The Double Life of Plants
Alternating Generations

All living things are required to reproduce to ensure success of the species. For most organisms, gametes are necessary for reproduction. **Gametes** are sex cells, such as egg and sperm, and are produced in the organism through the process of meiosis. Recall that during this process, the chromosome number of the organism is reduced to half—known as the **haploid** (n) number of chromosomes. When a sperm and egg join, fertilization has occurred. The result of fertilization is a **diploid** cell with twice the number of chromosomes of the haploid cell, or $2n$. Fertilization leads to the formation of a zygote, and the zygote further develops into the mature organism.

Within one life cycle, plants will alternate between two generations called the **gametophyte** (gamete-producing) and the **sporophyte** (spore-producing) generations. In the gametophyte generation the plant is multicellular, haploid, and undergoing mitosis to produce the male and female gametes. In ferns, the gametophyte stage is the heart-shaped prothallium, which produces gametes. When fertilized, these gametes will produce a zygote.

The zygote, which is diploid, will divide through mitosis to produce the next stage, the sporophyte. During the sporophyte generation the multicellular, diploid ($2n$) plant exists as its most familiar, mature form. During this stage, the plant is producing spores through meiosis in specialized structures known as **sori** located on the underside of the frond, therefore reducing the number of chromosomes to haploid, or n. These cells, now called **spores**, then go through mitosis to produce the new gametophyte stage.

Plants will alternate between the sporophyte stage and the gametophyte stage at least once in their lifetime; this is called the **alternation of generations**.

PURPOSE

In this activity, you will identify the sporophyte generation of a fern, the spore-producing structure, and the spores on a fern. You will also describe the relationship between the gametophyte and sporophyte generations of a fern, and compare and contrast that relationship.

MATERIALS

fern or sample of fern frond
depression microscope slides
light microscope
Petri dishes
forceps
copy of alternation of generation model
copy of alternation of generation model cut-out page
scissors
lab apron
glue stick

REFERENCES

Campbell, Neil and Reece, Jane. *Biology*. San Francisco: Pearson Education, Inc., 2008, pp. 252, 602.

http://en.wikipedia.org/wiki/File:Alternation_of_generations_in_ferns.png

Safety Alert!

This activity involves plant materials. Alert your teacher if you have any plant allergies.

PROCEDURE

PART I

1. Obtain a fern frond from your teacher, and carefully observe the top side and underside of the frond.

2. Using the low power objective of the microscope, make detailed drawings of your observations of both the top side of the frond and the bottom side of the frond in the space provided on your student answer page.

3. Using forceps, obtain one sorus from the underside of the frond and carefully extract a spore from a sporangium. Place the spore into the depression slide or Petri dish in a drop of water, and observe using both low and high power objectives on the microscope. Draw your observations in the space provided on your student answer page.

PART II

1. Using the handouts provided, cut out the pieces along the dotted lines on the model pieces page.

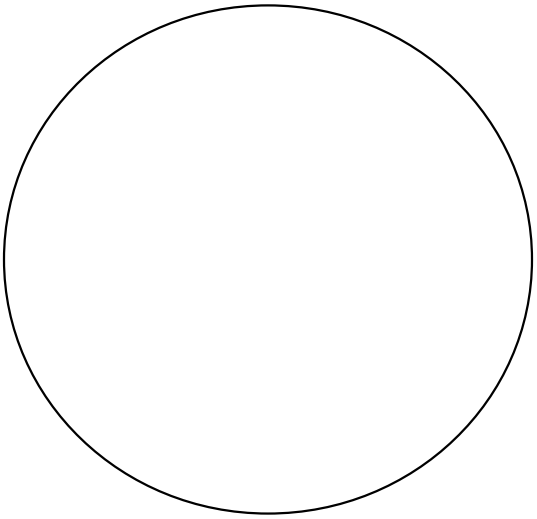
2. Once you have finished cutting out your pieces, arrange the pieces on the *Alternation of Generations Model* page. Refer to your class notes and the introductory paragraphs to help you place the pieces correctly. Before you glue your pieces to the paper, have your teacher check the arrangement.

The Double Life of Plants
Alternation of Generations

DATA AND OBSERVATIONS

Sketch the fern frond top side and underside as viewed under the microscope.

TOP SIDE



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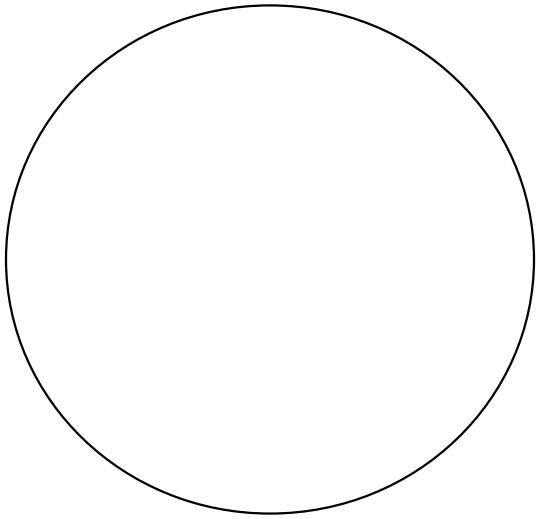
UNDERSIDE



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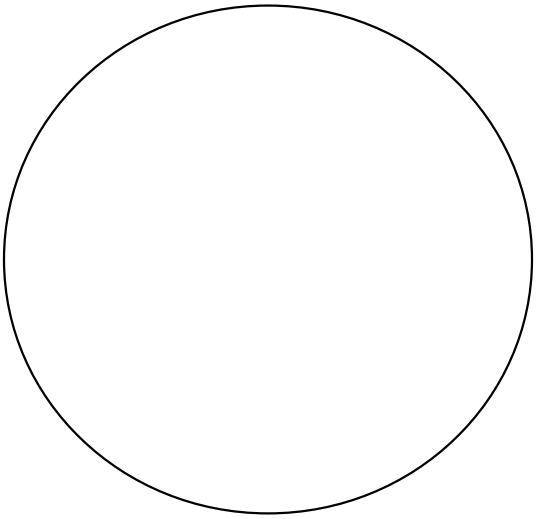
Draw the spore as viewed under the microscope for both low power and high power.

LOW POWER



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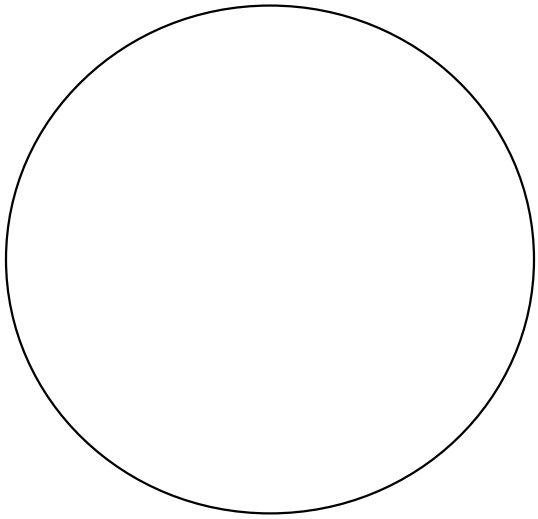
HIGH POWER



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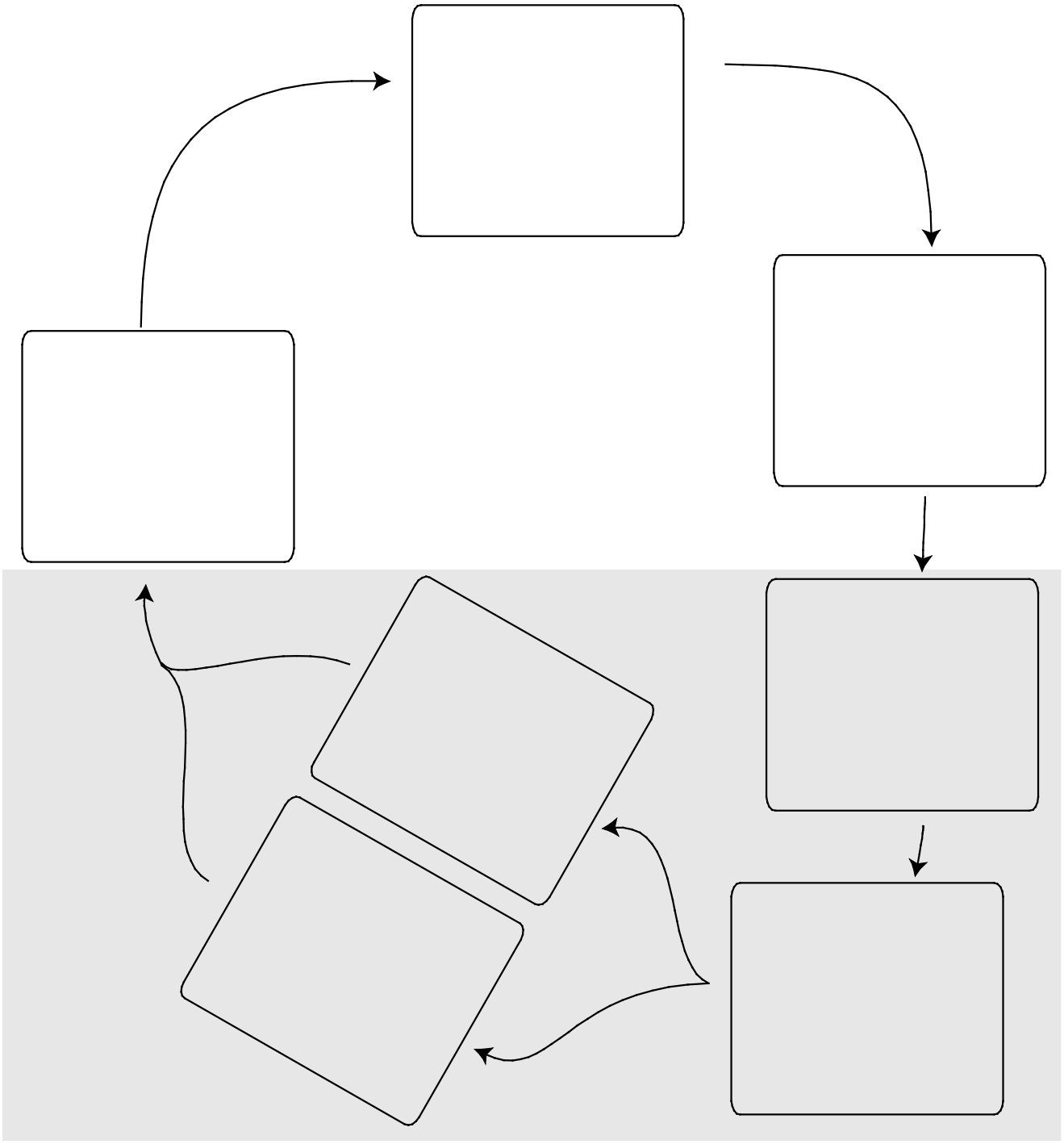
Alternation of Generations Model



Alternation of Generations Model Cutout Pieces

sori with spores

maturing sporophyte

meiosis

sporophyte

female gametes

2n

n

fertilization

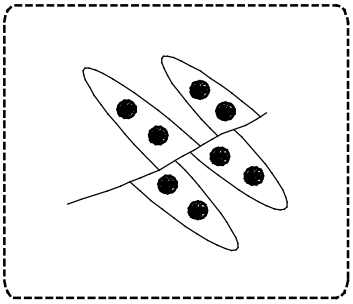
underside of fern frond with sori (sori hold spores)

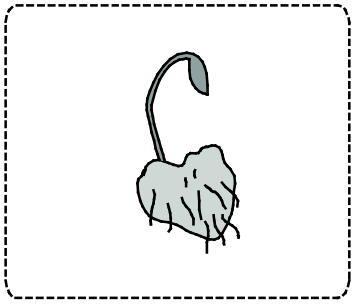
mitosis

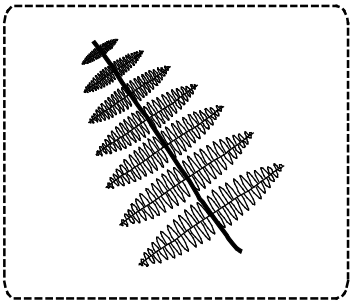
mitosis

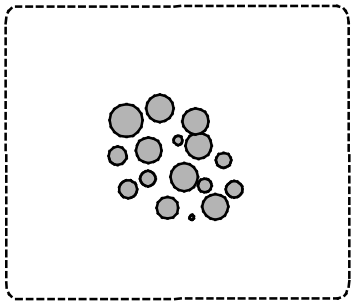
mitosis

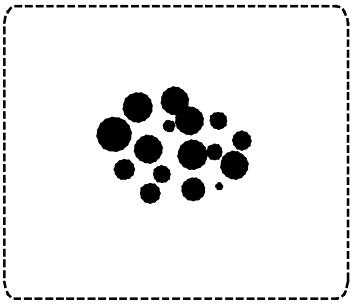
male gametes

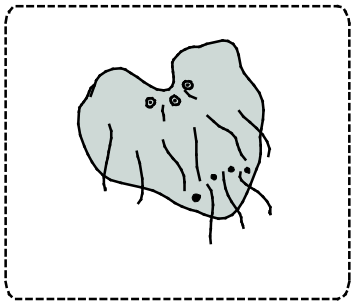






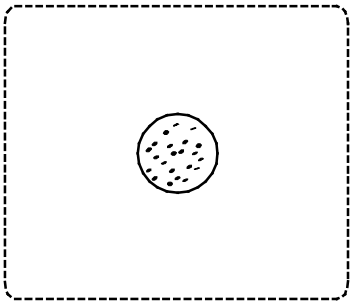






fern frond

gameophyte



Copy provided for training

Alternation of Generations Model Cutout Pieces

sori with spores

maturing sporophyte

meiosis

sporophyte

female gametes

2n

n

fertilization

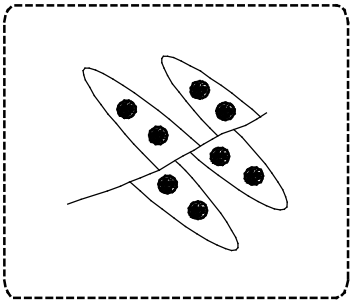
underside of fern frond with sori (sori hold spores)

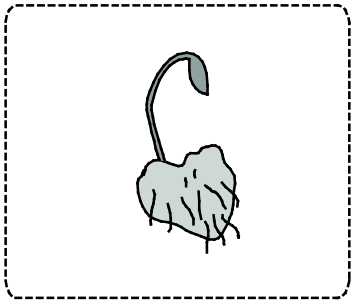
mitosis

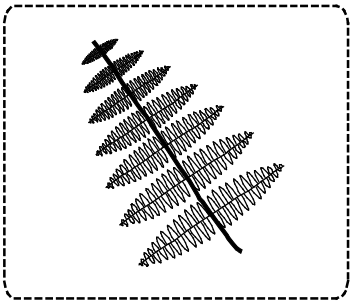
mitosis

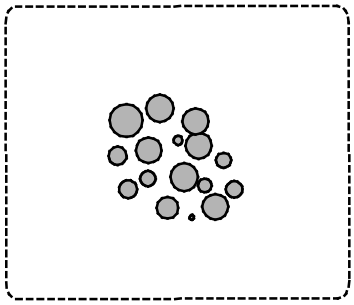
mitosis

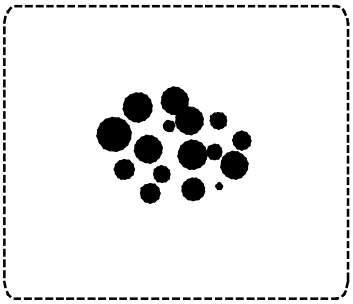
male gametes

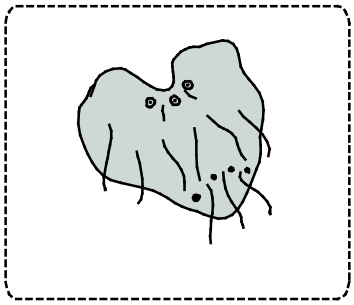






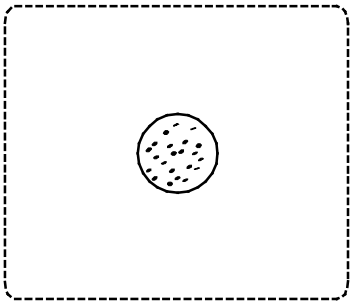






fern frond

gameophyte



Clean copy provided for classroom use

CONCLUSION QUESTIONS

1. Describe the sporophyte structure you observed (fern frond) and the location of the spore-producing structures.

2. Describe the spore-producing structure you observed. Are the cells being produced here haploid or diploid?

3. What is the fate of the spores being produced—that is, what will happen to the spores once they are distributed?

4. Ferns are typically found living on forest floors. Name some ways that you would expect spores to travel to new locations in the forest.

5. Compare and contrast the gametophyte stage and the sporophyte stage of plant life cycles.

6. Compare and contrast *meiosis* and *mitosis*, and describe the cells produced in each process, in particular, paying attention to chromosome numbers.