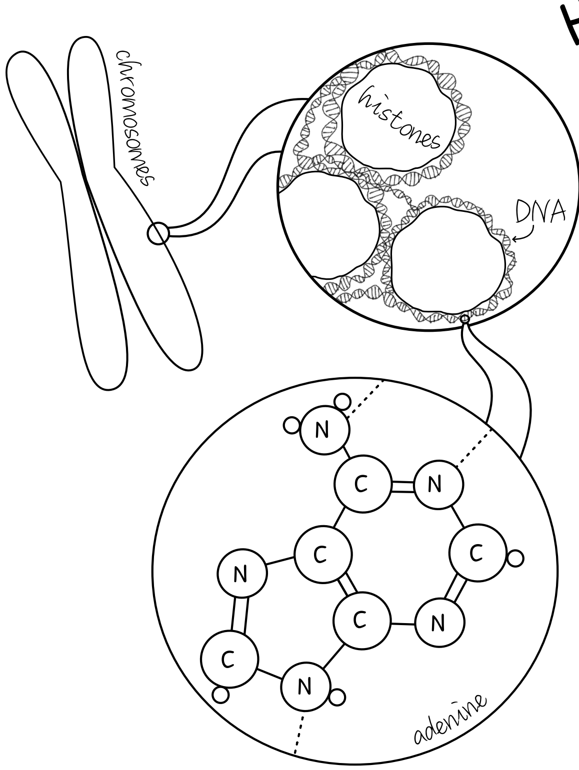
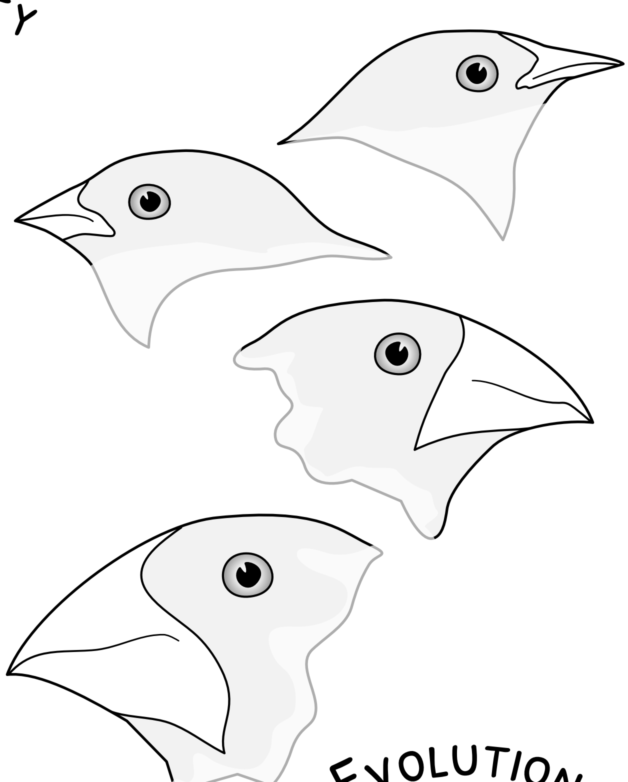
BIOLOGY TWO

	AB	Ab	aB	ab
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

HEREDITY





GENETICS

EVOLUTION

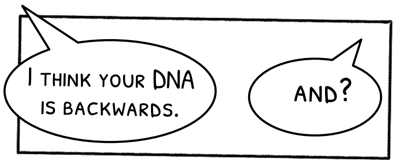
BIOLOGY TWO

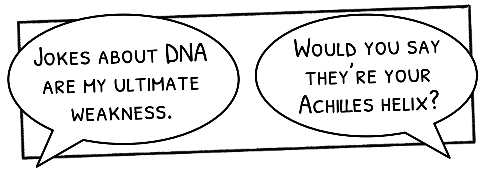
~ SPRING 2022 ~

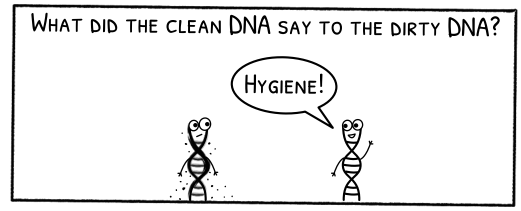
	Date	Topic	Page(s)
Week 1	Monday, Jan 24	What is a species?	-
	Wednesday, Jan 26	Life finds a way	-
	Friday, Jan 28	*Activity: Vegetative propagation with potato*	
Week 2	Monday, Jan 31	Mendel's famous experiment	
	Wednesday, Feb 2	The laws of heredity 1	
	Friday, Feb 4	*Deep dive: The Mendelian paradox.*	
Week 3	Monday, Feb 7	The laws of heredity 2	
	Wednesday, Feb 9	Pet pedigree puzzle	
	Friday, Feb 11	*Deep dive: Hemophilia and the royal families of Europe*	
Week 4	Monday, Feb 14	Punnett squares	
	Wednesday, Feb 16	**Heredity Quiz Show**	
	Friday, Feb 18	*Heredity anchor diagram*	
Week 5	Monday, Feb 21	What is a gene?	
	Wednesday, Feb 23	Chromosomes and linked traits	
	Friday, Feb 25	*Activity: Gummy worm karyotypes*	
Week 6	Monday, Feb 28	Blood types explained	
	Wednesday, Mar 2	Protein synthesis	
	Friday, Mar 4	*Activity: What's the blood type?*	
Week 7	Monday, Mar 7	Meiosis and mistakes	
	Wednesday, Mar 9	Mutations	
	Friday, Mar 11	*Deep dive: Red-green colorblindness*	
Week 8	Monday, Mar 14	Nature and nurture	
	Wednesday, Mar 16	Calico cat puzzle	
	Friday, Mar 18	*Deep dive: Why Red Delicious are the least delicious apples*	
Week 9	Monday, Mar 21	Modifying genes & gene therapy	
	Wednesday, Mar 23	**Genetics Quiz Show**	
	Friday, Mar 25	*Genetics anchor diagram*	
Week 10	March 28- April 1	SPRING BREAK	

Live classes are held each Monday and Wednesday. Activities and reading assignments listed on Fridays are completed independently. There are two sessions of each of the Monday/Wednesday classes. The first session starts at 11 am EST. The second session starts at 1:00 pm EST. Each live class lasts between 30 and 45 minutes.

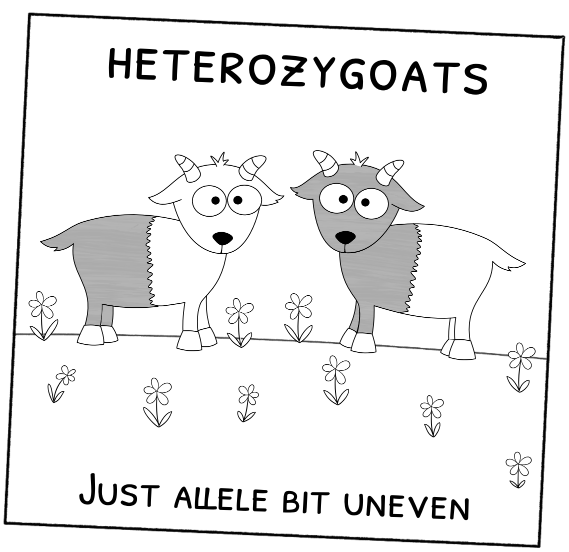
The classes are recorded and can be watched anytime after the recording date. Each week also has optional activities or reading assessments (deep dives). Students who complete and submit all activities and assignments will receive a bonus certificate of completion.

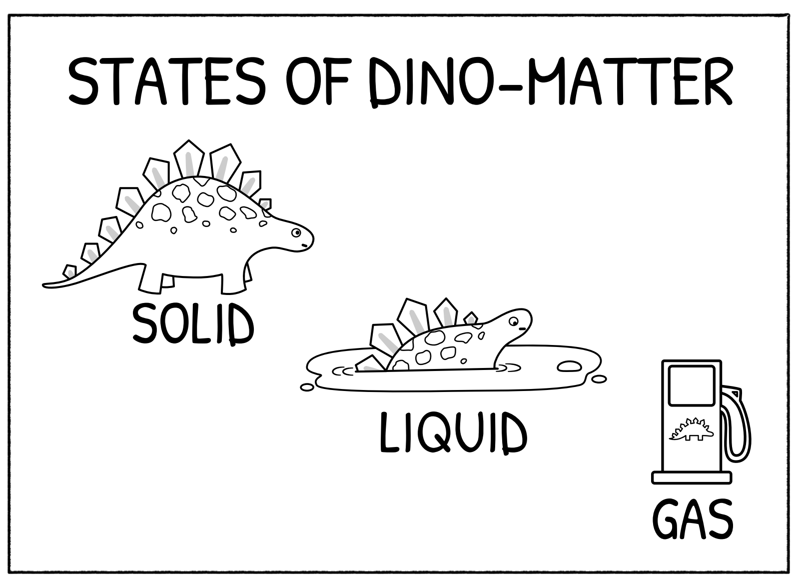






	Date	Topic	Page(s)
Week 11	Monday, Apr 4	Endangered vs invasive species	
	Wednesday, Apr 6	Darwin and the Galapagos	
	Friday, Apr 8	*Activity: Journey of the HMS Beagle*	
Week 12	Monday, Apr 11	Survival of the fittest	
	Wednesday, Apr 13	Color-changing moths	
	Friday, Apr 15	*Deep dive: When Sherpas climb Mt. Everest*	
Week 13	Monday, Apr 18	Genetic drift	
	Wednesday, Apr 20	Australia vs New Zealand	
	Friday, Apr 22	*Activity: Model a gene in a population*	
Week 14	Monday, Apr 25	What is a species really?	
	Wednesday, Apr 27	How are animals related?	
	Friday, Apr 29	*Deep dive: How DNA analysis rewrote phylogenetic trees*	
Week 15	Monday, May 2	Phylogenies and family trees	
	Wednesday, May 4	The fossil record	
	Friday, May 6	*Activity: Build your own phylogeny*	
Week 16	Monday, May 9	Timeline of life on Earth	
	Wednesday, May 11	**Evolution Quiz Show**	
	Friday, May 13	*Evolution anchor diagram and timeline*	





How to use this course:

For younger students (2nd-5th grade) we recommend a "get the basics" approach that focused on the Mon/Wed classes. For older or more advanced students (6th-8th grade) we recommend completing each of the activities and assignments to reinforce the concepts covered.

Option One: Get the Basics

Ideal for younger students

Participate in Mon-Wed classes only. Skip the Friday activities. Participate in quiz show review days. Save the science activities, deep dive articles, and other assignments for a later date.

Option Two: The Full Course

Ideal for older students & advanced learners

Participate in Mon-Wed classes and do the Friday activities and reading assignments.

Complete all quizzes and assignment to receive a certificate of completion at the end of the course.

Tips for best learning:

- ☑ Read the pages that go with each lesson before watching the video. Take 10-15 minutes before class to see if you can fill in the blanks. If you can't fill in everything, that's okay! Listen during class to see if you can complete the page.
- ☑ If a lesson moved too fast, rewatch it later to help learn the concepts.
- ☑ Download the answer key for the notes, but don't look at the answers until after you give things a try yourself!

Project Supply List:

Jan 28 - Vegetative Propagation with Potato
- Potato or sweet potato (for quicker results, use one where the eyes have already begun to sprout)
- Knife
- 4 small pots or cups
- Potting soil

Jan 24-Feb 18 - Heredity Anchor Diagram
- Paper and art supplies

Feb 25 - Gummy Worm Karyotypes
- Enough gummy worms or other oblong-shaped colorful candy to create 23 pairs of chromosomes
- Pencil
- Paper
- Knife or Scissors

Mar 4 - What's the Blood Type?
- Home blood typing kit (optional)

Mar 18 - Apple Variety Taste Test
- Several varieties of apple including Red Delicious, Granny Smith, and three other types.
- Knife

Feb 21-Mar 25 - Genetics Anchor Diagram
- Paper and art supplies

April 8 - Journey of HMS Beagle
- Printable world map
- Paper and scissors
- Yarn or art supplies such as crayons, colored pencils, markers, or paint

April 22 - Model a Gene in a Population
- 20 black marbles and 20 white marbles (or some items that can be drawn randomly in a sample)

May 6 - Build your own phylogeny
- Paper and art supplies

Apr 4-May 13 - Evolution Anchor Diagram and Timeline
- Paper and art supplies

Which science standards are covered in this course?

The standards listed below are the national science standards for K-12 education in the United States. They are commonly referred to as Next Generation Science Standards or NGSS.

MS-LS1-4. *Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.* ***April 4, April 6, April 11, April 13***

MS-LS1-5. *Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.* ***Mar 14***

MS-LS3-1. *Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.* ***Feb 21, Feb 23, Feb 28, Mar 2, Mar 9, Apr 4***

MS-LS3-2. *Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.* ***Jan 26, Jan 31, Feb 2, Feb 7, Feb 14***

MS-LS4-1. *Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.* ***April 25, April 27, May 4, May 9***

MS-LS4-2. *Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.* ***April 27, May 2***

MS-LS4-3. *Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.* ***May 2***

MS-LS4-4. *Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.* ***April 11, April 13***

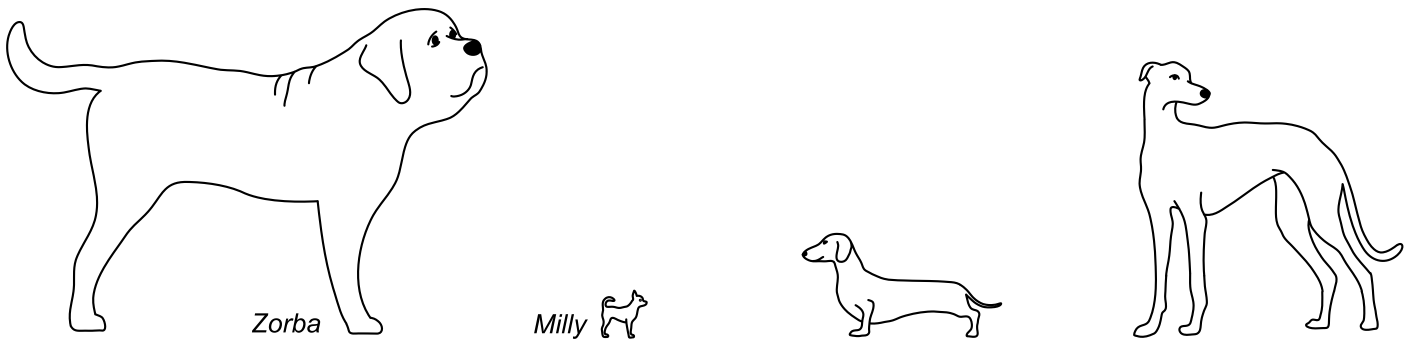
MS-LS4-5. *Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.* ***Mar 21***

MS-LS4-6. *Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.* ***April 18***

Date	Topic	NGSS	Page(s)
Wednesday, Jan 26	Life finds a way	MS-LS3-2	-
Monday, Jan 31	Mendel's Famous Experiment	MS-LS3-2	
Wednesday, Feb 2	The laws of heredity 1	MS-LS3-2	
Monday, Feb 7	The laws of heredity 2	MS-LS3-2	
Monday, Feb 14	Punnet squares	MS-LS3-2	
Monday, Feb 21	What is a gene?	MS-LS3-1	
Wednesday, Feb 23	Chromosomes and linked traits	MS-LS3-1	
Monday, Feb 28	Blood types explained	MS-LS3-1	
Wednesday, Mar 2	Protein synthesis	MS-LS3-1	
Wednesday, Mar 9	Mutations	MS-LS3-1	
Monday, Mar 14	Nature and nurture	MS-LS1-5,	
Monday, Mar 21	Modifying genes and gene therapy	MS-LS4-5	
Monday, Apr 4	Endangered vs invasive species	MS-LS1-4, MS-LS3-1	
Wednesday, Apr 6	Darwin and the Galapagos	MS-LS1-4	
Monday, Apr 11	Survival of the fittest	MS-LS1-4, MS-LS4-4	
Wednesday, Apr 13	Color-changing moths	MS-LS1-4, MS-LS4-4	
Monday, Apr 18	Genetic Drift	MS-LS4-6	
Monday, Apr 25	What is a species really?	MS-LS4-1	
Wednesday, Apr 27	How are animals related?	MS-LS4-1, MS-LS4-2	
Monday, May 2	Phylogenies and family trees	MS-LS4-2, MS-LS4-3	
Wednesday, May 4	The fossil record	MS-LS4-1	
Monday, May 9	Timeline of life on Earth	MS-LS4-1	

What makes a species?

The domestic dog includes hundreds of different breeds with diverse personalities, shapes, and sizes. The biggest dog, an English Mastiff named Zorba, weighed more than 143 kg (315 pounds) and measured 94 cm (37 inches) tall from ground to shoulder. The smallest dog, a Chihuahua named Milly, is just under 10 cm (4 inches) tall and weighs just 0.5 kg (about 1 pound). Mastiffs, Chihuahuas, Dachshunds, and Greyhounds are all called dogs, but they are incredibly different animals!



English Mastiff	**Chihuahua**	**Dachshund**	**Greyhound**
70-91 cm / 28-36 in	15-25 cm / 6-10 in	20-23 cm / 8-9 in	68-76 cm / 27-30 in
54-100 kg / 120-230 lbs	1.4-3 kg / 3.3-6.6 lbs	7-14 kg / 16-32 lbs	26-40 kg / 57-88 lbs

1. What makes a dog a dog? Share your opinion:

____

____

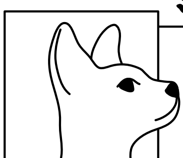
____

2. If the characteristics you described above were used as the official definition of a dog, would cats also be called dogs?

____

3. List three similarities and differences between cats (*Felis*) and dogs (*Canis*):

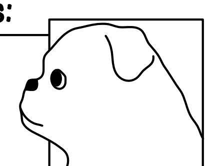
Similarities between cats and dogs:



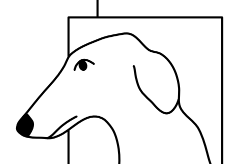
SPHYNX CAT

MAINE COON

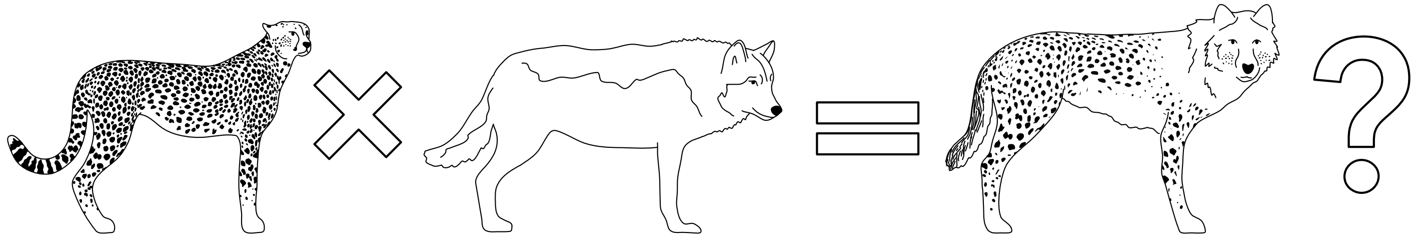
Differences between cats and dogs:



PUG

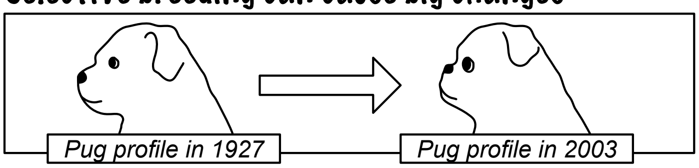


BORZI

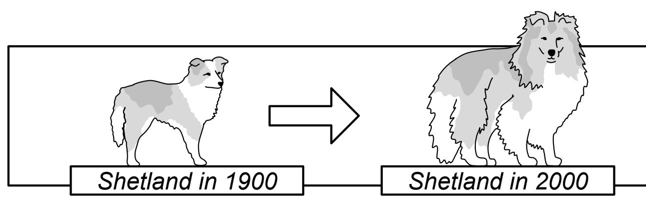


4. Coyotes, wolves, and dogs can all interbreed, creating hybrids like the wolfdog, coywolf, coydog or dogote. Lions and tigers can also be bred to create hybrids, which are called ligers or tigons. In your opinion, would it be possible to cross a cheetah with a wolf? If so, what would you call this hybrid? A woltah? A cheef?

Selective breeding can cause big changes



Breeders prized the "squished face" appearance of the Pug and chose dogs with shorter and shorter snouts. Because of their face shape, modern Pugs are susceptible to eye trouble and breathing problems.



In 1900, Shetland sheepdogs were reported to weigh between 7 and 10 pounds and have medium length fur. The modern Shetland Sheepdog has doubled in size and has much longer fur.

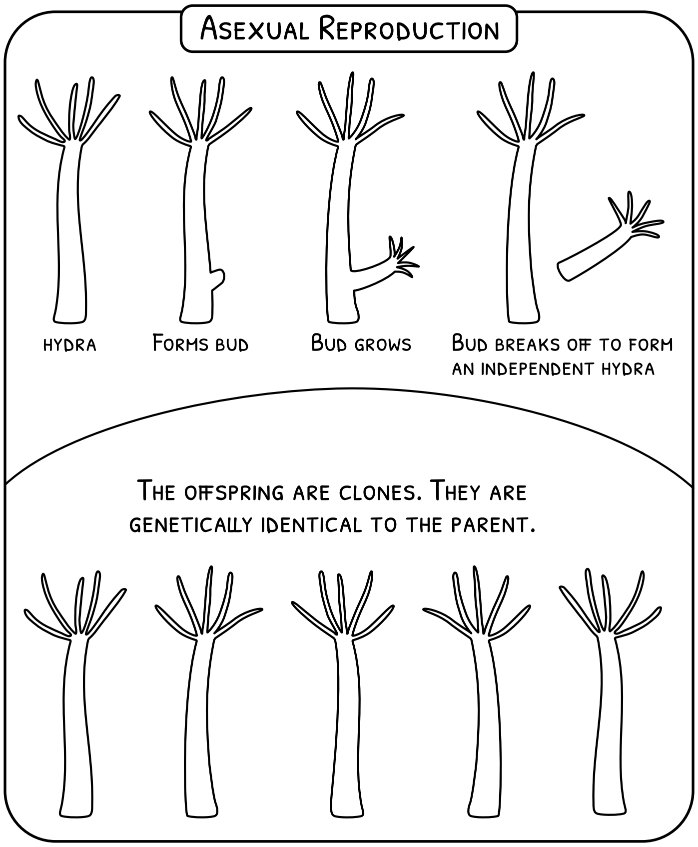
5. Suppose that a settlement on Mars uses Great Danes for pulling sleds while a different settlement uses Chihuahuas for hunting cockroaches that hide in small spaces. If the people in the first settlement selectively breed their Great Danes to be larger and stronger while the people in the second settlement breed their Chihuahuas to be smaller and faster, what would you expect Mars dogs to look like after approximately 1,000 years have passed? Would Great Danes and Chihuahuas be different species from each other then?

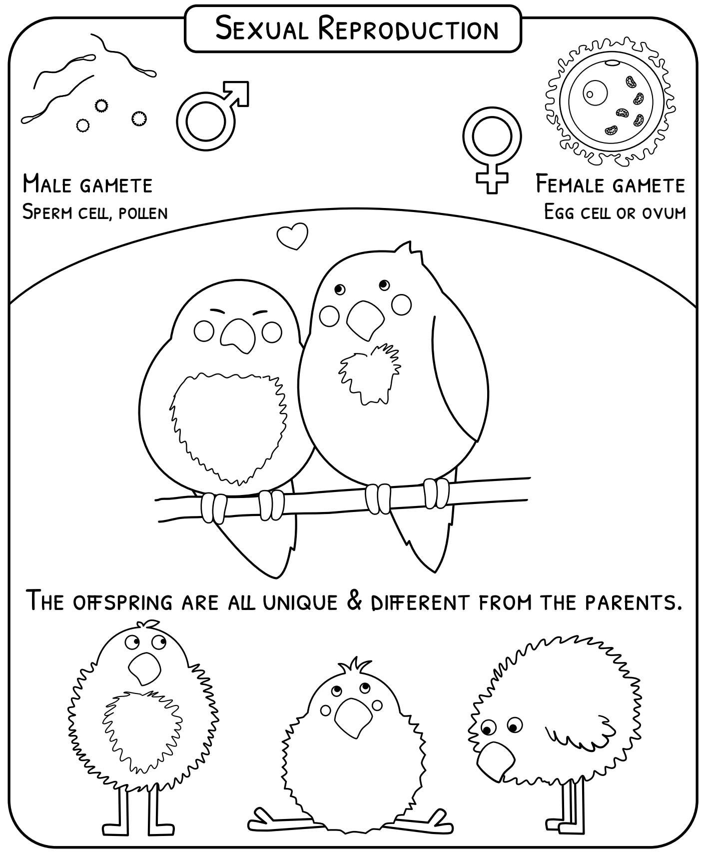
Martian Great Dane in 3020

Martian Chihuahua in 3020

Life finds a way

The **ability to reproduce** is one of the key characteristics in most definitions of life. There are two main strategies: asexual reproduction, which creates identical clones, and sexual reproduction which creates offspring that are different from each parent.





Record the primary advantages and disadvantages in each category below. Consider the following:

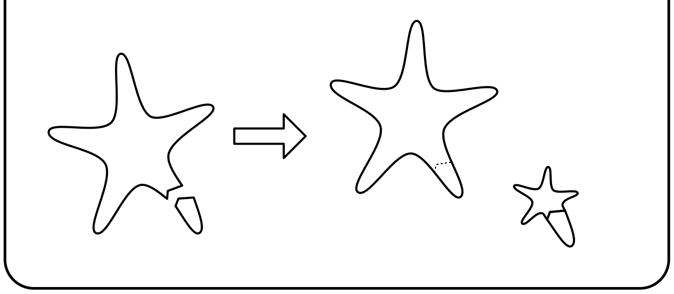
- Speed of reproduction: Is the next generation formed and independently growing within minutes or days? Does it take years to form an independent next generation?
- Genetic diversity: is the diversity high (which provides greater resistance to disease) or low (which makes a population more at risk from disease)?
- Does reproduction require a mate? Could one individual reproduce?

ASEXUAL REPRODUCTION	
ADVANTAGES:	DISADVANTAGES:

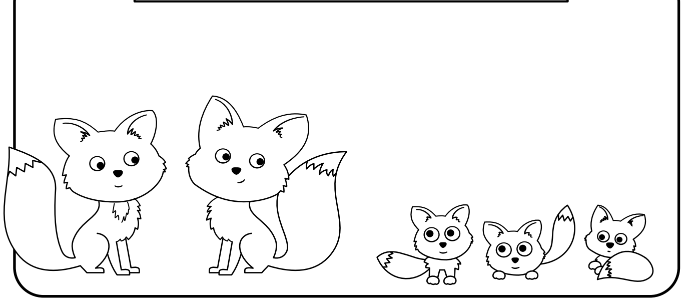
SEXUAL REPRODUCTION	
ADVANTAGES:	DISADVANTAGES:

Match each reproductive strategy with the correct definition:

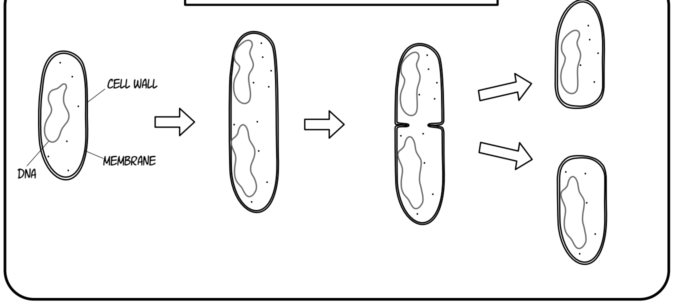
FRAGMENTATION



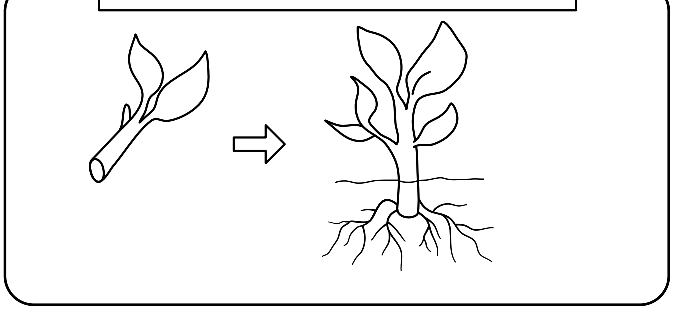
SEXUAL REPRODUCTION



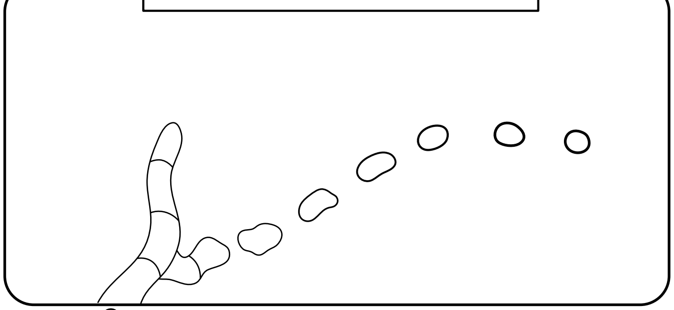
BINARY FISSION



VEGETATIVE PROPAGATION



SPORE FORMATION



Genetic information from two individuals is combined to create offspring that are different from both parents. This reproductive strategy is the most common among animals, fungi, and plants.

An organism is split into pieces. Each of those fragments then develops into adult individuals that are clones of the original organism. Molds, lichen, sponges, certain worms, and sea stars all use this reproductive strategy.

The division of a single cell into two identical cells. This reproductive strategy is used by bacteria and archaea.

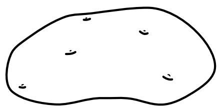
A specialized cell forms that can withstand harsh environmental conditions such as drought or extreme heat. Once the conditions improve, the cell germinates and begins growing. This strategy can be either sexual or asexual. Commonly used by fungi.

Asexual reproduction occurring in plants where a fragment or cutting is separated from the parent plant and grows as a separate individual. Commonly used with food crops such as bananas, sweet potato, sugarcane, and pineapple.

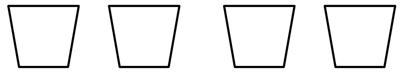
Hands-on Science Project

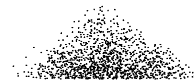
PROPAGATE A POTATO

MATERIALS:


Potato or sweet potato


Knife

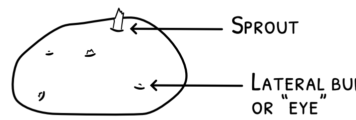

4 identically-sized pots
To harvest a good amount of potatoes, use a large 1 gallon pot or a 5 gallon bucket with drainage holes.


Potting soil or other growing medium such as coconut coir, peat moss, or sand.

For best results, use older potatoes

Most commercially-available potatoes are treated with chlorpropham, a compound that prevents sprouting. For best results, select a tuber where you can see small sprouts or swelling in the “eyes” of the tuber. If you do not see any sprouts or signs of budding, let the potato sit for two weeks at room temperature or select a different potato.

Potatoes are tubers, specialized root structures that store starch. They contain buds that can grow into new plants.



1. Cut the potato into 4 pieces that are roughly equal in size. Make sure that each piece of potato has at least one or two “eyes” from which new sprouts will form. If sprouts have already developed, break off all but the three best sprouts and plant the potato piece with the sprouts pointing up.

2. Let the cut pieces sit at room temperature for between three to seven days. This drying process helps prevent them from molding after being planted. Do not let the potatoes sit for so long that they become shriveled.

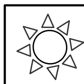
3. Fill the pots half full with potting soil and place one potato piece in each pot. Cover the potato piece so that it is at least 5 cm or 2 inch below the surface of the soil.

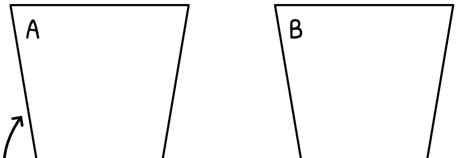
4. Water the soil in each pot so that it is moist. Do not let it become too wet or waterlogged and be careful that it doesn’t dry out completely. Place two of the pots in a very sunny location and the other two pots in a shady location.

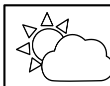
5. Care for the plants for at least 10 weeks by keeping the soil moist with regular watering. After sprouting, continue to add additional layers of potting soil until the pot is full. Record when the sprouts emerge from the soil and observations about the above-ground plants.

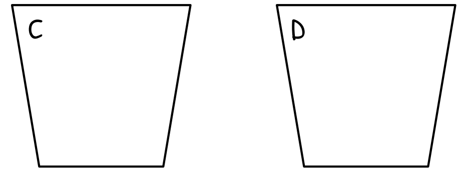
6. After 10 to 15 weeks, pull up the plants and sort through the soil to find the new potato tubers. Which plants produced the most potatoes?

Observations just after the first sprouts emerge:


Full sun




Partial sun or shade



Noting the date is a vital part of recording research!

DATE:

Draw a simple representation of your plants in these pots!

____

____

Write a line or two about what you observe.

Observations 3 weeks after
the first sprouts emerge:

DATE:

A B C D

Observations 6 weeks after
the first sprouts emerge:

DATE:

A B C D

Observations 9 weeks after
the first sprouts emerge:

DATE:

A B C D

Observations after digging up the potatoes:

DATE:

A B C D

The question of inheritance

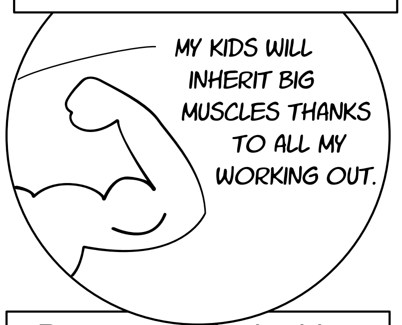
Throughout history, people have had different ideas about how traits are inherited. The three ideas described below were common when Mendel was alive. Which of these ideas best explains what you have observed about traits and how they are inherited? Rate them from one star (there are lots of counter examples for this idea) to four stars (this idea explains inheritance very well).

Lamarckism

Lamarckism is the belief that acquired traits can be inherited. Giraffes are able to lengthen their necks by constantly stretching, so their offspring will inherit a longer neck.

☆☆☆☆

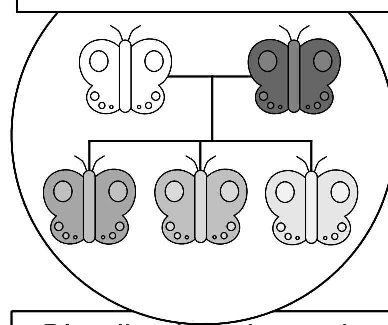
Pangenesis



Pangenesis is the idea that each part of the body produces small particles called gemmules that accumulate and are then passed on to offspring. It is the mechanism for Lamarckian inheritance.

☆☆☆☆

Blending



Blending inheritance is the idea that each trait will be inherited by the offspring at about the average level of each parent. For example, your hair color falls between your parents' hair colors.

☆☆☆☆

Gregor Mendel

mathematician, biologist, abbot, and founder of genetics.

FILL IN THE BLANKS USING THESE WORDS:

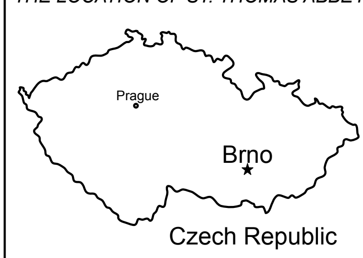
garden inheritance traits pea genetics

Gregor Mendel was a monk at St. Thomas Abbey. During Mendel's lifetime, the question of how ________ were passed from one generation to the next was one of the great mysteries of science. Popular ideas to explain ______________ included Lamarckism, the idea that acquired traits could be inherited.

In the 1850s, Mendel conducted experiments to discover how inheritance worked. He studied the characteristics of ________ plants, such as green and yellow seeds. His experiments were conducted in a small ____________ next to the abbey.

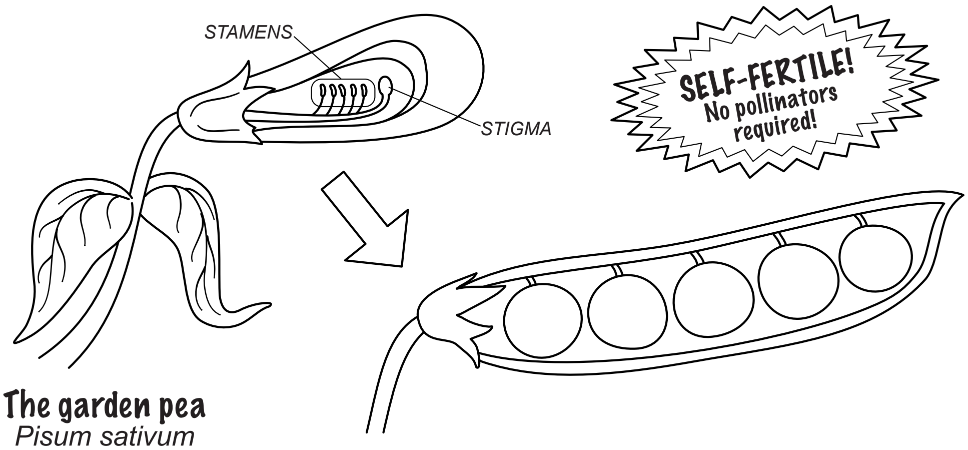
His conclusions were incredibly advanced for his time and he is widely considered to be the founder of modern ____________.

THE LOCATION OF ST. THOMAS ABBEY

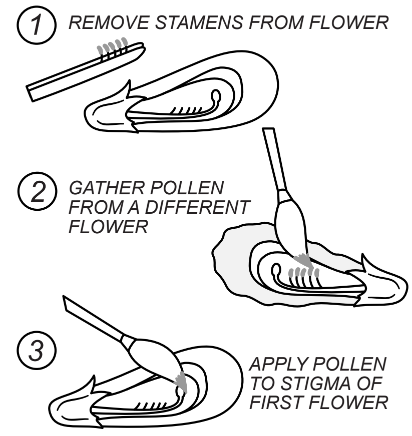


GREGOR MENDEL 1822-1884

A famous experiment

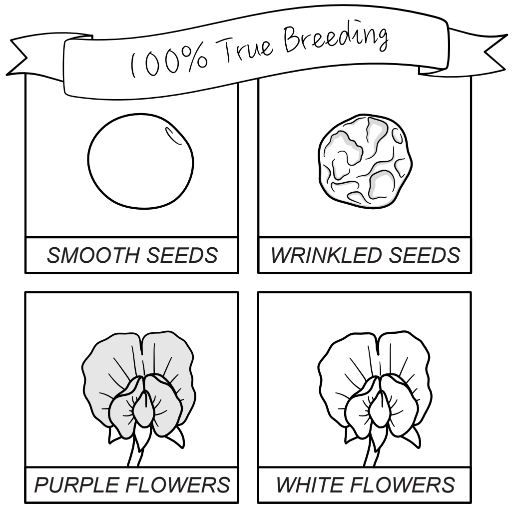


The garden pea
Pisum sativum

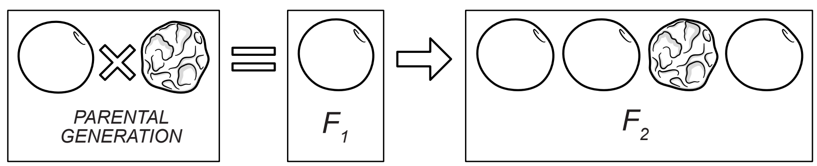


Peas are self-fertile. They do not need pollinators and unless a person intervenes, the pollen on the stamens will fertilize the stigma and produce a pea pod filled with seeds. To cross-pollinate two different pea plants, Mendel used tweezers to remove the stamens from one flower (1) and used a paintbrush to gather pollen from the flower of a different plant (2). The pollen was then applied to the stigma of the first plant to produce hybrid seeds (3).

MEET THE PARENT PEAS!



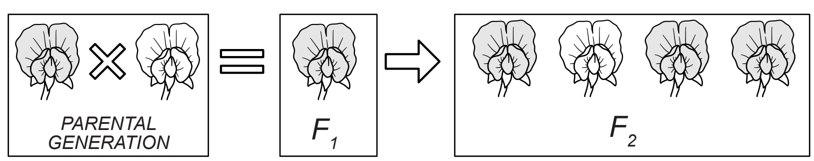
THE EXPERIMENT



A pea plant with smooth seeds is cross-fertilized with a plant that has wrinkled seeds.

ALL of the seeds in that first generation (called the F_1 generation) are smooth.

When those first generation seeds (F1) are self-fertilized, the next generation shows a 3 to 1 ratio of smooth to wrinkled seeds.



We see the same result with flower color.

If you were Mendel, how would you explain these results? Why is one trait disappearing in the F_1 generation and then coming back again in the next?

Disappearing and reappearing traits?

Mendel's results explained.

FILL IN THE BLANKS USING THESE WORDS:

inherited	generation	ignored	traits	dominant

When crossing two true-breeding pea plants with different traits, Mendel found that the first _____________ of plants looked identical to one of the parent plants. The trait from the other parent had "disappeared." But when these plants were self-pollinated, they were no longer true-breeding. Both _______ appeared with a consistent ratio: ¼ of the plants had the trait that had disappeared while ¾ of the plants had the other trait.

To explain this phenomenon, Mendel said that each plant ___________ two factors, one from each parent. Some factors (now called genes) were _____________ and others were recessive.

He published his research but it was _____________ for more than thirty years. Mendel wasn't recognized for his work until after his death and after other scientists discovered the same facts in the early 1900s.

Draw lines to match each term with the correct description:

Recessive

Dominant

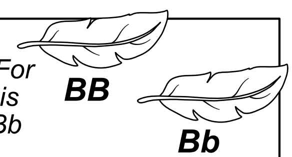
Homozygous

Heterozygous

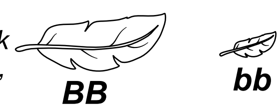
Genotype

Phenotype

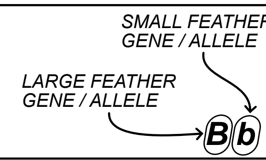
Only one copy (allele) of a gene is needed for the trait to be expressed. For example, if the trait for large feathers is represented by B, then both BB and Bb would result in big feathers.



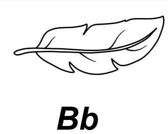
The copies (alleles) of the gene are both the same. From the Greek word "homos," which means same, and "zugos," which means yoked.



The genetic information of an organism. The term can also refer to the genetic information of a specific trait.



There are two different versions (alleles) of the gene. From the Greek words "heteros," which means different, and "zugos," which means yoked.



The trait will only be expressed if there are two identical copies (alleles) of the gene. For example, if small feathers are represented by b, then only the genotype of bb will produce small feathers.

The observable characteristics or traits of an individual, for example, having either small or large feathers.