Theme 3: How do Organisms Reproduce?

Prior Knowledge

It is recommended that you revise the following topics before you start working on these questions.

- Modes of reproduction
- Sexual reproduction in flowering plants
- Reproduction in human beings
- Reproductive health

Reproduction in Flowering Plants

While we know sexual reproduction occurs in animals as well as plants, do we have female and male flowers separate? We not only have the flowers separate but also the trees. According to Horticulturist Thomas Leo Ogren, the 1949 publication of the USDA Yearbook of Agriculture gave this advice to the reader: "When used for street plantings, only male trees should be selected, to avoid the nuisance from the seed." According to Thomas, this preference for male trees in the urban landscape has led to a disproportionate amount of pollen in the air, ultimately resulting in multiple allergy issues for humans. Thomas calls this Botanical Sexism.

Do you agree with Thomas? If you look around in your neighbourhood, do you think the plants are male plants, female plants or bisexual?

Case Study A - Unisexual and Bisexual plants

A bisexual flower will have male as well as female parts, whereas unisexual flowers will have only one of the two. Given below is a list of plants categorised as unisexual/bisexual. By looking at their flowers, can you determine if it is unisexual/bisexual?

Unisexual	Papaya	Corn	Watermelon	Wheat	Rice	Coconut	Pumpkin	Cucumber	Bitter Gourd
Bisexual	Rose	Hibiscus	Mustard	Brinjal	Tomato	Mango	Chilly	Long bean	Marigold

Table 3.1, List of commonly known plants, categorised as unisexual and bisexual

Question 1

Fig. 3.1-3.3 are diagrams of flowers showing only some parts of the flowers.

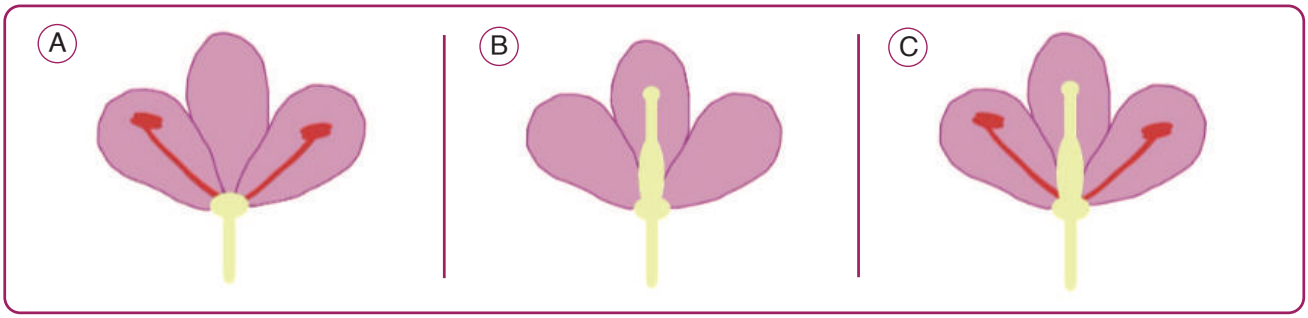


Fig. 3.1, option A **Fig. 3.2,** option B **Fig. 3.3,** option C

Which of the above can be used to represent a brinjal flower and a papaya flower, respectively? Place the brinjal flower diagram before the papaya while answering.

a. B, C	b. C, C	Answer
c. A, B	d. C, B	

Case Study B - Reproduction of Yeast

Humans have learnt the art of growing microorganisms in controlled environments. We employ them to make a variety of products. Interestingly, we do not hear of any animal rights violation protests for this because it is not considered unethical. One such microorganism which humans use is the unicellular organism yeast. It is used in many fermented products as well as to make fluffy baked food items. When dosa batter or bread dough is left aside, its volume increases after some time. Someone looking at this for the first time may conclude (incorrectly) that extra food got produced from thin air. The fact is that extra air gets produced to make the food appear to have grown in quantity. Where does this extra air come from? As the yeast/bacteria respire, they produce carbon dioxide, which leads to an increase in volume. Further, as these microorganisms feed on the sugar in the batter/dough, they reproduce and grow in number, thereby producing even more carbon dioxide. This leads to an increase in the rate at which carbon dioxide is produced till the microorganisms die, either because the food is cooked or oxygen supply is stopped or the food is insufficient for the total number of microorganisms. Some people believe that humans will also go through a similar growth cycle!

Question 2

i. Which of the following modes of reproduction does yeast exhibit?

a. Reproduction through male & female germ cells

b. Fission

c. Vegetative propagation

d. Spore formation

Answer

ii. A baker using yeast while baking is closely observing the rate at which it grows. Her goal is to find ways to speed up the yeast's growth so as to expedite her baking process. She heard someone claim that yeast grows exponentially i.e. the number of individuals in each new generation is a multiple of the number of individuals in the previous generation. Based on the information about its mode of reproduction, do you think this is true always / sometimes / never / cannot be claimed for sure? Justify your answer.

Answer

Case Study B (continued) - Rate of Reproduction of Yeast

What should the baker do to speed up the fermentation - add more sugar / more yeast to the dough or just leave the dough aside for more time? She conducted the following experiment to find an answer. Measured quantities of water, sugar and yeast were put in a plastic bottle. A balloon was fixed on top of the bottle and the amount of gas collected in the balloons was observed.

Fig. 3.6, 150 ml water taken in a bottle

Fig. 3.7, Measured quantity of sugar added to the water

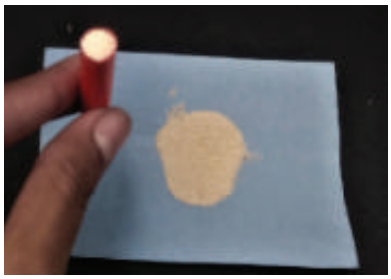


Fig. 3.8, Measured quantity of yeast added to the sugar and water mixture

Fig. 3.9, Balloon is fixed on the mouth of bottle to collect the gas released

Fig. 3.10, Setup left aside undisturbed for 6 hours

Fig. 3.11, Gas produced due to respiration inflates the balloon

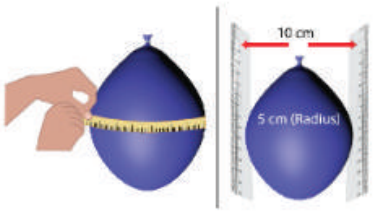


Fig. 3.12, Volume of balloon estimated every one hour

Fig. 3.13, Balloon removed after tying thread to prevent the escape of gas

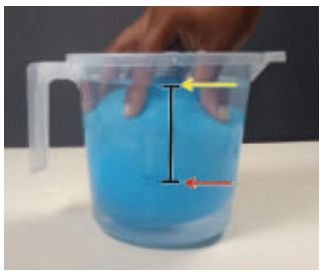


Fig. 3.14, Volume of gas collected is measured at the end

Fig. 3.15, Lime water solution prepared and shifted to a test tube

Fig. 3.16, Gas from the balloon is dissolved in the lime water solution

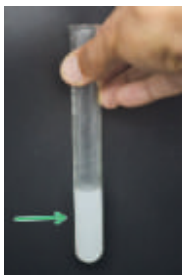


Fig. 3.17, Lime water turns milky, which indicates that the gas has CO_2

Question 3

Which parameter should be observed to infer the rate of fermentation?

a. Colour of lime water after the gas from the balloon is dissolved in it

b. Volume of the balloon at regular time intervals

c. Volume of the balloon after 6 hours

d. Maximum volume of the balloon, if left undisturbed for more than 6 hours

Answer

Question 4

The above experiment was conducted with three different setups (see table 3.2).

	Quantity of sugar	Quantity of yeast
Setup 1	3 g	2 g
Setup 2	9 g	2 g
Setup 3	3 g	6 g

Table 3.2, Details of the three experiment setups

The amount of water was kept as 150 ml for all the three setups. All setups were placed at the same temperature as well. The observations recorded are shown in table 3.3.

Time	Volume of balloon (in cm^3)		
	Setup 1	Setup 2	Setup 3
1 hour	9	9	57
2 hour	17	46	205
3 hour	57	83	503
4 hour	57	83	725
5 hour	46	69	725
6 hour	29	57	503

Table 3.3, Hourly observation data with each of the three setups

Multiple inferences can be drawn from this data, out of which some are listed below. Which of these are correct? More than one can be correct.

a. Most yeast are dead in Setup 1 and 2 after 5 hours.

b. The population of yeast inside Setup 1 and 2 remained the same as at the start of the experiment.

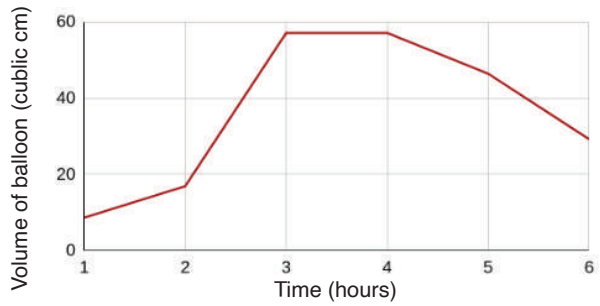
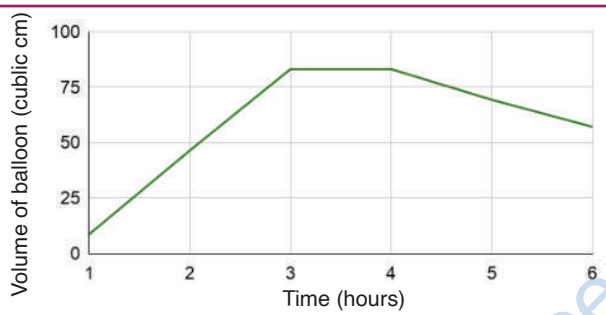
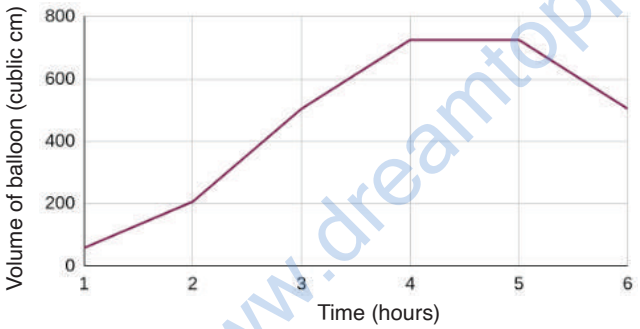
c. The population of yeast increased with time in Setup 3.

d. Most yeast are dead in Setup 3 after 3 hours.

Answer

Question 5

The graphs plotting the volume of the balloon with reference to time are given below for each setup.

Setup 1	 **Fig. 3.16,** Graph showing volume of balloon with time in Setup 1	**Phase 1:** upto 3 hours **Phase 2:** 3 to 4 hours **Phase 3:** atfer 4 hours
Setup 2	 **Fig. 3.17,** Graph showing volume of balloon with time in Setup 2	**Phase 1:** upto 3 hours **Phase 2:** 3 to 4 hours **Phase 3:** atfer 4 hours
Setup 3	 **Fig. 3.18,** Graph showing volume of balloon with time in Setup 3	**Phase 1:** upto 4 hours **Phase 2:** 4 to 5 hours **Phase 3:** atfer 5 hours

A common pattern can be seen across the three setups, in all the three graphs. The pattern has been identified in terms of three phases of the reaction in each setup. These phases have been captured in the column next to each graph. While the graphs show what is common, can the graphs be plotted differently to show the difference as well? If yes, how? If not, why not? Write your answer in the box given below.

Answer

Question 6

Provide a hypothesis to explain the reason behind the declining curve in Phase 3. Write your answer in the box given below.

Answer

Question 7

Based on the experiment's observations, if a baker wants to increase the rate of fermentation, what should she increase? Pick only one of the following and answer based on the data obtained from the experiment only. Do not apply your prior knowledge (if any) related to baking.

a. Water	b. Sugar	Answer
c. Yeast	d. Temperature	

Case Study C - Contraceptive Pills

Like yeast, any organism which gets access to sufficient food and conducive living conditions, starts to reproduce and the population continues to grow. The same applies to humans as well. However, some adults may not be ready - mentally, physically, socially, financially, etc - to reproduce at certain stages of life. Contraceptive options allow these individuals to wait/avoid reproduction while continuing to have sexual pleasures. However, certain contraceptive options also have a short/long-term impact on the individual's ability to reproduce, which is often referred to as fertility/infertility. Studies have been carried out on women of reproductive age to understand the relationship between the usage of contraceptive pills and infertility. Studies have shown that many women take anywhere from 2 to 15 menstrual cycles after stopping the contraceptive pills before they can conceive. It varies depending on the age as well as on whether the women were pregnant at least once before.

Question 8

Before going into the effect of oral contraceptive pills, let us look at the structure of the female reproductive system and the sequence of events occurring during the monthly cycles.

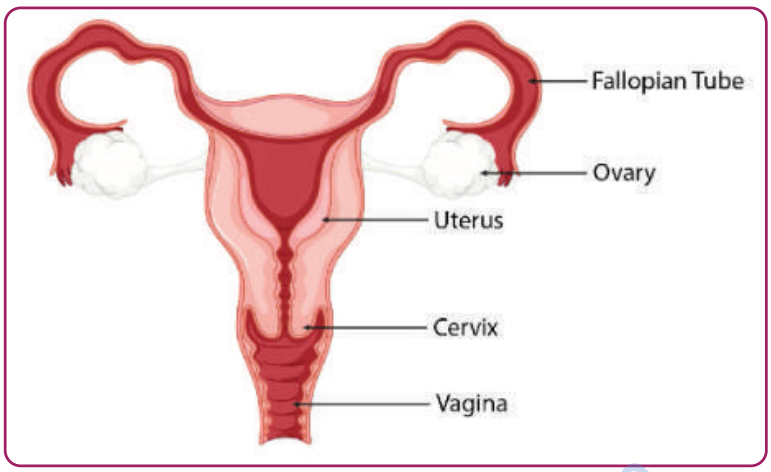


Fig. 3.19, Picture representing female reproductive system in humans

Given below is the length of different organs of a female reproductive system. This is an average range. What is the minimum distance which the sperm cells need to travel to fertilise the egg? Calculate from the point where they are released, which can be assumed to be 5 cm inside the system.

Part of female reproductive system	Average Length
Vagina	2.5 cm
Cervix	2 cm
Uterus	8 cm
Fallopian tube	9.5 cm

Table 3.4, Average length of parts of female reproductive system

a. 4 cm
b. 12 cm
c. 22 cm
d. Depends; anywhere between 1 to 17 cm

Answer

Case Study C (continued) - Stages of Menstrual Cycle

Inside the body of a female of reproductive age, one egg (sometimes more than one) is released each month. This is called ovulation. If this egg gets fertilised by the sperm, the zygote gets implanted in the uterus, where it divides and grows. The system prepares the uterus to receive the zygote, each month by thickening its linings. This happens regardless of whether the egg gets fertilised or not. If it does not, the lining is shed, which comes out through the vagina as the menstrual fluid which is called menstruation. Hence, there are four major events in the cycle: release of an egg(ovulation), thickening of the uterus lining, {fertilisation of egg and implantation of the zygote in uterus} or {shedding of uterus lining if fertilisation does not occur (menstruation)}. It is called a cycle since these four events repeat each month. For this cycle to repeat without error, a fine control is required which is achieved through various hormones to trigger each stage of the cycle. For example, when the oestrogen hormone level increases and reaches its peak, the eggs are released from the ovary.

Question 9

One of the most common oral contraceptive pills contains a combination of the hormones oestrogen and progesterone. These pills help maintain constant levels for these two hormones. This has two effects:

1. Since oestrogen levels remain constant, the peak of oestrogen is not detected.
2. Cervical mucus, which is secreted inside the cervix, thickens.

How will these two effects reduce the chances of pregnancy? Select all the options which could be correct.

a. Menstruation is prevented

b. Sperms are less likely to pass through the cervix and reach the fallopian tube

c. Ovulation is prevented

d. Eggs may be released and also meet sperms but uterus lining won't be maintained

Answer

Question 10

After ovulation, the egg has a life of 12 to 48 hours. The sperm cells, which meet the eggs in the fallopian tube, can survive in the female reproductive system for around 5 days. Intercourse may or may not result in pregnancy due to various reasons. What is the window during which an intercourse is most likely to result in pregnancy? The choices given below are in terms of the day number of an average menstrual cycle (see Fig. 3.20). Assume that the eggs and sperm cells are both fertile.

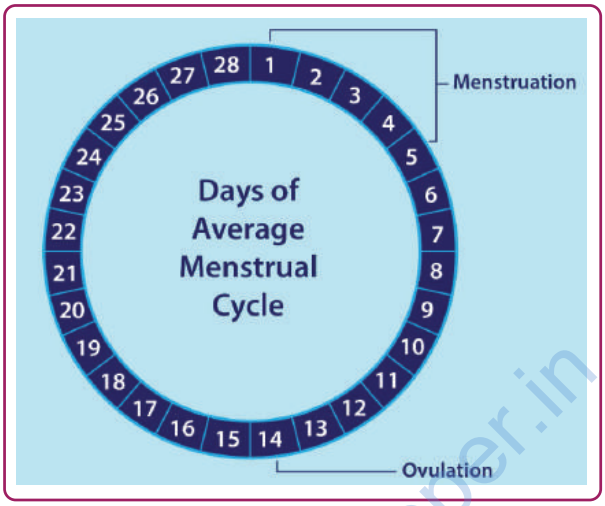


Fig. 3.20, Days and events in an average menstrual cycle

a. 1 to 5
b. 6 to 10
c. 11 to 16
d. 17 to 23
e. 24 to 28

Answer

Question 12

Given below are the events which occur in a human reproduction cycle, which results in a successful pregnancy. Arrange them in the order of occurrence.

A. Sperm cells enter the female body
B. Zygote is formed and implanted in the uterus
C. Egg matures and enters the fallopian tube
D. Uterus lining thickens

a. A, C, D, B	b. C, A, B, D
c. D, A, B, C	d. C, D, A, B

Answer

Exploration Pathway

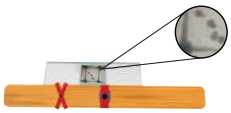
To explore this theme in an experiential manner you may work on the following hands-on activities:

Explore Flowers

Arguably the most beautiful part of a plant is the flower. They happen to be the reproductive part of many plants. Many flowers have both female and male parts. In this TACtivity, we will dissect a flower and observe its parts to understand how they participate in helping a plant reproduce to propagate its species for another generation.

Respiration - Anaerobic

Yeast can respire even in the absence of oxygen - breaking down sugar, releasing carbon dioxide and other by products. Here, yeast is allowed to act on sugar water in a bottle, the mouth of which is sealed with a balloon. Over time, as the yeast starts to digest the sugar, the balloon starts to inflate! This process is called anaerobic respiration and is also used to make alcohol commercially.



Microscope - Pollen

Every flower in a flowering plant produces pollen, the vital male ingredient required for plants to pollinate and reproduce. Pollen comes in various textures and colours, and here, with your own DIY Microscope, you can observe their fine structure on a microscope slide.