video demonstrating the process of a) wind pollination and b) insect pollination using 3D models or drawings to aid visualisation. You should speak over the video to describe what is happening during each step of the process.
3. If you are unable to create a video, you should instead act out the scenarios.
4. Present your video or play to the rest of the class.

5. Offer constructive feedback to your peers once you have seen their video or play.

Fertilisation

Dear learners, let us now discuss in detail what fertilisation is. Fertilisation is the fusion of the nucleus of a male gamete with the nucleus of a female gamete to form a zygote. Fertilisation takes place in the ovule, which contains the female gamete - the ovum. Ovules are found inside the ovary. Each ovule contains an egg. When a mature pollen grain lands on a mature stigma, it absorbs water and nutrients from the stigma and swells up. The wall of the pollen grain ruptures, and a pollen tube protrudes which penetrates the stigma and grows through its tissues into the style. This is the germination of the pollen grain. The pollen tube nucleus moves to the tip of the pollen tube. The pollen tube enters the ovule through the area called the micropyle. The pollen grain travels to the egg and fuses with it resulting in fertilisation. The fertilisation results in zygote formation which later develops into a seed. Following fertilisation, the zygote starts to divide, and it eventually turns into an embryo within the seed. The embryo is kept latent in a seed capsule until the right environmental factors allow it to germinate and grow into a new plant.

Following fertilisation, the ovary swells and forms the fruit. The role of fruit is in seed dispersal. Fruit can be considered the mobile stage in a plant's life cycle. Some fruits are carried by the wind, others are explosive and fire seeds far from the mother plant, others are attractive to animals are eaten and the indigestible seeds are transported and deposited in animal faeces, other fruits are sticky and transported after sticking to the animal's fur.

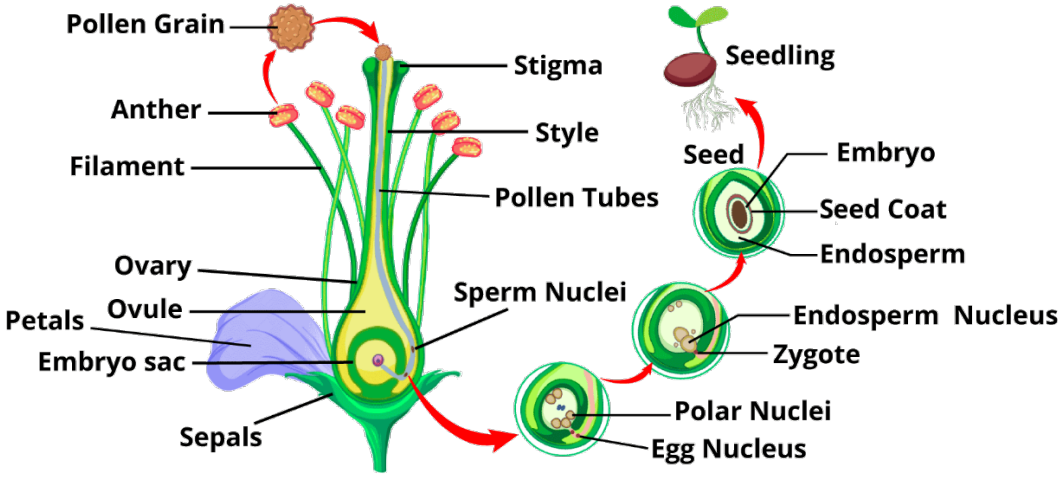


Fig.4.3: Fertilisation in Plants

Activity 4.5

Follow the QR code below to watch a video of an experiment that can be done in the lab to observe pollen germination.

Conclusion:

The experiment has demonstrated the intricate process of fertilisation in flowering plants, where the transfer of pollen, the growth of pollen tubes, and the eventual fusion of male and female reproductive cells lead to the formation of seeds, a crucial step in the plant's life cycle. Understanding this process is essential for appreciating the remarkable adaptations and strategies employed by flowering plants to ensure their successful reproduction and propagation.

Activity 4.6: Comparing the Costs and Constraints of Sexual vs. Asexual Reproduction in Plants.

Note: *this is a long-term experiment which should take place over several weeks.*

Aim: To investigate the key disadvantages that plants face when relying on sexual reproduction, compared to asexual reproduction strategies.

Materials needed:

- Seeds or seedlings of two plant species, one that reproduces primarily sexually (bean seed) and one that reproduces asexually (cassava sticks)
- Potting soil and containers for growing the plants
- Measuring tools (e.g. ruler, scale, and stopwatch)
- Access to pollinators (e.g. beehive, butterfly enclosure) or ability to manually pollinate
- Notebook and pen/pencil for observations

Procedure:

1. Plant the seeds/seedlings of the sexually reproducing and asexually reproducing plant species in separate containers with the same soil and growing conditions.
2. For the sexually reproducing plant introduce pollinators or manually pollinate to facilitate seed production.
3. Extension: Simulate environmental stresses, like nutrient deprivation or rapid climate changes, to observe how each species responds.
4. Monitor the growth, resource allocation, and reproductive output of each species over time, keeping notes in your notebook.
5. Write a conclusion including comments about the advantages and disadvantages of being a sexual or asexual reproducer (cost, time commitment and dependence on external factors are all important considerations).

Asexual Reproduction

Asexual reproduction is the mode of reproduction that does not involve the fusion of male and female gametes and produces individuals genetically identical to the parent. Asexual plant reproduction occurs through many modes including suckers, runners, bulbs, tubers, and layering. No flowers are required for this method. Asexual reproduction in plants is often termed vegetative propagation and can take place **naturally** or **artificially**.

Natural Asexual or Vegetative Reproduction

This method of propagation enables plants to reproduce without the need for seeds or the involvement of external agents like pollinators. Instead, new individuals are generated from specialised plant parts such as roots, stems, bulbs, or leaves.

Table 4.3: Natural Methods of Asexual Reproduction

Method	Description
Runners and Stolon	Some plants grow horizontal stems called runners or stolon along the ground. At different points on these stems, new plants can grow from the nodes, forming clones of the parent plant. Examples include strawberries and spider plants.

Method	Description
Rhizomes	Rhizomes are underground stems that spread horizontally and produce new shoots and roots at the nodes. Plants like ginger and bamboo use rhizomes to grow and spread over large areas.
Bulbs and Tubers	Certain plants store nutrients in underground structures called bulbs (like onions) or tubers (like potatoes). These structures can sprout and grow into new plants.
Fragmentation	If a part of the plant breaks off, it can sometimes grow into a completely new individual. For example, pieces of succulents like aloe vera or jade plants can develop roots and shoots when placed in the right conditions.
Roots	Some plants can produce new plants from modified roots called tubers. An example is the sweet potato.
Leaves	In some plants, small new plants called plantlets can grow from the edges of detached leaves, like in the *Bryophyllum* plant.

Artificial Propagation

Artificial propagation refers to the deliberate human intervention in the reproductive processes of plants and animals to produce offspring under controlled conditions. These methods are employed in various fields such as agriculture, aquaculture, and horticulture.

Artificial propagation allows people to grow more of the plants they want, often faster and more reliably than waiting for natural reproduction. This is important in agriculture to produce food crops, in gardening to grow ornamental plants, and in other fields where specific plants are needed.

Artificial Propagation Methods

In the following section, you will learn about various methods by which humans can artificially propagate plants and will perform experiments to replicate these. The main mechanisms are:

1. Cuttings
2. Grafting
3. Layering

4. Micropropagation

Activity 4.7

Research the terms listed above and give a brief summary of the processes involved.

Activity 4.8: Vegetative Propagation of Plants through Cuttings

Watch the following short videos on cuttings and perform the activity below:

1. (241) Asexual Reproduction | Vegetative Propagation : Cutting - YouTube
2. How to Propagate plant cutting ,Grow more trees by vegetative propagation (youtube.com)

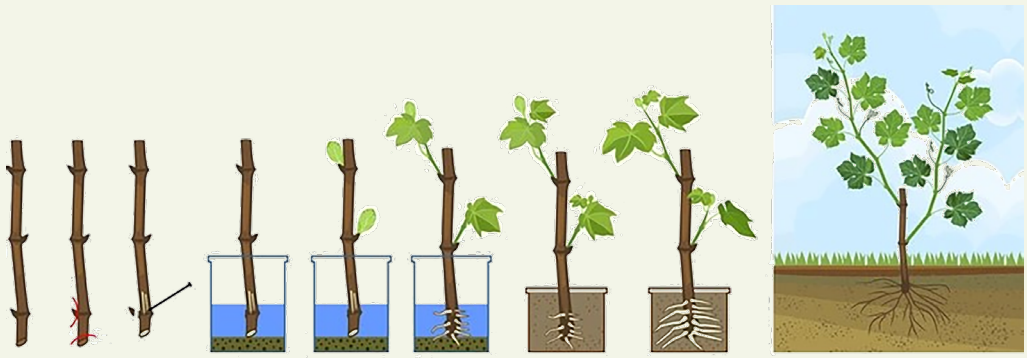


Fig 3.4: Cutting Method

Aim: To investigate the process of vegetative propagation in plants using stem cuttings and to observe the factors that influence the success of this asexual reproduction method.

Materials needed:

- Healthy, mature parent plant (donor plant) of the species to be propagated
- Sharp, clean scissors or pruners
- Potting mix or rooting medium (e.g., perlite, vermiculite, or a combination)
- Small pots or containers with drainage holes
- Rooting hormone powder (optional)
- Clear plastic bag or propagation dome (optional)
- Water spray bottle
- Labels and markers

Procedure:

1. Select a healthy, disease-free parent plant and identify the appropriate stem sections for taking cuttings.
2. Cut 4-6-inch stem segments, making a clean, diagonal cut just below a leaf node.
3. Remove the lower leaves, leaving only the top 2-3 leaves on the cutting.
4. Dip the cut end of the cutting in rooting hormone powder (optional).
5. Plant the cuttings in the prepared potting mix or rooting medium, ensuring the leaf node is buried.
6. Water the cuttings gently and place them in a warm, shaded location.
7. (Optional) Cover the cuttings with a clear plastic bag or propagation dome to maintain high humidity.
8. Monitor the cuttings regularly, keeping the soil moist but not waterlogged.
9. Observe for the development of new roots and shoots over the next few weeks, noting your findings with regards to:
    a. Rooting success rate of the cuttings
    b. Time taken for the development of new roots and shoots
    c. Differences in rooting and growth between cuttings treated with and without rooting hormone
    d. Variations in rooting and growth among different stem positions or plant species
    e. Challenges or issues encountered, such as fungal infections or drying out of the cuttings

Activity 4.9:Vegetative Propagation of Plants through Grafting

Learners, let us watch the video below on grafting:

(241) What is Grafting? l Artificial Propagation (Animation) - YouTube

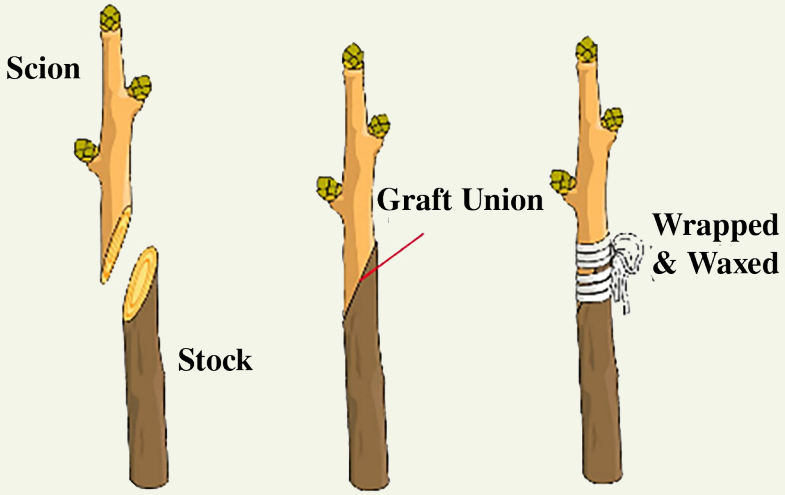


Fig. 4.5: Diagram showing whip/tongue slanted-grafting

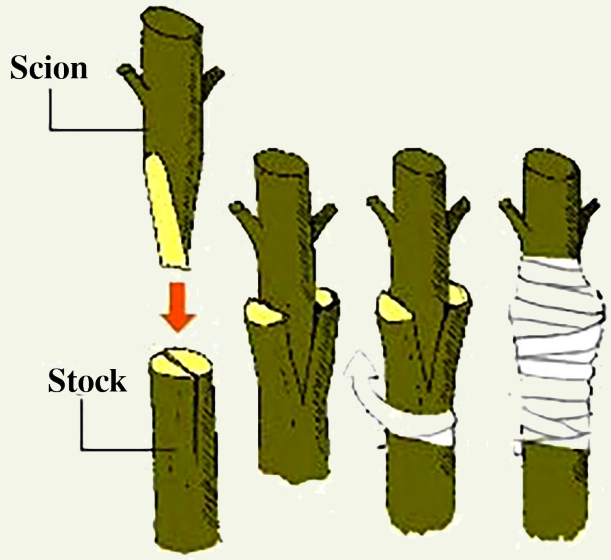


Fig. 4.6: Diagram showing Cleft/V-Shaped grafting

Aim: To investigate the process of vegetative propagation in plants using the grafting technique and to observe the factors that influence the success of this asexual reproduction method.

Materials needed:

- Two compatible plant species or cultivars (one as the rootstock and one as the scion)

- Sharp, clean grafting knife or razor blade
- Grafting tape or parafilm
- Grafting wax or sealant (optional)
- Potting mix or growing medium
- Pots or containers with drainage holes
- Labels and markers

Procedure:

1. Select a healthy, vigorous rootstock plant and a scion (the upper part of the plant to be grafted) from the desired cultivar or species.
2. Prepare the rootstock by making a clean, horizontal cut across the stem, leaving a smooth surface.
3. Prepare the scion by making a clean, sloping cut at the base, creating a wedge-shaped end.
4. Carefully align the cambium layers (the thin, living tissue just under the bark) of the rootstock and scion, ensuring a tight fit.
5. Wrap the graft union securely with grafting tape or parafilm, leaving the tip of the scion exposed.
6. (Optional) Apply a thin layer of grafting wax or sealant over the graft union to protect it.
7. Plant the grafted plant in the potting mix or growing medium, ensuring the graft union is slightly above the soil level.
8. Place the grafted plant in a warm, shaded location and maintain consistent soil moisture.
9. Monitor the graft union regularly for signs of successful union, such as new growth from the scion. Note your findings with regards to:
   a. The time taken for the scion (the upper part of the plant being grafted) to start growing and integrate with the rootstock.
   b. Differences in the graft union success between various plant species or cultivars that were used in the experiment.
   c. Challenges or issues encountered during the grafting process, such as the rejection of the scion or the development of disease problems.
10. After several weeks, gradually expose the plant to more light as the graft union strengthens.

Learners, let us now delve into layering and see how it is operated.

Activity 4.10

Let us watch the video below, discuss the content and perform the activity below.

(241) Science Grade 10 English medium Layering plant propagation - YouTube

Fig 4.7: Layering

Aim: To investigate the process of vegetative propagation in plants using the layering technique and to observe the factors that influence the success of this asexual reproduction method.

Materials needed:

- Healthy, mature parent plant with flexible, low-growing stems
- Sharp pruners or scissors
- Rooting hormone powder (optional)
- Potting mix or growing medium
- Small pots or containers with drainage holes
- Rocks or pebbles
- Rooting medium (e.g., perlite, vermiculite, or a mixture)
- Wooden or plastic stakes
- Twine or plant ties
- Water spray bottle

- Labels and markers

Procedure:

1. Identify a healthy, flexible stem on the parent plant that can be bent down and partially buried in the soil.
2. Prepare the layering site by clearing away any debris or weeds and loosening the soil.
3. Make a shallow wound or cut on the underside of the stem where it will be in contact with the soil.
4. (Optional) Apply rooting hormone powder to the wounded area.
5. Gently bend the stem and bury the wounded portion in the soil, securing it in place with a stake or weight.
6. Cover the buried portion of the stem with a rooting medium, such as a mixture of perlite and potting mix.
7. Water the layered stem gently and keep the soil moist but not waterlogged.
8. Monitor the layered stem for the development of new roots over the next few weeks.
9. Once the new roots have formed, carefully sever the layered stem from the parent plant and transplant it into a separate pot or container.
10. Make and note observations regarding:

a. The rooting success rate of the layered stems.

b. The time taken for the development of new roots on the layered stems.

c. Differences in the rooting and growth patterns between the layered stems that were treated with rooting hormone and those that were not.

d. Variations in the rooting and growth characteristics among different plant species or cultivars that were subjected to the layering process.

e. Challenges or issues encountered during the experiment, such as stem damage or drying out of the layered portion.

Dear learners, the next and last method of artificial propagation for this week is Micropropagation, also known as Tissue Culture.

Activity 4.11

The following videos will help you to understand what micropropagation is.

1. Tissue Culture (youtube.com)
2. (241) Tissue Culture - YouTube

The following experiment will be performed in the school laboratory, where possible. If you lack access to the appropriate facilities, you should watch the videos above with more care and summarise the information presented in your own words.

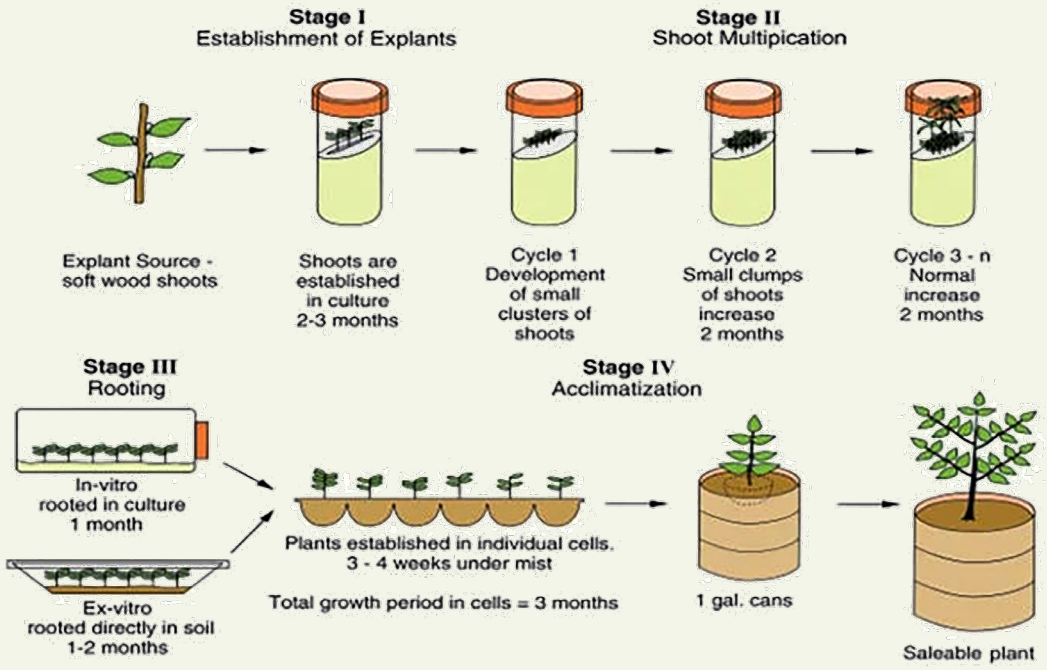


Fig. 4.8: Micropropagation of plants

Aim: To investigate the process of vegetative propagation in plants using the tissue culture technique and to observe the factors that influence the success of this asexual reproduction method.

Materials needed:

- Healthy, young plant material (e.g., leaves, stems, or root tips)
- Sterile workspace (e.g., laminar flow cabinet or clean table)
- Sterilised tools (e.g., scalpel, forceps, scissors)
- Culture media (e.g., Murashige and Skoog (MS) medium)
- Plant growth regulators (e.g., auxins, cytokinins)

- Petri dishes or culture vessels with lids
- Autoclave or pressure cooker for sterilising equipment
- Parafilm or plastic wrap for sealing culture vessels
- Incubator or growth chamber with controlled temperature and lighting
- Disinfectants (e.g., bleach, alcohol) for surface sterilisation
- Magnifying glass or stereomicroscope (optional)

Procedure:

1. Prepare the work area by thoroughly cleaning and sterilising the surfaces and equipment.
2. Collect the healthy plant material (e.g., young leaves, stem tips, or root tips) from the parent plant.
3. Wash the plant material under running water to remove any dirt or debris.
4. Disinfect the plant material by submerging it in a diluted bleach solution (e.g., 10% bleach) for a few minutes.
5. Rinse the plant material with sterile distilled water several times to remove any traces of the disinfectant.
6. Prepare the culture medium according to the specific protocol, including the necessary plant growth regulators.
7. Aseptically transfer the plant material to the culture vessels containing the prepared medium.
8. Seal the culture vessels with parafilm or plastic wrap to maintain a sterile environment.
9. Place the culture vessels in the incubator or growth chamber with the appropriate temperature and lighting conditions.
10. Monitor the cultures regularly for signs of growth and development, such as callus formation, shoot or root initiation, and plantlet regeneration. Note your findings.
    a. The survival rate of the plant explants (the small specialised plant parts used for tissue culture) in the culture medium.
    b. The time taken for the initiation of callus formation, shoot development, or root formation.

c. Differences in the growth and development patterns between the explants cultured on media with varying concentrations of plant growth regulators, such as auxins and cytokinins.

d. Variations in the overall success rate of the tissue culture process among different plant species or cultivars that were subjected to the same experimental conditions.

e. Challenges or issues encountered during the tissue culture propagation, such as contamination of the cultures, browning of the explants, or lack of regeneration of complete plantlets.

11. Carefully transfer the regenerated plantlets to larger vessels or soil for further growth and acclimatisation.

EXTENDED READING

- Curriculum document
- Ramawat, K. G., Merillon, J.-M., & Shivanna, K. R. (2016). Reproductive Biology of Plants. CRC Press.
- Tissue Culture (youtube.com)
- (241) Tissue Culture - YouTube
- (241) Science Grade 10 English medium Layering plant propagation - YouTube
- (241) What is Grafting? l Artificial Propagation (Animation) - YouTube
- (241) Asexual Reproduction | Vegetative Propagation : Cutting - YouTube
- How to Propagate plant cutting ,Grow more trees by vegetative propagation (youtube.com)
- Fertilisation and Seed Formation (youtube.com)
- Pollination Explained (youtube.com)

FEMALE REPRODUCTIVE SYSTEM

Hello learner, you are about to learn about the mechanism by which humans reproduce. When sexually mature females and males engage in sexual intercourse, it is possible for conception to take place under the right conditions.

To start with you will learn about the female human reproductive system, followed by the male reproductive system to appreciate how the two systems work together to produce offspring.

The female reproductive system is responsible for the production of eggs (ova), the reception of sperm for fertilisation, and the support of embryo development. It consists of several structures each with unique functions contributing to the reproductive process.

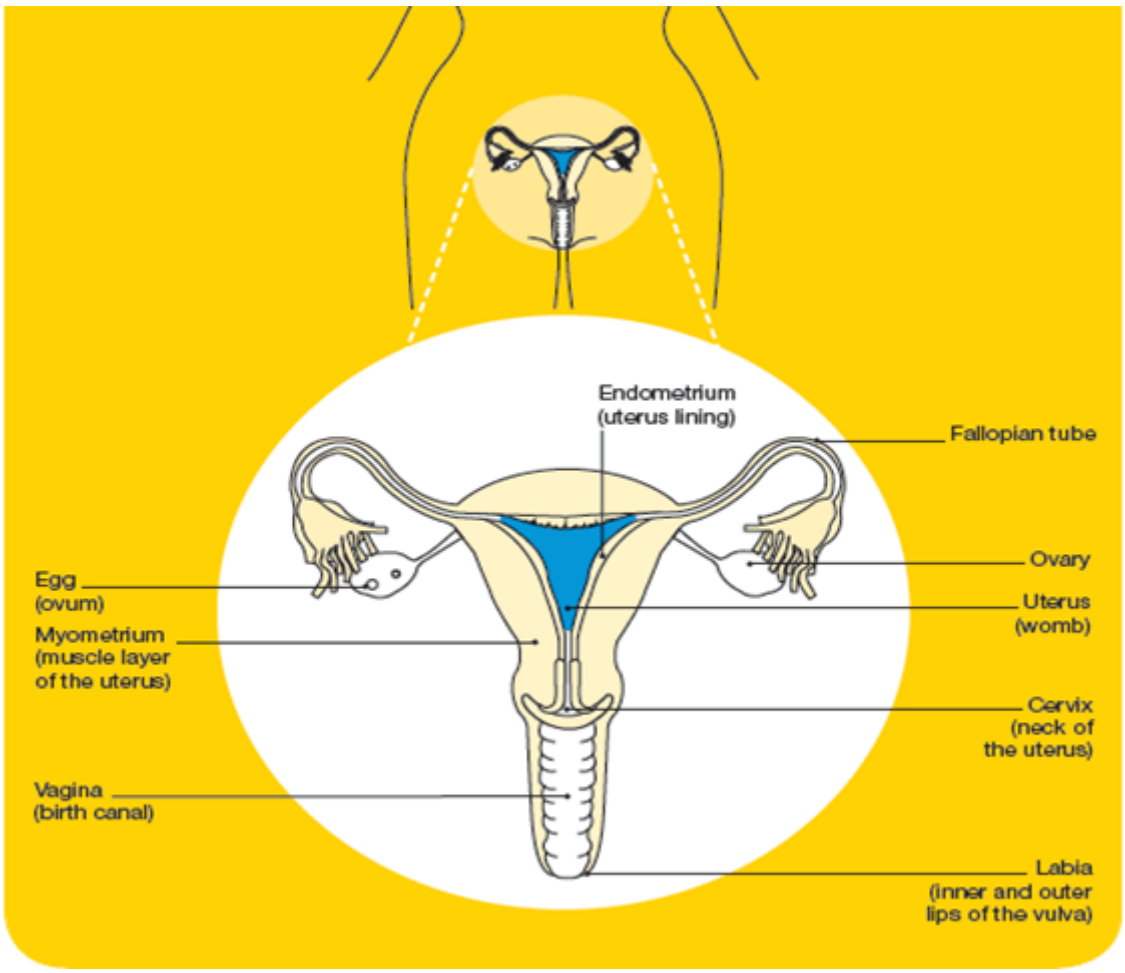


Fig. 4.9: Structure of Female Reproductive System of Humans

Activity 4.12

Look at Figure 4.9 carefully. Suggest the functions of each structure. Copy and complete the table below with your suggested functions of each structure. Find the solutions in **Annex 4.1** to correct and complete your Table 4.4 below.

Table 4.4: The main reproductive structures and their functions in the female reproductive system

	Description	Function
Ovaries		
Oviducts		
Uterus		
Cervix		
Vagina		
Vulva		

Activity 4.13: Drawing and Labelling the Female Reproductive System of Humans.

Materials needed:

- Hb pencil well sharpened
- Eraser
- Sheet of plain A4 paper

Procedure:

1. Look at the diagram of the female reproductive system carefully taking into consideration the proportion of the parts forming the system. Re-read your completed table from Activity 1.
2. Put all your notes and diagrams away; you will now replicate them from memory.
3. Using a pencil and paper, make an outline of the female reproductive system proportionately.
4. The outline must be entire, there should be no broken line or woolly outline.
5. If you make a mistake in the outline, use the eraser to clean the mistake and redo that part clearly and smoothly.

6. If it is a vertical/longitudinal section you are drawing, use double lines to show the thickness.
7. Avoid shading of any kind.
8. Label each vital part of the female reproductive system, giving its name and function.
9. Give your drawing an appropriate heading E.g. A Drawing of Longitudinal Section of a Female Reproductive System of Human.
10. Display your drawing for your friends or classmates to see and critique.

Hello learner, you are making progress. Now you are going to learn something about the male reproductive system of humans and appreciate how it compliments the female reproductive system in the reproduction of humans.

Structure of the Male Reproductive System

The male reproductive system is responsible for the production and delivery of sperms which are necessary for the fertilisation of the egg. Hormones such as testosterone play a crucial role in regulating the male reproductive system's functions.

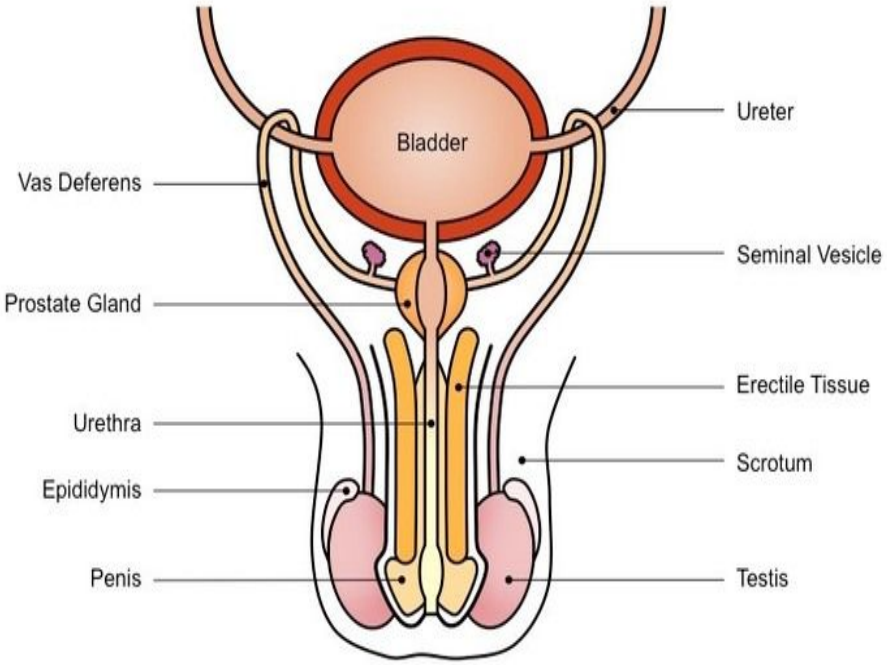


Fig. 4.10: Vertical Section of Male Reproductive System

Activity 4.14

Look at Figure 4.10 carefully. Suggest the functions of each structure. Copy and complete the table below with your suggested functions of each structure. Find the solutions in **Annex 4.1** to correct and complete your table below.

Table 4.5: The main reproductive structures and their functions in the male reproductive system

	Description	Function
Testes		
Epididymis		
Vas Deferens		
Seminal Vesicles, Prostate Gland and Bulbourethral Glands		

Activity 4.15: Drawing and Labelling the Male Reproductive System of Humans.

Materials needed:

- Hb pencil well sharpened
- Eraser
- Sheet of plain A4 paper

Procedure:

1. Look at the diagram of the male reproductive system carefully taking into consideration the proportion of the parts forming the system. Re-read your completed table from Activity 4.14.
2. Put all your notes and diagrams away; you will now replicate them from memory.
3. Using a pencil and paper, make an outline of the male reproductive system proportionately.
4. The outline must be entire, there should be no broken line or woolly outline.
5. If you make a mistake in the outline, use the eraser to clean the mistake and redo that part clearly and smoothly.

6. If it is a vertical/longitudinal section you are drawing, use double lines to show the thickness.
7. Avoid shading of any kind.
8. Label each vital part of the male reproductive system, giving its name and function.
9. Give your drawing an appropriate heading. For example, a drawing of the longitudinal section of a male reproductive system of humans.
10. Display your drawing for your friends or classmates to see and critique.

Processes of Reproduction in Humans

1. **Copulation:** Also known as sexual intercourse, copulation involves the insertion of the erect penis into the vagina. During this process, semen is ejaculated into the vagina.
2. **Fertilisation**: Fertilisation is the fusion of male and female sex cells in the oviduct. This forms a zygote, the single-cell embryo with a complete set of chromosomes from both parents.
3. **Implantation**: Implantation is the attachment of an embryo to the uterine wall for nourishment. After fertilisation, the zygote undergoes several divisions to form a blastocyst. The blastocyst moves down through the oviduct until it enters the uterus, it then implants itself into the lining of the uterus (endometrium), where it continues to grow and develop.
4. **Foetal Development:** Following implantation, the blastocyst develops into an embryo, and then into a foetus. During foetal development, organs and systems begin to form and differentiate. This stage spans three trimesters (each three months long), with distinct milestones such as the development of limbs, organs, and the nervous system.
5. **Role of the Placenta:** The placenta forms from tissues of both the embryo and the mother. It serves as the interface between the maternal and foetal circulatory systems facilitating the exchange of nutrients, oxygen, and waste products. Moreover, toxins such as nicotine and alcohol can cross the placenta from the mother's bloodstream and damage the foetus. The placenta also produces hormones essential for pregnancy maintenance.
6. **Birth:** Labour is the process by which a foetus is expelled from the uterus through the birth canal (vagina). It involves uterine contractions coordinated by hormonal signals. After birth, the umbilical cord is typically clamped and cut, separating the newborn from the placenta.

7. **Breastfeeding:** Breastfeeding is the process of feeding a newborn with breast milk produced by the mother's mammary glands. Breast milk provides essential nutrients, antibodies, and other factors crucial for the baby's growth, development, and immune system function. It also fosters bonding between the mother and the infant. In some cases, mothers choose not to or are unable to breastfeed, for a variety of reasons, and in these scenarios, formula derived from cow's milk is available.

Activity 4.16

Copy the link that follows into a browser and click to view and listen to a video of some processes of human reproduction: https://youtu.be/N66sAZH1VA8

Afterwards, make a schematic diagram or storyboard to show the stages of reproduction in humans.

Activity 4.17

Research some of the primary medical conditions which can adversely affect the function of both male and female sex organs. Create a fact sheet or poster summarising these, as well as giving advice as to how these conditions may be avoided, where possible.

EXTENDED READING

Access the websites and the resources below and read further about the reproductive systems of humans and how a new individual is produced.

- https://youtu.be/RFDatCchpus
- https://www.youtube.com/watch?v=PvYacgt7O48
- https://youtu.be/wuJsyojTGz4
- https://youtu.be/wd3gE9qgdos
- https://youtu.be/9rs2gNchQig

THE MENSTRUAL CYCLE

Hello learners. In this lesson, you will discuss menstruation, describe how it occurs and identify hormones responsible for menstruation. You will also look at the significance of the menstrual cycle in sexual reproduction.

Overview of the Menstrual Cycle

The menstrual cycle consists of natural changes that occur in a woman's body every month, if she is of reproductive age. It involves a series of hormonal, physiological and behavioural changes in the body that prepare it for potential pregnancy.

Menstruation starts at puberty, usually between 8 and 15 years of age. It usually begins two years after breasts and pubic hair start to develop and ends at menopause. However, the cycle will usually stop while a woman is pregnant.

The menstrual cycle typically lasts around 28 days, although it can vary from woman to woman. This varies between 20 and 40 days and sometimes from cycle to cycle. It is counted from the first day of a period (appearance of vaginal bleeding) to the first day of the next period.

It is important to mention that the cycle is regulated by the complex interplay of hormones which are produced by the ovaries and the pituitary gland.

Significance in Reproduction

The menstrual cycle plays a crucial role in reproduction as it regulates ovulation and the release of an egg from the ovaries. Additionally, the menstrual cycle prepares the uterus for potential pregnancy by thickening its lining. If fertilisation occurs, this lining provides a nourishing environment for the embryo to implant and develop into a baby. If fertilisation does not occur, the lining is shed during menstruation making way for a new cycle to begin.

Activity 4.18

In groups of 2-4, observe the image below and discuss the following:

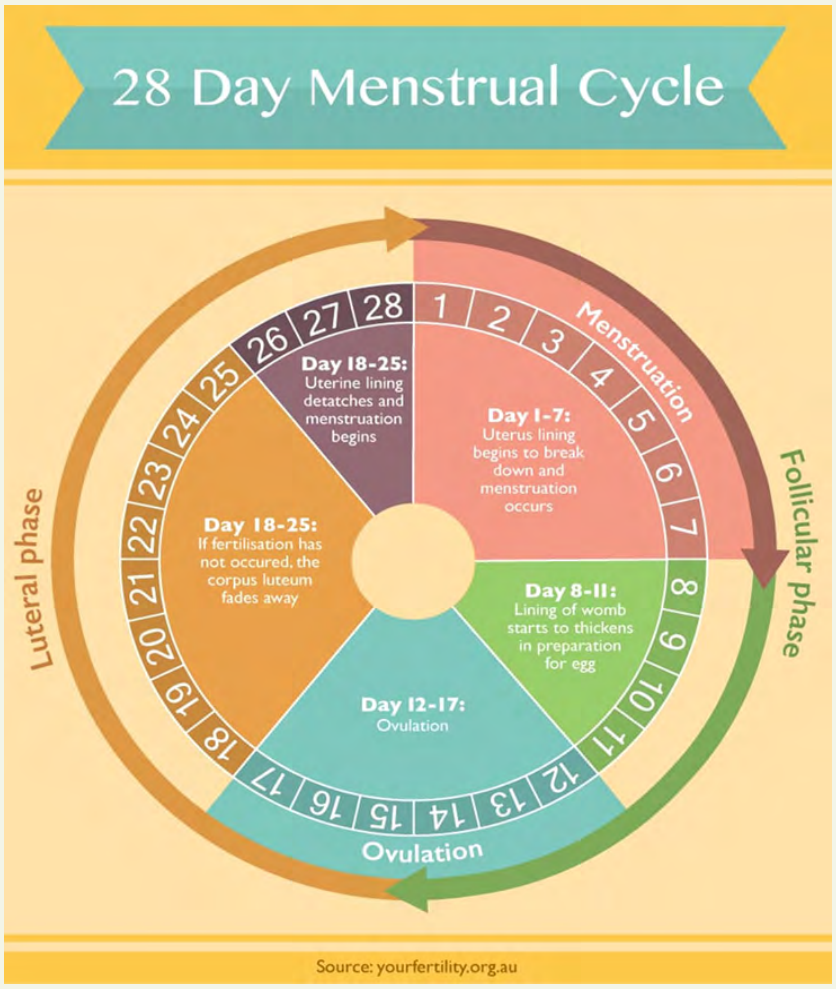


Fig. 4.11: The 28-day Menstrual Cycle. Image source:

1. In which phase of the cycle do you think pregnancy can occur?
2. Explain your answer.
3. Share your thoughts as part of a whole-class discussion.

Phases of the Menstrual Cycle

In this discussion, you will focus on the phases of the menstrual cycle. Be reminded that, the female reproductive system includes a cycle of events called the menstrual cycle. There are four key phases of the menstrual cycle: the follicular phase, ovulation, the luteal phase, and menstruation. It is tightly controlled by the release and interplay of four main hormones. You will discuss more on hormones later. Discuss the cycle days below.

1. **Days 1-5** Menstruation – here, bleeding occurs
2. **Days 6-14:** Follicular phase – when an egg matures in the ovarian follicle, and the uterine lining prepares to receive a fertilised egg (embryo)
3. **Day 14:** Ovulation – the ovary releases the egg, which can be fertilised by a man's sperm if present
4. **Days 15-28:** Luteal phase – the egg travels through the fallopian tubes (oviducts) to the uterus; if fertilised, the embryo may attach to the uterine lining and the woman will become pregnant; if the egg is not fertilised, the uterine lining will shed, and the cycle will begin again.

Hormones involved in the menstrual cycle

Hormones are chemical messengers produced by glands in the endocrine system and released into the bloodstream. They regulate various physiological functions in the body, including growth and development, metabolism, mood, sexual function, and reproduction. Hormones interact with specific target cells or organs, where they exert their effects by binding to hormone receptors.

Hormonal Regulation

Hormone levels are controlled by the pituitary and ovaries. Progesterone and oestrogen are produced in the ovaries whilst Luteinising Hormone (LH) and Follicle Stimulating Hormone (FSH) are produced in the pituitary.

Table 4.6: Hormones associated with the menstrual cycle.

FSH	FSH stimulates the growth and development of follicles (fluid-filled sacs) in the ovaries. Within each follicle is an immature egg. FSH is produced in the pituitary.
Oestrogen	As the ovarian follicles grow and mature, they produce increasing amounts of oestrogen. Oestrogen plays a key role in thickening the uterine lining (endometrium) in preparation for potential implantation of a fertilised egg.
LH	LH surge triggers ovulation, the release of a mature egg from the ovary. LH is also produced in the pituitary.

Progesterone	After ovulation, the ruptured follicle transforms into a structure called the corpus luteum which produces and secretes progesterone. Progesterone helps maintain the uterine lining and prepares it for implantation of a fertilised egg. If fertilisation does not occur, the corpus luteum breaks down, leading to a decline in progesterone levels.

Importance of Ovulation

Ovulation is crucial in the menstrual cycle because it marks the release of a mature egg from the ovary, making pregnancy possible. Tracking ovulation is essential for those trying to conceive or avoid pregnancy as it indicates the most fertile window of the cycle; see **Annex 4.3 – Further Information** for more detail.

Contraception

Teenagers who are aware of their menstrual cycle are better equipped to choose suitable contraception methods. Having discussed forms of birth control and their efficacy, it is important to know what contraceptive is consistent and appropriate particularly during the days in the menstrual cycle where conception is most likely to occur. Medical professionals can be engaged to provide advice on contraception.

Contraception refers to methods or techniques used to prevent pregnancy. There are many methods used to prevent pregnancy from hormonal pills, inter-uterine devices, condoms, and hormonal implants. The methods of tracking ovulation (OPKs, cervical mucus monitoring and BBT) can also be used to plan periods of sexual abstinence when fertilisation is most likely. This can be used as a method of contraception though it is unreliable in younger women when periods are unpredictable and vary from month to month.

Activity 4.19

Research and summarise how the following contraception methods work:

Method	How it works
Hormonal pills	
Inter-uterine devices (e.g. the hormonal coil / the copper coil)	
Condoms	
Cycle tracking	

Menstrual Disorders

Issues affecting a woman's regular menstrual cycle are referred to as menstrual disorders, these come in a variety of forms. Issues can vary from painful, heavy periods to no periods at all. Menstrual patterns vary widely, but women should be concerned if their periods continue longer than 10 days or if they occur less frequently than 21 days or more. Such occurrences could be a sign of ovulation issues or other illnesses. Some examples of menstrual disorders are given in **Annex 4.3**.

Reproductive Health Issues

Reproductive health refers to the state of physical, mental, and social well-being in all matters relating to the reproductive system. It encompasses a broad range of issues, including fertility, contraception, sexually transmitted infections (STIs), menstrual health, pregnancy, childbirth, and reproductive cancers. It is crucial to address these issues through education, access to healthcare, and support services to ensure individuals can make informed decisions and maintain their reproductive health.

Menstrual Health

Good menstrual health and hygiene practices can prevent infections, reduce odours, and help stay comfortable during your period. Some menstrual products that can be used to absorb or collect blood during your period, include sanitary pads, tampons, menstrual cups and menstrual discs. The tips in **Annex 4.3** can be followed to keep you safe and healthy.

Activity 4.20

As a group, watch these videos and take part in a whole-class discussion surrounding the questions that follow:

1. https://www.youtube.com/watch?v=42WIByexiXc
2. https://www.youtube.com/watch?v=2NjzlvAV1lc
3. https://www.youtube.com/watch?v=Is1LOacgWkc

   a. From the videos, how would you describe reproductive health?

   b. Identify at least four challenges associated with *menstrual health* and *reproductive health*.

c. As either a male or a female, how will you stay healthy during the reproductive stage?

Adolescent Reproductive Health

It is important to discuss among yourselves issues of menstruation cleanliness, fertility awareness, where to find reproductive healthcare services, and normal or abnormal changes during puberty. Sharing thoughts and experiences is the best way to keep everybody safe.

EXTENDED READING

- Menstrual Hygiene: Reading Material for ASHA - https://www.nhm.gov.in/images/pdf/programmes/mhs/Training_Materials/PDF_English/reading_material.pdf
- The Integration of Menstrual Health into Sexual and Reproductive Health and Rights Policies and Programmes. https://www.nhm.gov.in/images/pdf/programmes/mhs/Training_Materials/PDF_English/reading_material.pdf
- Take Charge Of Your Cycle: 4 Period Books That Every Woman Needs To Read https://thefoundationblog.com/blog/4periodbooks

ANNEXES

Annex 4.1 – Possible Solutions To Activities

Activity 4.1

Learners, reproduction can take place in plants or in humans/animals. Reproduction in plants is a fundamental biological process that allows plants to propagate and ensure the continuation of their species. Through these mechanisms plants can produce offspring, disperse their genetic material, and colonise new habitats.

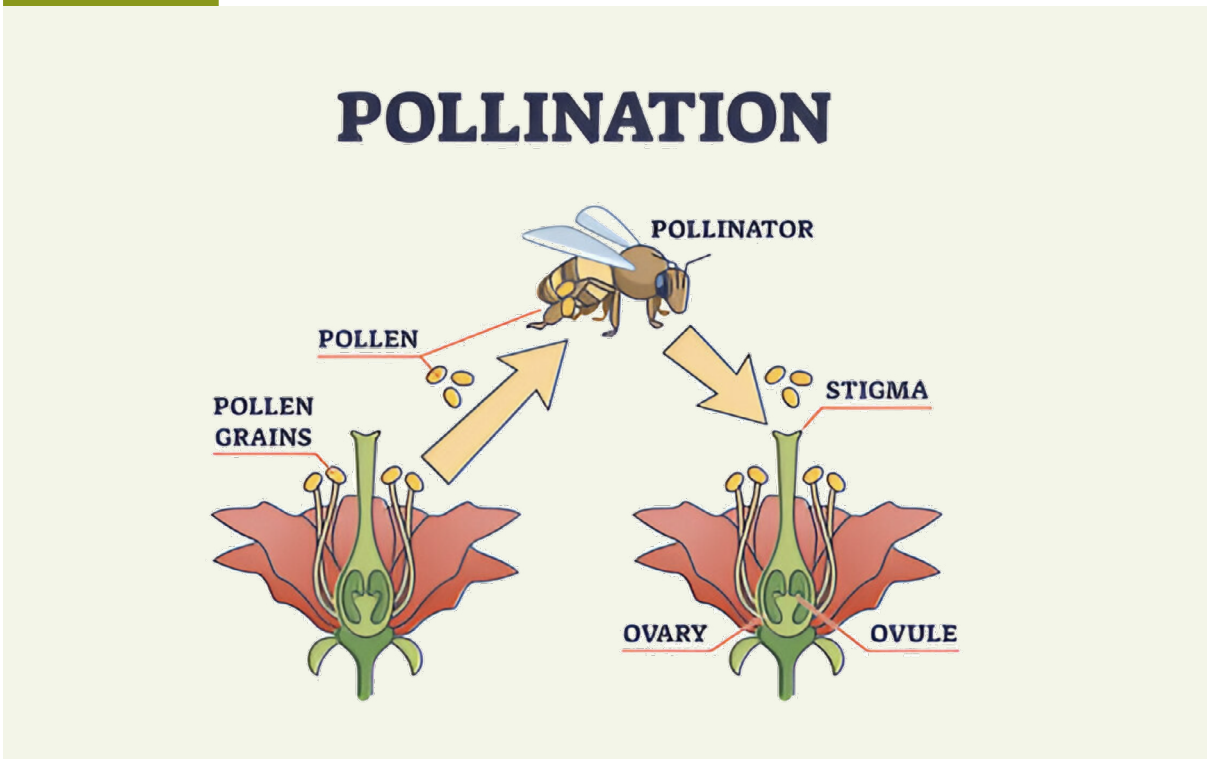
There are two types of reproduction: ***sexual reproduction*** and ***asexual reproduction***.

Activity 4.2

Parts of a flower	Structure	Function
Sepals	The sepals are the outermost whorl which is small and green in colour.	Brightly coloured sepals attract pollinators to pollinate the flower. Green sepals perform photosynthesis to manufacture food for the plant. They protect the delicate flower bud before it opens.
Petals	Petals are large and brightly coloured.	Produces scent to attract pollinators. Produces nectar to attract insect pollinators.

Parts of a flower	Structure	Function
Stamens	This is male organ of the plant and consists of the anther and the filament. The filament holds the anthers.	The male sex organs. The anthers produce pollen which can be considered the male gametes of the plant.
Stigma	The stigma is on the top of the style connected to the ovary. The stigma, style and ovary can be considered the female parts of the flower.	Stigma collects pollen grains.
Ovary	Located above or below the petals/sepals, the ovary holds the ovules.	Produces ovules which will develop into seeds once fertilised. The ovary develops into a fruit at the same time.

Activity 4.3



Activity 4.6

Observations:

- The sexually reproducing plant may exhibit slower overall growth and allocate significantly more resources to reproductive structures compared to the asexually reproducing plant. For example, the bean seed may start germinating after one week, while the cassava sticks may start showing its buds within three days.
- The sexually reproducing plant's reproduction may be highly dependent on the presence and activity of pollinators.
- Under environmental stress, the sexually reproducing plant may struggle to maintain seed production, while the asexual reproducer may be more resilient.
- The asexually reproducing plant may be able to spread and colonise new areas much more quickly than the sexually reproducing plant.

Conclusion:

The experiment demonstrates key disadvantages that plants face when relying on sexual reproduction, including the higher energy costs, dependence on pollinators, and slower rates of reproduction. These factors can make sexually reproducing plants less competitive, especially in rapidly changing or resource-limited environments, compared to plants that can reproduce asexually. Understanding these trade-offs is important for predicting vegetation dynamics and informing conservation strategies.

Activity 4.7

- **Cuttings:** Portions of stems or roots are cut and planted in suitable conditions to grow into new plants. Typically, cuttings are obtained from healthy, established plants while they are actively growing. Rooting hormone is then applied to the cutting to promote the formation of roots. The cutting is placed in a growing medium to facilitate further growth after the roots have formed.
- **Grafting:** Grafting is a technique in which the parts of two separate plants are connected so that they develop as a single plant. During grafting, the stems of two separate plants are cut and joined together in such a way that they grow as a single plant. One of the two cut stems has roots and

is referred to as **stock.** The other stem, known as the **scion,** is cut without roots. Scion and stock cut surfaces are fitted and stitched together with a piece of cloth before being covered with a polythene cover. It guards the stem against infections and other issues. Soon, the stock and scion combine to form a new plant. This is often done where the delicate fruit-bearing variety is grafted onto a hardier rootstock.

- **Layering:** This technique involves bending a lower branch of a plant and covering it with damp soil leaving the developing tip exposed. Before the stem is bent down, a ring of bark is sometimes removed. When it has rooted, it can be separated from the parent plant and grown as an independent plant. In some species, long branches emanating from the tree trunk or bush stem can touch the surrounding soil surface (or are pinned to the ground) and soon start to develop roots which anchor the branch to the soil and start to draw water and nutrients. Once established, the layered branch detaches (or can be cut) from the mother trunk and the rooted branch becomes an independent plant. For instance, grapevine, strawberries, bougainvillaea, and jasmine.
- **Micropropagation (Tissue Culture):** Involves the growth of plant cells, tissues, or organs in a sterile nutrient medium under controlled conditions. A little portion of tissue, an organ, or even just one cell is removed from the plant and placed in an aseptic, sterile container with a nourishing medium. The tissue quickly becomes an unorganised lump known as a **callus**. There is no limit to how long the callus can persist and grow. Plantlets, or tiny plants, are created when little amounts of tissue are transplanted to a different specialised media containing **hormones.** This process drives differentiation. The plantlets are grown into mature plants and can be gradually transplanted into pots or soil.

Activity 4.8

The experiment demonstrates the feasibility of vegetative propagation through stem cuttings, which allows for the asexual reproduction of plants. The success of this method depends on factors such as the health and vigour of the parent plant, the proper selection and preparation of the cuttings, the rooting medium, and the environmental conditions. The use of rooting hormone can potentially enhance the rooting process, but it is not always necessary. Understanding the principles of vegetative propagation can help in

the multiplication and conservation of desirable plant varieties, as well as the rapid propagation of plants for commercial or ecological purposes.

Activity 4.9

The experiment demonstrates the process of vegetative propagation through grafting, which allows for the combination of desirable traits from different plant varieties. The success of grafting depends on factors such as the compatibility between the rootstock and scion, the quality of the graft union, and the environmental conditions during the grafting and healing process. Grafting is a valuable technique for propagating plants that are difficult to reproduce through other methods, as well as for creating new plant varieties with improved characteristics. Understanding the principles of grafting can be beneficial in horticulture, agriculture, and plant breeding applications.

Activity 4.10

The experiment demonstrates the process of vegetative propagation through layering, which allows for the asexual reproduction of plants. Layering is a useful technique for plants that are difficult to propagate through cuttings or other methods. The success of layering depends on factors such as the health and flexibility of the parent plant, the proper preparation of the layered stem, the rooting medium, and the environmental conditions. The use of rooting hormone can potentially enhance the rooting process, but it is not always necessary. Understanding the principles of layering can be beneficial in propagating plants for horticultural, agricultural, or conservation purposes, as it allows for the multiplication of desirable plant varieties without the need for seeds or other specialised equipment.

Activity 4.11

The experiment demonstrates the process of vegetative propagation through tissue culture, which is a powerful technique for the rapid multiplication of plants. Tissue culture allows for the asexual reproduction of plants from small, specialised plant parts (explants) under controlled laboratory conditions. The success of tissue culture propagation depends on factors such as the choice of explant, the composition of the culture medium (including plant growth

regulators), the sterile techniques employed, and the environmental conditions maintained during the culture period.

By understanding the principles of tissue culture, this method can be leveraged for a wide range of applications, including the mass propagation of rare or valuable plant species, the conservation of endangered plants, and the production of disease-free planting materials. This experiment provides a valuable hands-on experience for grade 8 students to explore the intricacies of this advanced vegetative propagation technique.

Activity 4.12

	Description	Function
Ovaries	The ovaries are a pair of small, almond-shaped organs in the pelvic cavity.	1. Egg Production. 2. Hormone Production.
Oviducts	The oviducts are two narrow tubes that extend from the ovaries to the uterus.	1. The oviduct is the site of fertilisation where the egg meets the sperm. 2. The oviduct subsequently carries the fertilised egg (zygote) to the uterus.
Uterus	The uterus, or the womb, is a hollow, muscular organ in the pelvis. It is lined with tissue with an enhanced blood supply called the endometrium.	1. Site for implantation. 2. The uterus wall supplies nourishment and oxygen to the developing foetus. 3. Provides protection and support to the developing foetus.
Cervix	The cervix is the lower part of the uterus that connects it to the vagina.	1. Muscular entrance and exit of the uterus. 2. Allows the entry of sperm and the exit of menstrual blood, and through which the baby passes from the uterus to the vagina in childbirth.

	Description	Function
Vagina	The vagina is a muscular canal that serves as the birth canal during childbirth and as the site for sexual intercourse.	1. Accepts the penis during sexual intercourse. 2. Allows the exit of menses during menstruation. 3. The birth canal allowing the baby to pass through into the outside world.
Vulva	The external parts of the female reproductive system comprised of the labia majora, labia minora, and clitoris. Labia minora are folds of skin protected by the outer labia. The clitoris is the main site of female sexual pleasure located above the urethra.	1. The labia protect the opening of the urethra and vagina. 2. The labia and clitoris provide sexual sensations making sex pleasurable.

Activity 4.14

	Description	Function
Testes	The testes, or testicles, are the primary reproductive organs in males.	1. Sperm production. 2. Hormone production – especially testosterone.
Epididymis	The epididymis is a coiled tube located on the surface of each testis. It functions as a storage and maturation site for sperm cells.	1. Site for sperm maturation. 2. Temporary storage of sperms.
Vas Deferens	The Vas Deferens is a muscular tube that connects the epididymis to the ejaculatory duct.	1. Sperm transport. 2. Provides sensation.

	Description	Function
Seminal Vesicles, Prostate Gland and Bulbourethral Glands	These accessory glands produce fluids that combine with sperm to form semen.	The seminal vesicles and glands produce a fluid rich in fructose and other nutrients that provide energy for sperm. The fluid also contains prostaglandins, which help in sperm motility and fertility. They make up a significant volume of semen.

Annex 4.2 - Further Information on Reproduction in Plants

Pollination

Wind Pollination	Insect Pollination
1. Wind pollination is really good for plants that live in places where there aren't many other pollinators like bees or butterflies. The wind is always blowing, so the plants don't have to wait for a special visitor to come by. 2. The wind can carry pollen long distances, even to plants that are far apart. This is helpful for plants that live in areas where there aren't a lot of other plants around.	1. Insect pollination is an efficient way for plants to reproduce, as it relies on specialised pollinators that help facilitate the process. 2. Insect pollination promotes cross-pollination, where insects carry pollen from one flower to another as they forage for food, allowing for genetic diversity among the plant population.

Wind Pollination	Insect Pollination
3. Wind-pollinated plants have special adaptations to help them make the most of the wind. They produce lots of lightweight pollen that can easily blow away in the breeze. 4. Unlike flowers that need insects, wind-pollinated flowers don't have nectar, smells, or bright colours to attract bugs. This saves the plant energy that it can use for other important things. 5. Some plants rely on specific pollinators, but wind-pollinated plants are less affected by changes in the number of pollinators or changes in the environment that might hurt certain insects.	3. Plants have adapted to attract insects by producing nectar, scents, and vibrant colours, which enhance the success of pollination by making the flowers more enticing to the pollinators. 4. Insect-pollinated flowers often have specific structures, such as landing pads or specialised shapes, that make it easier for the insects to access the pollen and facilitate its transfer. 5. This mutualistic relationship between plants and pollinating insects ensures reproductive success for the plants, as the insects benefit from the nectar and the plants benefit from the pollination. 6. Insect pollination has evolved as a highly effective reproductive strategy, especially in diverse ecosystems where there is a wide variety of plant and insect species interacting with one another.

In conclusion, the importance of insect pollination cannot be overstated. From its role in maintaining genetic diversity and supporting crop production to its contribution to ecosystem balance and environmental monitoring, this ecological process is fundamental to the well-being of our planet and the sustainability of human society.

Advantages and Disadvantages of Sexual Reproduction in Plants

Advantages	Disadvantages
1. ***Genetic Diversity*** When plants reproduce sexually, each parent contributes half of their genetic information to the offspring. This means the offspring will have a unique combination of traits from both parents. This genetic diversity is important because: - Some offspring may have traits that help them survive better in certain environments. This increases the chances of the species surviving and thriving. - Genetic diversity makes the population less vulnerable to diseases or pests. If a disease affects one type of plant, the other genetically different plants may be able to survive.	***1. Requires More Energy and Resources*** Sexual reproduction in plants requires more energy and resources compared to asexual reproduction. The plant has to produce flowers, pollen, and seeds, which takes a lot of the plant's energy and nutrients.
2. ***Evolutionary Advantage*** Sexual reproduction helps plants evolve and adapt over time. By creating new genetic combinations, sexual reproduction provides the raw material for natural selection to work on. This allows plants to slowly change and adapt to new environments and conditions over many generations.	***2. Relies on Pollinators*** Many plants need help from pollinators, like bees and butterflies, to transfer the pollen from one flower to another. If there are not enough pollinators around, the plant may not be able to reproduce sexually.

Advantages	Disadvantages
3. Seed Dispersal	***3. Slower Reproduction Rate***
When plants reproduce sexually, they produce seeds. These seeds can be carried to new locations by wind, animals, or water. This allows the plant's offspring to spread out and grow in different areas. This helps the plant species establish new populations in new habitats.	The process of sexual reproduction, including pollination, fertilisation, and seed development, takes a long time. This slower rate of reproduction can be a disadvantage for plants that need to grow and spread quickly, especially in environments that are changing rapidly.

Advantages of Natural Asexual Reproduction in Plants vs Artificial Propagation of Plants

Natural	Artificial
1. Asexual reproduction in plants is efficient, as it does not require the time and energy needed for pollination or the production of seeds.	1. Consistency - Artificial methods can ensure that new plants have the same desirable traits as the parent, like the colour of their flowers or how well they resist diseases.
2. Offspring produced through asexual reproduction are genetically identical to the parent plant, ensuring consistency in desirable traits such as disease resistance or fruit quality.	2. Rapid Production - Techniques like tissue culture allow growers to quickly produce large numbers of identical, healthy new plants from just a small piece of the original plant.
3. Rapid propagation of plants with favourable traits occurs without the need for genetic recombination.	3. Propagating Sterile or Hybrid Plants - Some plants don't make good seeds, but artificial propagation provides a way to still grow more of them.
4. Asexual reproduction allows plants to colonise new environments rapidly, enabling them to spread even from a single individual.	4. Year-Round Production - Artificial methods allow plants to be grown anytime, not just during the normal growing season. This keeps the supply steady.

Natural	Artificial
5. Some plants can reproduce asexually under adverse conditions such as drought or nutrient scarcity, serving as a survival strategy.	5. Conservation - Endangered plant species can be protected by artificially propagating them to prevent the plants from going extinct.
6. Genetic purity is maintained as there is no mixing of genetic material from different plants, preserving specific traits that are well-adapted to environments.	6. Disease Prevention - When starting with sterile plant material, artificial propagation reduces the risk of spreading plant diseases to the new plants.

Advantages and Disadvantages of Different Artificial Propagation Methods

	Advantages	Disadvantages
Cuttings	1. Cuttings root quickly and can establish themselves as new plants in a short time. 2. Cuttings produce plants that are genetically identical to the parent plant, ensuring desirable traits are maintained. 3. Cuttings allow for precise control over the size and growth habits of the resulting plants. 4. Cutting propagation is often cost-effective as it requires minimal materials and equipment.	1. Cuttings are more prone to disease and rot since they lack a developed root system and are more vulnerable to environmental stress. 2. Some plant species are challenging to propagate from cuttings due to low rooting success rates. 3. Newly rooted cuttings may experience transplant shock when moved to a new environment, requiring extra care and attention.

	Advantages	Disadvantages
Grafting	1. Grafting allows for the combination of different plant varieties or species, enabling the creation of plants with desirable qualities such as disease resistance, improved yield, or unique characteristics. 2. Grafted plants often exhibit faster growth rates and earlier fruiting compared to plants propagated by other methods. 3. Grafted plants can benefit from the root system of a vigorous rootstock, providing improved nutrient uptake, drought resistance, and overall resilience. 4. Grafting can be used to repair damaged plants or rejuvenate old or weak specimens by incorporating them into a new, healthier root system.	1. Grafting success depends on genetic compatibility between the scion (upper portion) and the rootstock leading to potential incompatibility issues. 2. Grafting can be a labour-intensive process requiring specialized skills and equipment leading to higher production costs compared to other propagation methods. 3. Grafting can potentially transmit diseases from the rootstock to the scion especially if proper sanitation practices are not followed

	Advantages	Disadvantages
Layering	1. Layering is a delicate and non-invasive method of growing new plants since it resembles natural plant growth techniques. 2. Having established roots prior to being split off from their parent plant, layered plants have a better chance of establishing themselves. 3. Layering encourages branching and general plant vigour, which results in stronger, healthier plants. 4. Plant species that are challenging to reproduce by cuttings can benefit from layering.	1. Compared to cuttings, layering may result in established plants more slowly because roots need time to grow while still connected to the parent plant. 2. In general, layering produces fewer young plants at a time than cutting propagation techniques. 3. To accommodate the expanding branches, layering might need additional room in the nursery or garden.

	Advantages	Disadvantages
Micro-propagation	1. Micropropagation enables the rapid production of many plants from a small amount of plant material making it an efficient method for commercial plant production. 2. Micro-propagated plants are grown in sterile conditions, reducing the risk of disease transmission, and producing healthy stock free from pathogens. 3. Micropropagation preserves the genetic integrity of plant varieties, ensuring the propagation of true-to-type plants with desired traits. 4. Micropropagation allows for continuous production of plants regardless of seasonal limitations, providing a consistent supply of plant material.	1. Micropropagation can lead to genetic uniformity among propagated plants, which may result in reduced genetic diversity and increased susceptibility to pests and diseases. 2. Setting up and maintaining a tissue culture facility can be expensive, making micropropagation a costly method of plant propagation. 3. Micro-propagated plants may require care and acclimatization post-propagation to transition successfully from sterile laboratory conditions to outdoor environments.

Annex 4.3 – Further Information on Menstrual Cycle

Methods of Tracking the Menstrual Cycle

These methods include monitoring basal body temperature, monitoring cervical mucus (vaginal discharge) and ovulation predictor kits to identify the fertile window.

Tracking basal body temperature (BBT): Tracking BBT can be useful for monitoring ovulation patterns and fertility. To do this, you would measure your temperature first thing in the morning just after waking. Consistent tracking over time can help predict ovulation and optimise chances of conception if that is your goal. There are various apps available to help track BBT and the menstrual cycle.

Cervical mucus changes: Hormonal variations cause the consistency of cervical mucus to fluctuate during the menstrual cycle. During most of the menstrual cycle, cervical mucus is very thick and viscous and forms a plug blocking the cervix. As ovulation draws near, the cervical mucus becomes runnier, thinner, and much less viscous (like egg white) as the cervical mucus plug breaks down potentially allowing sperm to enter the uterus. This less viscous cervical mucus promotes sperm motility and survival which makes conception easier. It gets thicker and less abundant again after ovulation. It is possible to anticipate ovulation and fertility by monitoring these changes in the vaginal discharge (which is cervical mucus).

Ovulation Predictor Kits: The image below shows an ovulation predictor kit (OPKs). It is a tool used to predict ovulation to maximise the chances of pregnancy. It work by detecting levels of luteinising hormone (LH) in urine which surges just before ovulation. OPK's can help women identify their most fertile days aiding in conception or in contraception. It is essential to follow the instructions carefully and consider other fertility signs for accurate predictions.

How to use the ovulation predictor kits (OPKs)

Understand your cycle: Determine the length of your menstrual cycle. Typically, ovulation occurs around 14 days before your next period starts, but this can vary.

1. **Start testing:** Begin testing a few days before you expect to ovulate based on your cycle length. For example, if you have a 28-day cycle, start testing around day 10.
2. **Choose the time of day:** Most kits recommend testing with your first morning urine, as the LH surge (which indicates ovulation is about to occur) is usually most concentrated then.
3. **Follow the instructions:** Read the instructions provided with your OPK carefully. They typically involve either urinating on a stick or dipping it into a cup of urine.
4. **Interpret the results:** Look for the appearance of a test line. If it is dark or darker than the control line, it indicates a positive result meaning you are likely to ovulate within the next 12-36 hours.
5. **Time intercourse:** Plan to have intercourse over the next couple of days after receiving a positive result to maximise your chances of conception.
6. **Continue testing:** Keep testing daily until either you detect ovulation or your cycle ends. Some kits come with multiple strips to cover your entire fertile window.
7. **Record your results:** Keep track of your results and the days you had intercourse to better understand your fertility pattern over time.

Menstrual disorders

Dysmenorrhea: Dysmenorrhea is severe, frequent cramping during menstruation. Pain occurs in the lower abdomen but can spread to the lower back and thighs.

Menorrhagia: The medical word for noticeably heavier periods is menorrhagia. There are numerous reasons for menorrhagia. An average woman sheds 30ml of blood during a typical menstrual cycle and changes her sanitary items three to five times a day.

Amenorrhea: Amenorrhea is the absence of menstruation and can result from malnutrition or from heavy sustained exercise. Many female athletes have periods of amenorrhea.

Oligomenorrhea and Hypomenorrhea: The disorder known as oligomenorrhea causes menstrual cycles to be irregular and spaced apart by more than 35 days. Early adolescence is a common time for it to occur, and it typically does not signify

a medical issue. Before menopause and in the first years following menarche, light, or insufficient flow (hypomenorrhea) is also typical.

Premenstrual Syndrome (PMS): PMS is a collection of behavioural, emotional, and physical symptoms that often appear a week before menstruation in the final week of the luteal phase. Usually, the symptoms do not appear until at least day 13 of the cycle and go away four days after the bleeding starts.

Menstrual Health

1. Wash your hands before and after using the restroom and before using a menstrual product.
2. Discard used disposable menstrual products properly: Wrap them with toilet paper, a tissue, or other material and then toss it in a trash bin. Do not flush menstrual products down the toilet.
3. Sanitary pads: Change sanitary pads every few hours, no matter how light the flow. Change them more frequently if your period is heavy.
4. Tampons: Change tampons every 4 to 8 hours. Do not wear a single tampon for more than 8 hours at a time.
5. Use the lowest-absorbency tampon needed. If you can wear one tampon for up to 8 hours without changing, the absorbency may be too high.
6. Sanitise menstrual cups after your period is over by rinsing them thoroughly and then placing them in boiling water for one to two minutes.
7. Wear lightweight, breathable clothing (such as cotton underwear). Tight fabrics can trap moisture and heat, allowing germs to thrive.
8. Change your menstrual products regularly. Trapped moisture provides a breeding ground for bacteria and fungi. Wearing a pad or period underwear for too long can lead to a rash or an infection.
9. Keep your genital area clean. Wash the outside of your vagina (vulva) and bottom every day. When you go to the bathroom, wipe from the front of your body towards the back, not the other way. Use only water to rinse your vulva. The vagina is a self-cleaning organ. Changing the natural pH balance of your vagina by washing or using chemicals to cleanse out the vagina can be harmful and may result in a yeast infection or bacterial vaginosis.
10. Use unscented toilet paper, tampons, or pads. Scented hygiene products can irritate the skin and impact your natural pH balance.
11. Drink enough liquids. This can help wash out your urinary tract and help prevent infections, like vaginal candidiasis.

12. Track and monitor your period. Your menstrual cycle is a valuable marker for your overall health. Irregular periods can be a sign of conditions like diabetes, thyroid dysfunction, and celiac disease. You can track your period on a calendar or with an app on your phone designed for this purpose.
13. Talk to a doctor if you experience a change in odour, have extreme or unusual pain, or have more severe period symptoms than usual (such as a heavier flow or longer period).
14. Avoid using chemical products on your vulva.
15. Try to avoid a pad rash: A heavy flow can cause a pad rash. This will happen as the pad can be wet for a longer time. Try to change the pad by staying dry and using an ointment, as suggested by an expert after a bath and before bed, this will heal the rash. Pad lining may cause irritation to sensitive skin too. If rashes persist, the skin can be sensitive and indicate high blood sugar or allergy to the product.
16. Do not forget to take a shower: This can help you to keep yourself clean, stay fresh, get rid of any unpleasant odour down there, and prevent infections.

REVIEW QUESTIONS

Review Questions 4.1

1. Why is reproduction an essential biological process for the survival and continuation of plant and animal species?
2. How do the different types of plant reproduction, including sexual and various asexual methods, differ in their mechanisms and outcomes?
3. Describe the key stages involved in the sexual reproduction process of flowering plants, from pollination to seed and fruit formation.
4. Design and conduct a hands-on experiment to demonstrate one or more vegetative propagation techniques, such as layering, grafting, or taking cuttings, and explain the practical applications of these asexual reproduction methods.

Review Questions 4.2

1. How will a blocked fallopian tube affect human reproduction?
2. What defect in the male reproductive system can cause the same effect as in question 1?

Review Questions 4.3

1. What are some ways you could cope with menstrual cramps while in school?
2. How should a girl handle talking to a male classmate or teacher about needing to take a break for menstrual reasons?
3. How should one navigate the challenges of exercising or participating in physical activities while menstruating?
4. How can access to reproductive health care contribute to overall health and well-being for individuals and communities?
5. What steps should one take to track and monitor her menstrual cycle, particularly if trying to manage symptoms like irregular periods?

6. Emma is an 18-year-old woman who is in a long-term relationship and wants to prevent unintended pregnancies. She is considering various contraceptive options and is unsure which method would be best for her. She has heard about different types of contraceptives such as the birth control pill, contraceptive implant, and intrauterine device (IUD), but is unsure about the potential side effects and effectiveness of each method. Emma is also concerned about the cost and accessibility of these contraceptive options. Guide her to make an informed decision about which contraceptive method would be most suitable for her lifestyle and health needs.

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GLOSSARY

Pollination is the transfer of pollen grains from the anther of a stamen to the stigma of a pistil.

Ova: They are the cells produced by the female reproductive system when they undergo reduction division to produce egg cells. The plural of ovum is ova.

Sperm cells: They are male reproductive cells that are produced in the testicles. The sperm cells swim to meet the female egg for fertilisation.

Penis: It is a copulating organ, which males use to inseminate semen into the body of a female.

Semen: It is a male reproductive fluid, containing spermatozoa in suspension.

Testicles: They are also called testes which are housed in the scrotum for protection and regulation of their temperature. The testicles produce sperm and secrete a hormone called testosterone.

Urethra: It is a duct that transmits urine from the bladder to the outside of the body.

Hormones: They are chemical messengers secreted by ductless glands called endocrine glands directly into the bloodstream.

Copulation: It is also known as sexual intercourse, copulation involves the insertion of the erect penis into the vagina. During this process, semen is ejaculated into the vagina.

Fertilisation: The fusion of male and female sex cells in the oviduct to form a zygote.

Hormones are chemical substances that act like 'messenger molecules' in the body. They travel in your bloodstream to tissues or organs.

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