Introduction to
LIFE SCIENCE

BACKGROUND INFORMATION—LIFE SCIENCE

Characteristics of Living Things

Living things (**biotic**) have a number of characteristics that make them different from non-living (**abiotic**) things.

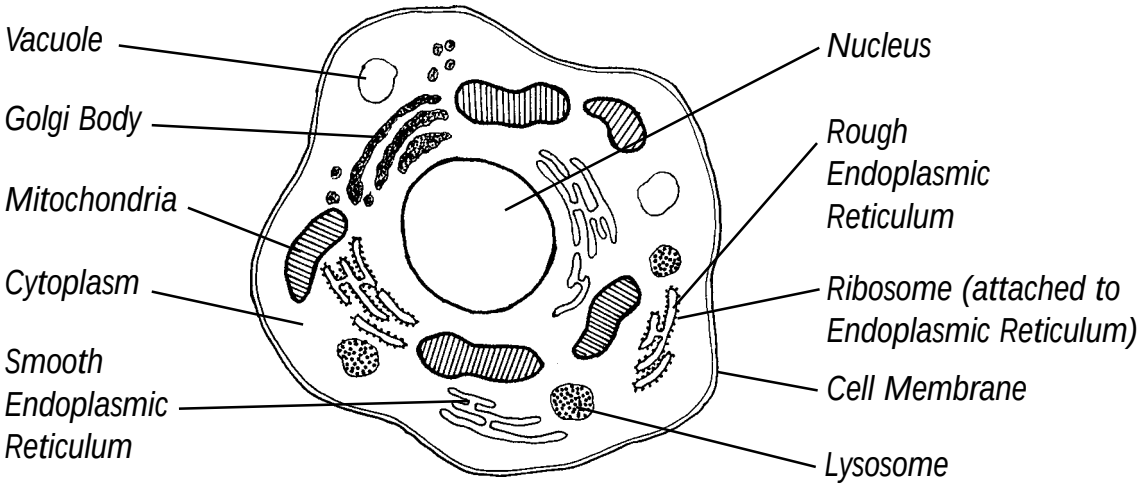
- They are made of one or more **cells**.
- Living things have structures that perform specific functions.
- Living things maintain an internal environment. The internal environment can be that of a single cell or that of an entire multi-cellular organism.
- Living things require and use energy. The energy is used to carry out life functions.
- Life functions of living things can include respiration, excretion, movement, and growth.
- Living things reproduce, passing along genetic information to future generations.
- Living things change over time, or evolve.

If an object does not have all these characteristics, it is not living. For example, light bulbs use energy and have an organized structure, but they do not move, respire, or reproduce. A marine sponge does not appear to move, but it does move during its early development and only later attaches itself to the sea floor or some other stationary object.

While all living things have these characteristics in common, there are seemingly infinite variations on the theme. These variations give us the enormous diversity of life on Earth today—perhaps between 10 and 100 million different **species**. To date, only about 1.4 million of these species have been identified.

The Cell

A cell is the smallest structural unit of life that is capable of functioning independently. In fact, cells are so small you could fit 9,000 of them, side by side, between the millimeter dashes on a ruler! Naturalists Robert Hooke and Anton van Leeuwenhoek were the first to view the microscopic world in the mid-1600s. It was Hooke who coined the term "cell" to describe the room-like partitions that he observed in cork through his microscope.



All living things are made up of one or more cells, but not all cells are the same. For example, protist cells are very different from human nerve cells, which are very different from blood cells. However, there are some basic similarities among all cells. These characteristics allow cells to carry out their basic functions of 1) interacting with their environment, 2) harnessing energy, and 3) digesting and storing food.

The **cell membrane** surrounds the outside of the cell. It is a thin layer made up of chemical compounds that act as a guard and gate to the inside of the cell. The cell membrane is **semi-permeable**, allowing only certain chemicals to enter or leave the cell.

The inside of the cell contains **cytoplasm**. Cytoplasm is a viscous fluid that acts as the cell's "blood" by transporting food and other chemicals from one part of the cell to the other. Other parts of the cell are also anchored to the cytoplasm. The **nucleus** and the **mitochondria** are two of the structures that can be found in the cytoplasm. The nucleus houses the genetic instructions (genes made up of DNA) for the cell. These genetic instructions determine the type of cell (nerve, blood, or protist) and how it will function. The mitochondria are the "power plants" for the cell, where food is turned into energy that the cell can use.

Lysosomes are another structure found in the cytoplasm. Lysosomes contain the enzymes used to break down food and discard waste products produced by chemical reactions in the cell. When the food is digested, the products are passed to the **vacuoles**. Vacuoles are also important in regulating water balance within the cell. For example, in plants, vacuoles help keep the plant stiff and rigid. When the vacuoles lose too much water, the plant wilts.

Change and Adaptation

Organization and order is one characteristic of living organisms, but change is the rule. Change occurs at several different biological levels. It occurs at the level of the individual organism, within groups of organisms, and within ecosystems. For instance, an individual organism changes as it grows and matures. A newborn wolf is different in shape, size, and behavior from that of an adult wolf. This kind of change is one part of the organism's **life cycle**. A life cycle is the combination of birth, growth, life, and death. Changes in individuals can be drastic, such as the complete changing of body form called **metamorphosis**. Metamorphosis occurs in butterflies and frogs, for example. Other changes are subtle, such as a ruby-throated hummingbird increasing its fat reserves for migration.

Change also takes place at the genetic level of individuals and their offspring. One type of genetic change is the process of **mutation**. A mutation is a change in the make up, or arrangement, of the genetic "instructions" for an organism. Sometimes mutations help an individual to survive better in its environment. Other mutations make it more difficult for an organism to survive. And still others are simply neutral and do not affect survival one way or another.

When an animal reproduces, another kind of genetic change takes place. This change occurs during **meiosis**, a type of cell division that occurs in sex cells. Parental genes, or traits, on the cells are halved when new sex cells are made. When a male and female reproduce, the halved male and female sex cells come together to form the offspring. That offspring displays a combination of physical traits from both parents. For example, you might have your mother's eye color and your father's curly hair. But, the combination of all the traits is different from either parent. Some traits may have been "hidden" in the parents' genetic makeup, but because of the "shuffling," those traits may show up in the offspring. In this way, change has occurred at the genetic level from one generation (the parents) to the next (the offspring).

Since organisms must reproduce in order for life to continue, survival and successful reproduction are paramount. If a mutation or trait helps an organism survive, the organism is more likely to reproduce and pass its genetic information to its offspring. If a mutation or trait is detrimental, the organism is less likely to survive and reproduce. Without reproduction and birth, the individual's genetic information will not be passed on. The more beneficial a trait is for survival and reproduction, the more likely that

trait will persist in future generations. In other words, those traits are "selected" in the population. This process is called **natural selection** and results in **biological adaptation**. If an organism faces changes in its environment and a particular trait is selected, then the organism is said to have adapted to the environment. Biological adaptation occurs at the genetic level and requires at least one reproductive cycle. Over time, groups of organisms **evolve** because of natural selection and adaptation.

It is sometimes difficult to convey to students that natural selection and biological adaptation are not deliberate acts. However, teachers must be very careful to describe the evolutionary process accurately. Organisms do not "want" to adapt or "decide" to select certain genetic traits. Likewise, the environment does not "create" traits or characteristics at the genetic level. The environment is only the testing ground for the existing genetic characteristics of an individual.

Classification in the Life Sciences

Biologists have looked to the past to understand how today's organisms live and interact with each other and their environment. Biologists "map" these associations by first studying the similarities among modern organisms and fossils. By determining the age of the rocks where fossils are found, scientists have learned when in Earth's history different organisms lived. Fossil records show the order in which animals developed over millions of years. This information is represented in a historical time line of organisms, called a **geologic time line** (Table 1). Biologists use this information to study how modern organisms are related to one another and to help them organize and classify groups of organisms.

Now, imagine keeping track of 8,000 different kinds of birds or over 20,000 kinds of insects! What about classifying 1.4 million different types of living organisms? In order for biologists to make sense of all the different kinds of organisms, they group them with other similar organisms. In this way, biological information is organized much like a supermarket organizes its produce or a library organizes books. Scientific classification categorizes organisms into groups of similar organisms, but it also takes into account how those organisms are related to one another. Biologists who specialize in classification are called **taxonomists**.

Taxonomists group organisms into large, general categories called **kingdoms**. The kingdom concept is similar to categorizing library books into fiction and non-fiction.

Table 1—Geologic Time Line

ERA	PERIOD	MILLIONS OF YEARS AGO (APPROX.)	MAJOR EVOLUTIONARY EVENTS
Cenozoic	Quaternary	0 to 1.8	Humans evolve
	Tertiary	1.8 to 65	Mammals and birds dominant
Mesozoic	Cretaceous	65 to 144	First placental mammals Flowering plants dominant
	Jurassic	144 to 200	First birds First flowering plants
	Triassic	200 to 251	First mammals First dinosaurs
Paleozoic	Permian	251 to 295	Cone-bearing plants dominant
	Carboniferous	295 to 355	First reptiles First seed plants
	Devonian	355 to 410	First amphibians First seeds (plants)
	Silurian	410 to 435	First fossil plants First jawed fish
	Ordovician	435 to 500	Algae dominant First fungi
	Cambrian	500 to 540	First vertebrates Simple invertebrates
Precambrian	Precambrian	Before 540	Life diversifies Eukaryotes Prokaryotes Origin of Life

Table 2—Characteristics of the Four Kingdoms of Eukaryota

KINGDOM	MAJOR MODE OF FEEDING	MOTILITY (MOVEMENT)
Protista	Absorb, ingest, or photosynthesize	Both motile and non-motile
Fungi	Absorb	Generally non-motile
Plantae	Photosynthesize	Generally non-motile
Animalia	Ingest	All motile at some stage

There are currently four recognized kingdoms: protists (Protista), fungi (Fungi), plants (Plantae), and animals (Animalia) (Table 2). Older texts often include a fifth kingdom, the Monera, which includes bacteria. However, as biologists learned more about bacteria, they discovered they were very different from all other organisms—so different, that bacteria are now included in a new category called a domain. The three domains are the Bacteria domain; the Eukaryota domain, which includes four kingdoms (protists, fungi, plants, and animals); and a new domain, called Archaea, which includes bacteria-like organisms with a genetic makeup that is very different from bacteria.

Just as the fiction category in the library includes mysteries, westerns, and romantic novels, kingdoms also include other categories of organisms. Beneath the kingdom, the categories are arranged in descending order or in a hierarchy (Table 3). This means that the categories at each level contain all the organisms in the categories below. The top of the hierarchy contains larger groups of organisms that are similar, but not necessarily closely related. For example, humans, porcupines, and black bears are all mammals, but are only distantly related. They share the same categories at the top levels: kingdom Animalia, phylum Chordata and class Mammalia. But, humans belong to the Order Primates, porcupines belong to the Order Rodentia, and black bears belong to the Order Carnivora.

The increasingly smaller categories contain organisms that are more similar and more closely related. For example, wolves, bears, and cougars are all meat eaters and belong to the order Carnivora. Even more closely related are dogs, wolves, and coyotes,

Table 3—Hierarchy of Categories

SAMPLE ANIMALS	Bald Eagle	Humans	Porcupine	Black Bears	Crocodile (American)	Domestic Dogs
KINGDOM	Animalia	Animalia	Animalia	Animalia	Animalia	Animalia
PHYLUM	Chordata	Chordata	Chordata	Chordata	Chordata	Chordata
CLASS	Aves	Mammalia	Mammalia	Mammalia	Reptilia	Mammalia
ORDER	Falconi-formes	Primates	Rodentia	Carnivora	Crocodylia	Carnivora
FAMILY	Accipit-ridae	Hominidae	Erethi-zontidae	Ursidae	Crocodylidae	Canidae
GENUS	*Haliaeetus*	*Homo*	*Erethizon*	*Ursus*	*Crocodylus*	*Canis*
SPECIES	*leuco-cephalus*	*sapiens*	*dorsatum*	*americanus*	*acutus*	*familiaris*

which all belong to the genus Canis. This system of scientific classification helps biologists organize the vast quantity of organisms that have been identified. It also makes the huge job of sorting through and classifying the vast array of newly discovered organisms much easier!

Naming Species

When identifying each individual species, scientists use a naming system developed by Carolus Linnaeus in the 1700's. **Binomial nomenclature** is a system that uses two Latin names to identify the genus and species of each organism. These scientific names are used worldwide by scientists and they help eliminate the confusion sometimes caused when a species has multiple common names in several different languages. An organism's scientific name is always italicized or underlined. The genus name always begins with a capital letter, but the species name is always lower case. For example, the scientific name for humans is written: Homo sapiens or *Homo sapiens*. Homo is the

name of the genus, and sapiens is the name of the species. These basic rules, once learned, make the exchange of information between biologists clear and concise.

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INFORMACIÓN BÁSICA—LAS CIENCIAS DE LA VIDA

Características de los seres vivos

Los seres vivos (**bióticos**) tienen varias características que los distinguen de los objetos no vivos (**abióticos**).

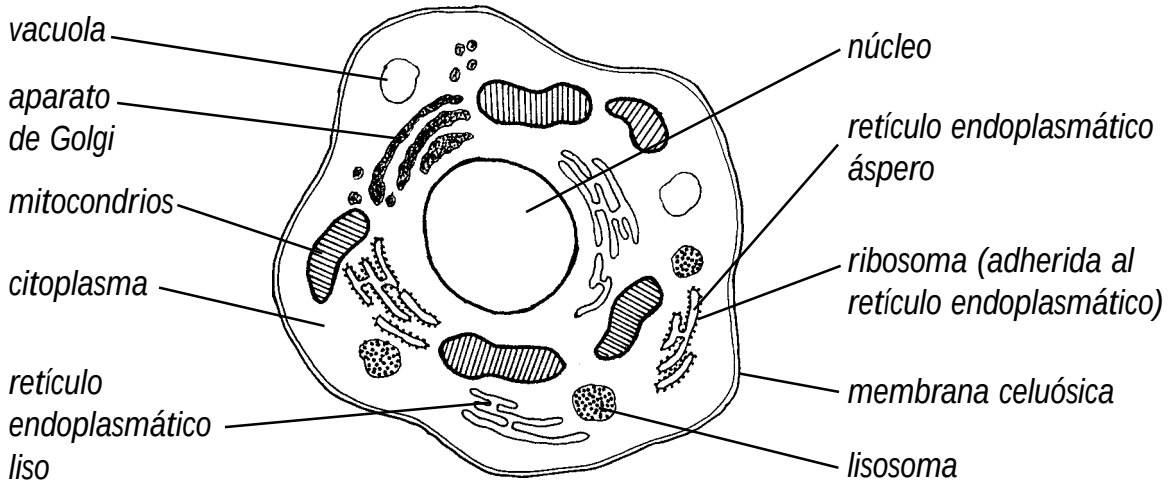
- Están compuestos por una o más **células.**
- Los seres vivos tienen estructuras que realizan funciones específicas.
- Los seres vivos tienen un medio interno. Este medio interno puede ser una sola célula o puede tratarse de un organismo multicelular.
- Los seres vivos necesitan y utilizan energía. Esta energía se usa para realizar funciones vitales.
- Las funciones vitales de los seres vivos abarcan, entre otras, la respiración, la excreción, el movimiento y el crecimiento.
- Los seres vivos se reproducen y pasan información genética a las generaciones futuras.
- Los seres vivos cambian o evolucionan a través del tiempo.

Si un objeto no tiene todas estas características, no se lo considera un ser vivo. Por ejemplo, una bombilla de luz usa energía y tiene una estructura organizada pero no se mueve, ni respira ni se reproduce. Una esponja de mar no parece moverse, pero en realidad se mueve durante la primera etapa de su desarrollo y sólo en una etapa posterior se adhiere al fondo del mar o a algún otro objeto estacionario.

Aunque todos los seres vivos tienen estas características en común, parece haber un número infinito de variaciones sobre el tema. De estas variaciones emana la enorme diversidad de tipos de vida que existen en la Tierra en la actualidad—quizás entre 10 y 100 millones de **especies** diferentes. Hasta ahora, se han identificado 1.4 millones de especies.

La célula

La célula es la unidad estructural viviente más pequeña que existe, capaz de funcionar independientemente. De hecho, las células son tan pequeñas que podrías ubicar 9,000 de ellas, una al lado de la otra, en el espacio que ocupa ¡un milímetro en una regla! Los naturalistas Robert Hooke y Anthony von Leeuvenhoek fueron los primeros en ver el mundo microscópico, a mediados de los años mil seiscientos. Hooke fue quien



acuñó el término "célula" (del latín *cellulla*: celdilla) para describir las pequeñas celdas que vio en un corcho a través de su microscopio.

Todos los seres vivos están compuestos de una o más células, pero no todas las células son iguales. Por ejemplo, las células de los protistas son muy diferentes de las células del sistema nervioso de los seres humanos y a la vez, muy diferentes de los glóbulos rojos. Sin embargo, existen similitudes entre todas las células. Estas características permiten a las células llevar a cabo sus funciones básicas 1) interactuar con el medio ambiente, 2) aprovechar energía, digerir y acumular alimentos.

La **membrana celular** rodea a la célula por afuera. Es una capa delgada formada por sustancias químicas que actúan como guardián y puerta de entrada hacia el interior de la célula. La membrana es **semipermeable** y sólo permite que cierto tipo de químicos entren o salgan de la célula.

El interior de la célula contiene **citoplasma**. El citoplasma es un fluido viscoso que actúa como si fuera la "sangre" de la célula, transporta alimentos y otras sustancias químicas de una parte de la célula a la otra. Otras partes de la célula también están ancladas al citoplasma. El **núcleo** y la **mitocondria** son dos de las estructuras que se encuentran en el citoplasma. La información genética (los genes están compuestos por ADN) está dentro del núcleo de la célula. Esta información genética determina qué tipo de célula será (nerviosa, sanguínea o protista) y cómo funcionará. La mitocondria es la "planta de energía" de la célula, donde los alimentos se transforman en la energía que usa la célula.

Otra estructura que se encuentra dentro del citoplasma son los **lisosomas**. Éstos contienen las enzimas que degradan los alimentos y eliminan los desechos producidos por las reacciones químicas dentro de la célula. Cuando los alimentos se digieren, los productos pasan a las **vacuolas**. Las vacuolas también son importantes para regular el agua dentro de la célula. Por ejemplo, las vacuolas de la planta la ayudan a que permanezca erguida y rígida. Cuando las vacuolas pierden mucha agua, la planta languidece.

Cambios y adaptaciones

Una de las características de los seres vivos es la organización y el orden, pero es el cambio lo que prevalece. El cambio ocurre a distintos niveles biológicos. Ocurre en organismos individuales, en grupos de seres vivos y en ecosistemas. Por ejemplo, un ser vivo cambia al crecer y madurar. Un lobo recién nacido tiene forma, tamaño y comportamiento diferentes de los de un lobo adulto. Este tipo de cambio es una de las partes del **ciclo vital** del organismo. El ciclo vital es una combinación de nacimiento, crecimiento, vida y muerte. Los cambios que sufren algunos individuos pueden parecer drásticos, por ejemplo la transformación total de la forma del cuerpo llamado **metamorfosis**. La metamorfosis ocurre en animales tales como las mariposas y las ranas. Hay otros cambios más sutiles, por ejemplo, el colibrí de pecho rojo que acumula reservas de grasa para utilizar durante el proceso migratorio.

Las transformaciones a nivel genético también ocurren en los individuos y en su progenie. Un tipo de cambio genético proviene de las **mutaciones**. Una mutación es un cambio en la organización o configuración de la "información" genética de un organismo. A veces las mutaciones ayudan a que un individuo pueda sobrevivir más facilmente en su medio ambiente. Otras mutaciones dificultan la supervivencia del organismo. Y, otras mutaciones son simplemente neutrales y no afectan la supervivencia de manera alguna.

Otro tipo de cambio genético ocurre con la reproducción de los animales. Este cambio se observa durante la **meiosis**, un cierto tipo de división celular que ocurre en las células sexuales. Los genes de los padres, es decir los rasgos que están impresos en las células se dividen por la mitad cuando se forman nuevas células sexuales. Cuando un macho y una hembra se reproducen, la mitad de las células sexuales masculinas y la mitad de las células femeninas se juntan para formar el nuevo ser. Ese nuevo ser tiene una combinación de características físicas de ambos padres. Por ejemplo, tú puedes tener el color de ojos de tu madre y el cabello rizado de tu padre. Pero, la

combinación de todos estos rasgo será diferente a ambos padres. Algunos rasgos pudieron haber permanecido "escondidos" dentro de la estructura genética de los padres pero como se "mezclan" todos otra vez, es posible que resurjan en el nuevo ser. De esta manera, un cambio al nivel genético ocurre de generación (los padres) a generación (los hijos).

Ya que la mayoría de estos seres vivos se reproducen para que la vida continúe, la supervivencia y la reproducción exitosa tienen suprema importancia. Si alguna mutación o algún rasgo ayuda a que el ser vivo sobreviva, este organismo tiene más posibilidades de reproducirse y de pasar este rasgo genético a su progenie. Si esta mutación o rasgo genético es perjudicial, entonces el organismo tendrá menos posibilidades de sobrevivir y reproducirse. Sin reproducción y nacimiento, la información genética del individuo no pasará a otras generaciones. Cuanto más beneficioso sea el rasgo para la supervivencia y la reproducción, tanto más probable es que ese rasgo persista y se transmita a futuras generaciones. En otras palabras, esas son las características "seleccionadas" para esa población. Este proceso se llama **selección natural** y el resultado es la **adaptación biológica**. Si un ser vivo se enfrenta con cambios en el medio ambiente y "selecciona" esa característica en particular, entonces se dice que ese ser vivo se ha adaptado al medio ambiente. La adaptación biológica ocurre al nivel genético y requiere que, por lo menos, se produzca un ciclo reproductivo. A través del tiempo, los grupos de seres vivos **evolucionan** debido a la selección natural y a la adaptación.

A veces es fácil confundirse y pensar que la selección natural y la adaptación biológica son acciones deliberadas. Sin embargo, las maestras deben prestar atención y describir el proceso evolutivo con precisión. Los organismos ni "desean" ni "deciden" seleccionar determinados rasgos. De la misma manera, el medio ambiente no "crea" los rasgos o las características genéticas. El medio ambiente es sólo el lugar donde se prueban las características genéticas de cada individuo.

Ciencias de la vida: clasificación

Los biólogos estudian el pasado para entender cómo viven los organismos actuales y cómo interactúan entre ellos y con el medio ambiente. Los biólogos hacen "mapas" de estas asociaciones estudiando, primero, las similitudes entre organismos modernos y fósiles. Los científicos han aprendido en qué momento de la historia de la Tierra han habitado los diferentes organismos, fechando las rocas en donde se han encontrado dichos fósiles. La información recolectada sobre fósiles muestra el orden cronológico

Cuadro 1—Línea temporal geológica

ERA	PERÍODO	HACE CUÁNTOS MILLIONES DE AÑOS (APROX.)	PRINCIPALES ACONTECIMIENTOS EVOLUTIVOS
Cenozoica	Cuaternario	0–1.8	Aparece el ser humano
	Terciario	1.8–65	Los mamíferos y las aves dominan
Mesozoica	Cretácico	65–144	Primeros mamíferos con placenta, las plantas con flores dominan la flora
	Jurásico	144–200	Primeras aves Primeras plantas con flores
	Triásico	200–251	Primeros mamíferos Primeros dinosaurios
Paleozoica	Pérmico	251–295	Las plantas coníferas dominan la flora
	Carbonífero	295–355	Primeros reptiles Primeras plantas de semillas
	Devónico	355–410	Primeros anfibios Primeras semillas (plantas)
	Silúrico	410–435	Primeras plantas fosilizadas Primeros peces mandibulados
	Ordovícico	435–500	Dominan las algas Primeros hongos
	Cámbrico	540–540	Primeros vertebrados Invertebrados simples
Precámbrica	Precámbrico	Anterior a 540	La vida se diversifica Eucariotes Procariotes El orígen de la vida

Cuadro 2—Características de los cuatro reinos de los eucariota

REINO	FORMA DE ALIMENTACÍON	MOTILIDAD (MOVIMIENTO)
Protista	Absorción, ingestión o fotosíntesis	Tanto móvil como estacionario
Fungi	Absorción	Generalmente estacionario
Plantae	Fotosíntesis	Generalmente estacionario
Animalia	Ingestión	Todos móviles en alguna etapa

en que los animales se desarrollaron a través de millones de años. Esta información se puede ver en la línea histórica temporal de los seres vivos, o **línea geológica de tiempo** (Cuadro 1). Los biólogos utilizan esta información para estudiar la relación de los seres vivos modernos entre ellos y para organizar y clasificar los organismos en grupos.

Ahora, ¡imagínate llevar la cuenta de 8,000 especies diferentes de aves o de 20,000 tipos de insectos! ¡Y, piensa en clasificar 1.4 millones de seres vivos diferentes! Para que los biólogos puedan organizar y extraer información de todos los distintos tipos de organismos, los agrupan con otros seres vivos similares. De esta manera, la información biológica se organiza de manera parecida a la de los productos frescos en un supermercado o a la de los libros en una biblioteca. La clasificación científica ubica a los organismos en categorías con características similares, pero también toma en consideración la relación entre ellos. Los biólogos que se especializan en la clasificación de organismos se llaman **taxónomos.**

Los taxónomos agrupan a los organismos en categorías generales y amplias llamadas **reinos**. El concepto de reinos tiene similitud con la categorización de libros en las bibliotecas: literatura novelística y no novelística (historia, biografías, ensayos, etc.). Actualmente existen cuatro reinos reconocidos: protistas (Protista), hongos (Fungi), plantas (Plantae) y animales (Animalia) (Cuadro 2). Los textos más antiguos hablan de un quinto reino que incluye las bacterias, el reino Monera. Sin embargo, a medida que

los biólogos descubrieron más sobre el tema, se dieron cuenta que las bacterias son muy diferentes de otros seres vivos—tan diferentes, que en la actualidad las bacterias se incluyen en una categoría llamada dominio. Los tres dominios son el Bacteriano, el Eucariota que incluye los cuatro reinos (protista, hongos, plantas y animales) y un nuevo dominio llamado Archaea, que se creó cuando se descubrieron organismos del tipo de las bacterias pero con una composición genética muy diferente a la de las bacterias.

De la misma manera que la categoría de novelas de la biblioteca incluye novelas policíacas, del lejano oeste y románticas, los reinos también incluyen categorías de seres vivos. Bajo el rótulo de reino, las categorías se organizan en orden de jerarquía descendente o ascendente (Cuadro 3). Esto significa que las categorías a cada nivel contienen todos los seres vivos de las categorías inferiores. El punto más alto de la jerarquía contiene grupos más amplios de seres vivos que son similares, pero no necesariamente relacionados. Por ejemplo, el ser humano, el puerco espín y el oso negro son todos mamíferos, pero no son parientes cercanos. Comparten las mismas categorías al nivel más alto de la jerarquía: reino Animalia, filo Chordata y clase Mammalia. Pero, el ser humano pertenece a la orden de los Primates, el puerco espín pertenece a la orden de los Rodentia y el oso negro pertenece a la orden de los Carnivora.

Las categorías se hacen cada vez más pequeñas y a medida que se reducen contienen seres vivos cada vez más similares y más relacionados. Por ejemplo, tanto los lobos, como los osos y los pumas comen carne y pertenecen a la orden de los Carnívora. Pero los perros, los lobos y los coyotes tienen una relación más cercana; todos pertenecen al género Canis. Este sistema de clasificación científica ayuda a que los biólogos organicen la amplia variedad de seres vivos que han identificado. ¡Además facilita el increíble trabajo de clasificar la gran gama de organismos que se siguen descubriendo!

Los nombres de las especies

Los científicos usan un sistema, inventado por Carolus Linnaeus en los años mil setecientos, que permite asignarle un nombre a cada una de las especies que identifican. La **nomenclatura binomial** es un sistema que utiliza dos nombres en latín para identificar el género y la especie de cada organismo. En el mundo de las ciencias se usan estos nombres científicos para evitar las confusiones que provienen de dar múltiples nombres comunes a cada especie en distintos idiomas. El nombre

Cuadro 3—Jerarquías dentro de las categorías

EJEMPLO DE ANIMALES	Águila calva	Ser Humano	Puerco espín	Oso negro	Cocodrilo (americano)	Perros domésticos
REINO	Animalia	Animalia	Animalia	Animalia	Animalia	Animalia
FILO	Chordata	Chordata	Chordata	Chordata	Chordata	Chordata
CLASE	Aves	Mammalia	Mammalia	Mammalia	Reptilia	Mammalia
ORDEN	Falconi-formes	Primates	Rodentia	Carnivora	Crocodylia	Carnivora
FAMILIA	Accipit-ridae	Hominidae	Erethi-zontidae	Ursidae	Crocodylidae	Canidae
GÉNERO	*Haliaeetus*	*Homo*	*Erethizon*	*Ursus*	*Crocodylus*	*Canis*
ESPECIE	*leuco-cephalus*	*sapiens*	*dorsatum*	*americanus*	*acutus*	*familiaris*

científico de un ser vivo siempre se pone en letra cursiva o se subraya. El nombre del género siempre se escribe con mayúscula al principio pero el nombre de la especie se escribe con letra minúscula. Por ejemplo, el nombre científico para los seres humanos se escribe: Homo sapiens u *Homo sapiens*. Homo es el nombre del género y sapiens es el nombre de la especie. Una vez que se aprenden esas reglas básicas, el intercambio de información entre científicos resulta claro y conciso.

QUESTIONS, OBSERVATIONS, AND HYPOTHESES

Preguntas, observaciones e hipótesis

Grades		
3-8	Whole Class	45–60 min.

Purpose

Students will practice asking questions, observing a living organism, inferring how that organism lives, and developing hypotheses based on their observations.

Materials

Living organisms such as ants, toads, fish, crickets, or worms
Hand lenses (optional)
Rulers (optional)

Concepts

- Observation is an important scientific skill.
- The scientific method is a set of steps used to systematically test ideas and find answers to questions

Conceptos

- La observación es una técnica científica muy importante.
- El método científico es un conjunto de etapas que se usan sistemáticamente para comprobar ideas y para buscar respuestas.

Safety

Students should wash their hands after handling organisms.
Review school's procedures for handling animals in the classroom.

Vocabulary

Observation
Scientific question
Inference
Hypothesis

Vocabulario

Observación
Preguntas científicas
Inferencia
Hipótesis

In Advance

Obtain living organism(s) listed in materials section.

Procedure

1. Asking questions

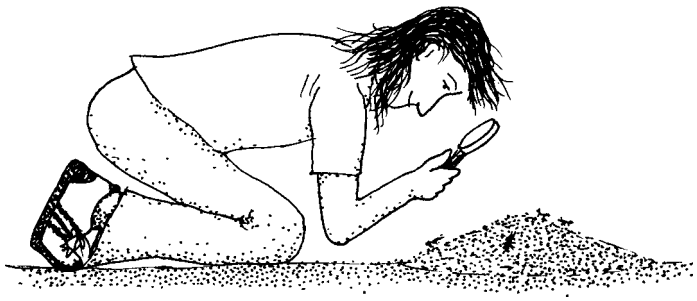
Choose an object from the classroom—a particular table, chair, a poster on the wall, etc. The object you select should have a distinguishing characteristic or two, but there should be similar objects in the classroom.

Tell students that you are thinking of an object in the classroom. Have them take turns asking **questions** about the object. The questions should have "yes" or "no" answers that will help them guess what the object is. Younger students may need a hint if they are stumped.

Once the object is identified, point out that precise questions were needed in order to figure out what the object was. Scientists also need to ask precise questions to help them in their search for answers and to make careful **observations**.

2. Observing

Display or pass around organisms for students to observe. (If organisms are in short supply, have students take turns observing the organisms in small groups.) Students should write down or draw their observations about the organism's size, color, shape, and behavior on the Student Activity Sheet provided. When they are finished observing, review their observations as a group and collect the organisms.



3. Inferring

Next, ask students what they were not able to learn about the organisms by simply observing them. For example, could they tell what kind of food the animal eats? Does the animal sleep? How fast can the animal move? Where does the animal normally live? Does temperature affect the animal's activity level?

Explain the term "**infer**" to students. Inferring is making an assumption based on observations. For instance, based on the fact that worms have no legs, students might infer that worms can't move as fast as an animal with legs. Ask students what they can infer about the animal they observed. Write their responses on the chalk board or have them write their responses on the Student Activity Sheet.

4. Hypothesis

Tell students that scientists are frequently unable to learn all there is to know about an organism by simply observing it. Sometimes their observations and inferences are only the first step. Help students further develop their inferences into a **hypothesis**. Explain that a hypothesis is the best guess to a question. The hypothesis should be something that can be tested and the results of a test should show that the guess was correct or not. For example, one hypothesis about the worm might be that "crickets move faster than worms." To test that hypothesis, worms and crickets could race to a finish line. Write down some of the hypotheses that students develop on the chalk board. Older students can develop more hypothesis ideas and write them on the Student Activity Sheet.

5. Conclusion

Explain to students that scientists go through similar steps when studying a question or problem. They make observations, develop hypotheses, then create an experiment to gather more information about the hypothesis. Scientists go a little further by analyzing the experiment results and forming a conclusion. The whole process is called the "**scientific method**." You may want to write down the steps of the scientific method on the chalk board for students. (See Teacher Background Information at the beginning of this section.)

Next, ask students if they can think of a time when they naturally used the scientific method to figure something out. Have they ever watched a line of ants, then conducted an "experiment" to see what the ants would do if an obstacle was put in their path? Have they ever made a "hypothesis" about what their cat or dog would do with a new toy? Point out that while science may seem complicated at times, they have probably acted like scientists many times!

Questions to Ask During the Activity

1. Did you notice that your observations about the object needed to be more detailed as you made more guesses about the object in the classroom?

2. Where do you think your organism would live in the wild? Why?

3. How do you think the organism obtains food? What is your guess based on?

4. How do you think the organism might protect itself from danger? Why do you think so?

5. What kind of experiment could you design to test one of your hypotheses about the organism?

Preguntas sobre el tema de la actividad

1. ¿Has notado que tus observaciones sobre el objeto elegido tienen que ser muy detalladas para poder adivinar cuál es?

Preguntas (continuación)

2. ¿En qué lugar crees que el organismo que elegiste viviría si estuviera al aire libre? ¿Por qué?

3. ¿Cómo crees que ese ser vivo obtiene sus alimentos? ¿En qué basas tu suposición?

4. ¿Cómo crees que ese ser vivo se protege a sí mismo del peligro? ¿Por qué crees que lo hace de esa manera?

5. ¿Qué tipo de experimento puedes diseñar para comprobar una de tus hipótesis relacionadas con ese organismo?

Modifications

This activity can also be used for younger students (including K–2) by using procedure steps one through three only.

Extensions

Using one of the hypotheses developed by the class, have students design and conduct a simple experiment using the organisms they observed.

QUESTIONS, OBSERVATIONS, AND HYPOTHESES

Student Activity Sheet

Use the space below to write down your observations. You may want to draw a picture of what you see.

Size	
Color	
Shape	
Behavior	
Other	

QUESTIONS, OBSERVATIONS, AND HYPOTHESES

Student Activity Sheet

Use the space below to list your inferences about the organism. (In other words, what can you assume about the organism based on your observation.)

Use the space below to list your hypothesis about the organism. (In other words, what best guess can you form about the organism that you would be able to test with an experiment.)

PREGUNTAS, OBSERVACIONES E HIPÓTESIS

Actividades prácticas para el estudiante

Escribe tus observaciones en el espacio en blanco que aparece a continuación. Quizás prefieras hacer un dibujo de lo que observas.

Tamaño	
Color	
Forma	
Compor-tamiento	
Otras caracte-rísticas	

PREGUNTAS, OBSERVACIONES E HIPÓTESIS

Actividades prácticas para el estudiante

Escribe tus inferencias acerca del organismo en el espacio que aparece a continuación. (En otras palabras, de acuerdo a tus observaciones, ¿qué supuestos puedes hacer acerca de ese organismo?)

Usa el espacio provisto a continuación para escribir tus hipótesis sobre ese organismo. (En otras palabras, ¿qué crees que sucederá con el organismo que usarás en tu experimento?)

WHAT IS A LIVING THING?

¿Qué es un ser vivo?

Grades		
3-8	3–4	45–60 min.

Purpose

Students will develop a definition of living and non-living things by observing common items. The definition will then be used to determine whether or not dry ice is a living thing.

Materials

A variety of living and non-living items (or pictures) such as: leaves, insects, small animals, rocks, paper, etc.
Dry ice—a 2"x2" chip is fine
Metal tongs
Pot holders
1 cup blue dishwashing liquid
10 cups water
Clear glass bowl or jar—at least 11-cup size
Ice chest (to carry dry ice)

Concepts

- Living things have characteristics that make them different than non-living things.
- An object must have *all* the characteristics in order to be considered a living thing.

Conceptos

- Los seres vivos u organismos tienen caracteristicas que los diferencian de los seres no vivos.
- Un objeto tiene que tener *todas* las caracteristicas para ser considerado un ser vivo.

Safety

DO NOT touch dry ice. Use potholders and tongs. Only the teacher should handle dry ice.

Vocabulary

Abiotic
Biotic

Vocabulario

Abiótico
Biótico

In Advance

Gather living and non-living items for students to examine. Obtain dry ice and materials for handling dry ice. Mix together dishwashing soap and 10 cups of water in a container large enough to accommodate the dry ice chunk.

Procedure

1. Observe

Organize students into groups of 3-4. Give each group several of the gathered items (or pictures) to examine. Tell students to look at the items and decide which items are living things (**biotic**) and which items are not living things (**abiotic**). When they are finished, have each group develop a list of characteristics that defines what a living thing is. Younger students may need help writing their list down.

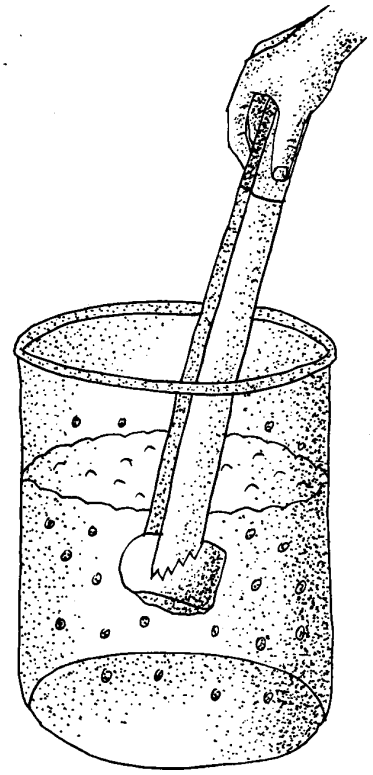
2. Discuss

Ask each group to share their findings with the class. Write a class list on the board and lead the class in a discussion of the characteristics on the board. Do all the responses describe *all* living things? Cross out the items that are not characteristics of all living things and add any characteristics not mentioned by the students. The definition should include only characteristics shared by *all* living things. (A list can be found in the background information for this section or in the "Why it Happens" section at the end of this activity.)

3. Bring out the "Thing"

Tell students that they have been selected to analyze a specimen brought back from Mars. Their assignment is to decide if the specimen is a living thing or not.

Carefully remove the dry ice from the ice chest with metal tongs. The specimen will "squeak" as you pick it up with the tongs. Place the "Thing" in the dishwashing soap and water. Explain that the "Thing" was found in this type of environment and seems to be more active in the blue liquid. Have students watch the specimen and observe what happens. The "Thing" will appear to make noise, move, grow, breathe (make bubbles), and respond to its environment. Put the "Thing" back into the ice chest.



4. Re-evaluate the Definition of a Living Thing

Is the "Thing" living? Discuss as a class how the characteristics of the "Thing" compared to their definition of a living thing. Did the "Thing" exhibit *all* the aspects of a living thing, according to their definition? Do they need to change their definition?

Questions to Ask During the Activity

1. Which aspects of the specimen were they unable to observe? (Reproduction, energy intake, adaptation.)

2. Do some non-living things have characteristics of living things? (Non-living things may exhibit one or two of the characteristics, such as movement or energy intake, but not all. For example, a light bulb requires and uses energy.)

3. How might you investigate the "Thing" further in relation to your definition? (Watch it over a longer period of time to observe energy intake and adaptation.)

Preguntas sobre el tema de la actividad

1. ¿Qué aspectos del espécimen no pudieron observar? (Reproducción, absorción de energía, adaptación.)

2. ¿Qué características de los seres vivos puede tener un organismo no vivo? (Los organismos no vivos pueden presentar una o dos características: movimiento o absorción de alimentos, pero no ambas. Por ejemplo, una bombilla de luz requiere y usa energía.)

3. ¿Qué tipo de investigación realizarías con "tu objeto" si quisieras profundizar más en relación con tu definición? (Puedes observarlo por un período más largo de tiempo para poder ver la absorción de energía y la adaptación).

Why It Happens/More on the Topic

The generally accepted characteristics of living things are:

Movement—plants bend towards the light, roots grow down, and stems grow up.
Responding to stimuli
Requiring energy from the environment
Excretion
Respiration
Made of one or more cells
Needs water
Reproduction and inheritance
Maintaining internal organization
Growth and development
Adapting to the environment

Dry ice is carbon dioxide in its solid form. Carbon dioxide is a solid at very cold temperatures and relatively low air pressure (like that found in higher elevations). When warmed above -108° F (-78° C), carbon dioxide changes directly from a solid to a gas. At this air pressure, there is no liquid phase. (Liquid carbon dioxide only exists at very high pressure produced in a laboratory.)

The dry ice "melts" in the relatively warm dishwashing liquid. Without the dishwashing liquid, the carbon dioxide gas that forms as the solid melts would not be visible. However, the gas is released from the solid into the liquid, making the gas observable as bubbles. There is a very large temperature difference between the dry ice and the tongs and the dishwashing liquid. The "melting" is very rapid and produces the squeaking noise as the solid changes to gas.

Algo más sobre el tema...

Las características generalmente aceptadas de los organismos vivos:

Movimiento—las plantas se inclinan buscando la luz, las raíces crecen hacia abajo y los tallos hacia arriba
Responden a los estímulos
Usan energía del medio ambiente
Excretan
Respiran
Formados por una o más células
Necesitan agua

Algo más sobre el tema (continuación)

Se reproducen y heredan
Mantienen una organización interna
Crecen y se desarrollan
Se adaptan al medio ambiente

El hielo seco es dióxido de carbono en forma sólida. El dióxido de carbono es un sólido a temperaturas muy frías y a presión relativamente baja (como la que existe en alturas elevadas.) Cuando la temperatura sube a más de -108º F (-78º C), el dióxido de carbono se transforma de materia sólida a gaseosa. A este nivel de presión, no existe una fase líquida. (El dióxido de carbono líquido se logra sólo en condiciones de muy alta presión producidas en laboratorios.)

El hielo seco se "derrite" en detergente para lavaplatos que es relativamente tibio. Sin este detergente para lavaplatos, no se vería el gas del dióxido de carbono que se forma al derretirse la materia sólida. Sin embargo, es posible observar el gas que se libera de la materia sólida al detergente líquido porque produce burbujas de gas. Hay mucha diferencia de temperatura entre el hielo seco y las pinzas y el detergente para lavaplatos. El "deshielo" ocurre con rapidez y cuando el sólido se transforma en gas se produce un chirrido.

Modifications

This activity can be done with younger students (including K-2); however, they will need more assistance with developing and using their definition of a living thing. The activity can be done as a class with teacher facilitation.

Extensions

Have students write a short description of an imaginary creature that has been recently discovered by scientists. Remind them to include all aspects of their definition of a living thing when describing this new creature. Encourage them to include the creature's habitat, unique features, and way of life.

References

The New Mexico Museum of Natural History & Science. Proyecto Futuro Life Science Curriculum. 1st Ed. Albuquerque, NM, 1996.

Mader, Sylvia S., editor. Biology. 5th Ed. Dubuque, IA: Wm. C. Brown Publishers, 1996.

USING A MICROSCOPE

Uso del microscopio

Grades		
3–8	2–3	60–90 min.*

Purpose

Students will learn how to use a light microscope, how to prepare a wet mount slide, and will observe a variety of cells under the microscope.

Materials

Light microscopes
Dissecting microscopes (for K–3 modifications)
Commercially-prepared slides
Slides and slip covers
Eye droppers
Banana peels, onion slices
Toothpicks
Q-tips cut in half

Concepts

- Microscopes are tools that can be used in science to observe objects more closely.
- Careful slide preparation and use of the microscope is important for safety and accurate viewing of objects.

Conceptos

- El microscopio es una herramienta que se puede utilizar en ciencias para observar objetos más de cerca.
- Es importante prestar atención cuando se usa el microscopio y preparar con cuidado el portaobjeto, no sólo por razones de seguridad, sino también para poder ver los objetos con precisión.

Safety

Broken glass should be carefully thrown away. Warn students that a microscope bulb is hot. Plastic slides are available for younger students.

** This activity can be done in two parts.*

Vocabulary

Eyepiece
Stage
Stage clip
Coarse adjustment knob
Fine adjustment knob
Body tube
Nosepiece
Objectives
Base
Light source
Diaphragm
Arm

Vocabulario

Ocular
Platina
Sujetador
Tornillo de ajuste grueso o macrométrico
Tornillo de ajuste fino o micrométrico
Tubo binocular
Portaobjetivo
Objetivos
Base
Fuente de luz
Diafragma
Brazo

In Advance

Gather materials**.** Make copies of the student activity sheets for each student.

Procedure

1. Demonstrate microscope use

Divide your class into groups according to the number of microscopes available. If possible, pair experienced students with students who have never used a microscope before.

Demonstrate how to carry and use the light microscope, using Student Activity Sheet 1 as a guide. As you explain each step, have students practice with their microscopes. Make sure that each student has an opportunity to practice before moving on to the next step.

2. Student practice

Pass out copies of Student Activity Sheet 1 and commercially-prepared slides. Have students follow the Activity Sheet as they view the slides. If you have a variety of slides, have students trade slides when they are finished. Be sure students are filling out the activity sheet as they go. Collect the slides once everyone has seen them.

3. Demonstrate wet slide mount preparation

Using Student Activity Sheet 2 as a guide, demonstrate how to prepare a wet mount slide. Be sure to emphasize that only one or two drops of water should be used on the slide. Also, show them how to put the cover slip onto the slide so they can avoid trapping air bubbles. (Have them touch the edge of the cover slide to the edge of the water drop, then gently lower the cover slide.)

4. Student Practice

Hand out copies of Student Activity Sheet 2. Using toothpicks, help students get a small sample of the onion and banana peel for their slide. With the cut end of a Q-tip, tell students to gently scrape the inside of their cheek. Have students follow the Student Activity Sheet to complete the activity. As a class, review the answers and discuss the observations students recorded on the activity sheet.

Questions to Ask During the Activity

1. If you are having trouble locating the object through the **eyepiece**, what should you check first? (Make sure you are using the shortest **objective**. Check to see that the object is directly beneath the lens.)

2. Why should you never focus downward? (You might push the objective through the slide and break it.)

3. The shorter objective will make things look how many times bigger than they really are? (100 times.)

4. The longer objective will make things look how many times bigger than they really are? (200 times.)

5. What other items might be interesting to look at through the microscope?

Preguntas sobre el tema de la actividad

1. Si te resulta difícil tratar de localizar un objeto a través del **ocular**, ¿qué debes revisar primero? (Asegúrate de que estás usando el **objetivo de menor aumento**. Asegúrate de que el objeto esté directamente debajo del lente.)

2. ¿Por qué debes evitar siempre enfocar directamente hacia abajo? (Podrías romper el portaobjeto con el objetivo.)

3. ¿Cuántas veces más grande se verán los objetos a través del objetivo de menor aumento? (100 veces)

4. ¿Cuántas veces más grande se verán los objetos a través del objetivo de mayor aumento? (200 veces)

5. ¿Qué otras cosas te interesaría ver a través del microscopio?

Modifications

Younger students (including K–2) can bring in several items from home or from the schoolyard to look at through dissecting scopes. Demonstrate how to use the dissecting scopes and then have students work in groups to look at their items through the microscope. If you have a light microscope available, show students how it can be used to look at their items. More mature students can help prepare a slide for the light microscope.

Extensions

Have students bring in a new item to look at through the microscope. Before they prepare the slide, have them predict what the item will look like under magnification. Students can draw a picture of their prediction and another picture after they look through the microscope. Was their prediction just a guess, or did they base their prediction on some prior knowledge?

References

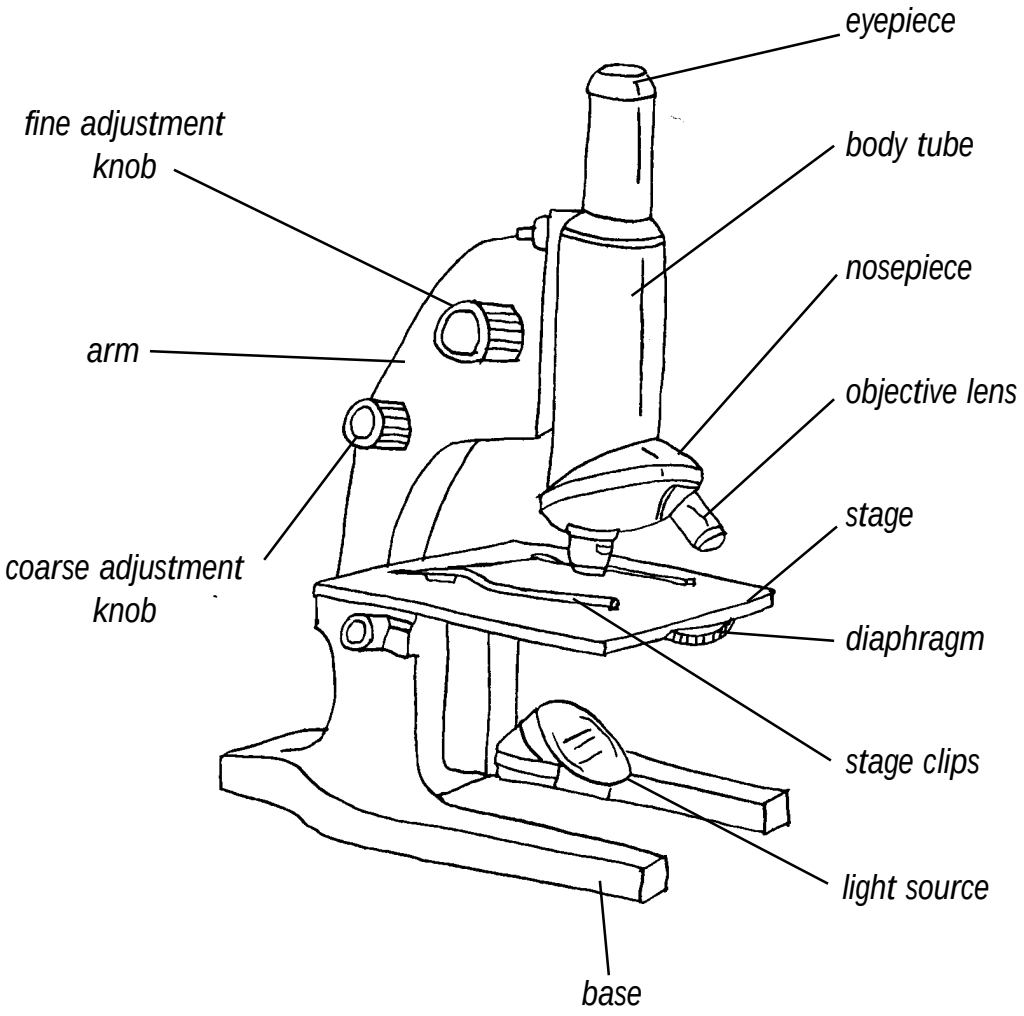
Mader, Sylvia S., Editor. Biology. 5th Edition. Dubuque, IA: Wm. C. Brown Publishers, 1996.

Heil, Discover Science. Glenview, IL: Scott, Foresman and Company, 1991.

Dykstra, Mary. The Amateur Zoologist: Explorations and Investigations. New York, NY: Franklin Watts, 1994.

The New Mexico Museum of Natural History and Science. Proyecto Futuro Life Science Curriculum. 1st Edition. Albuquerque, NM, 1996.

Parts of a Microscope



What are the parts of a microscope? (in alphabetical order)

Arm – The arm supports the barrel or body tube, and is used to carry the microscope.

Base – The base is the bottom part of the microscope that is shaped like a horseshoe. To carry the microscope properly you should hold the arm in one hand and have your other hand under the base.

Body tube – This is a hollow tube through which light passes. It holds the lenses apart.

Coarse adjustment knob – This knob turns and is used to raise or lower the body tube to focus the microscope.

Diaphragm – The diaphragm changes the amount of light entering the body tube.

Eyepiece – The eyepiece is located at the top of the microscope. It holds the ocular lens.

Fine adjustment knob – This knob also raises or lowers the body tube. It is used to bring objects into sharp focus.

Light source – The light source sends light toward the hole in the stage. The light source can be an electric bulb built into the microscope or a mirror that reflects light into the microscope.

Nosepiece – The nosepiece holds the objective lenses.

Objective lens – Each lens has a different magnification power; there are several objective lenses.

Stage – The stage is where you place the object you are looking at.

Stage clips – The stage clips hold down the slide on the stage.

¿Cuáles son las partes del microscopio? (por orden alfabético)

Base – La base o pie es la parte inferior del microscopio y tiene la forma de una herradura. Para transportar el microscopio correctamente debes sostener el brazo con una mano y debes poner la otra debajo del pie.

Brazo – El brazo sostiene la barra o tubo binocular y se usa para transportar el microscopio.

Diafragma – El diafragma modifica la cantidad de luz que penetra en el tubo binocular.

Fuente de luz – La luz se proyecta directamente desde la fuente hacia el orificio de la platina. Esta fuente de luz puede ser una bombilla eléctrica integrada al microscopio o un espejo que refleje la luz dentro del mismo.

Objetivos intercambiables – Cada lente tiene un poder de magnificación diferente. Existen distintos tipos de objetivos intercambiables.

Ocular – El ocular se encuentra en la parte superior del microscopio. Dentro del ocular se encuentra el lente ocular.

Platina – En la platina se pone el objeto que quieres observar.

Portaobjetivo – El portaobjetivo sostiene los lentes objetivos intercambiables.

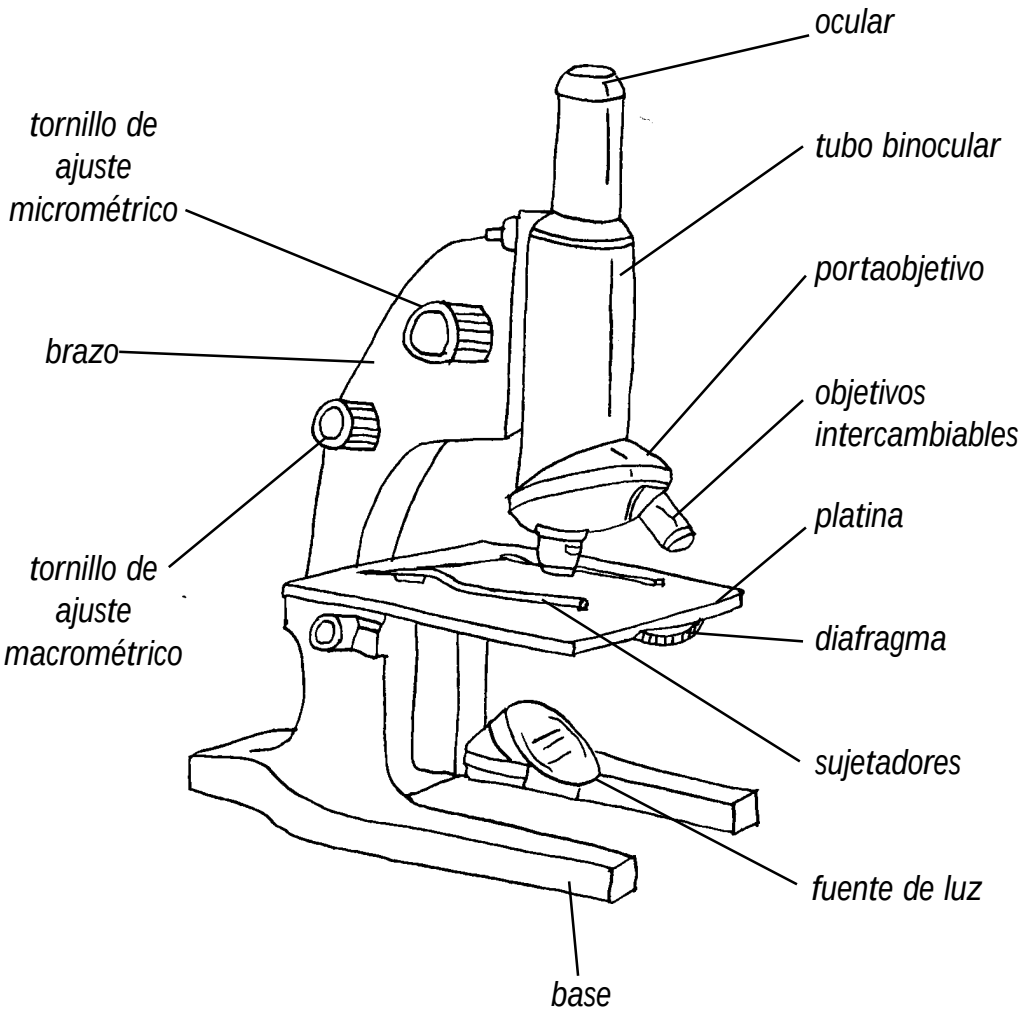
Sujetadores – Los sujetadores sostienen el portaobjeto sobre la platina.

Tornillo de ajuste macrométrico – Este tornillo gira y se utiliza para levantar o bajar el tubo binocular para enfocar el microscopio

Tornillo de ajuste micrométrico - Este tornillo también levanta y baja el tubo binocular. Se usa para enfocar los objetos con precisión.

Tubo binocular – Este es un tubo hueco a través del cual pasa la luz. Mantiene los lentes separados.

Partes del microscopio



EXAMINING THE MICROSCOPE

Student Activity Sheet 1

1. Look at your microscope and find the parts named on the diagram; become familiar with each part.

2. Insert the prepared slide.

3. Move the microscope so that the arm is turned toward you.

4. Turn the focusing knob slowly and watch how the objectives and eyepiece move.

5. Raise the objective as high as it will go.

6. Hold the arm of the microscope with one hand and turn the nosepiece slowly until one of the objectives snaps into place.

7. Look at the plate on the barrel. It will show 100X and 200X. This tells you that the shorter objective will magnify an object 100 times its real size, and that the longer objective will magnify the object 200 times its real size. (Note: The magnification will vary with the type of microscope.)

8. Draw and label pictures of the magnified items on the slides below.

MAKING WET SLIDES
Student Activity Sheet 2

1. Using the eye dropper, place a drop of water on your slide.

2. Place a piece of onion on the drop of water.

3. Touch the edge of the cover slide to the edge of the drop of water.

4. Lay the cover slip gently down over the drop of water and slide. This is called a wet mount.

5. Snap the shorter objective into place.

6. Look into the eyepiece with one eye, keeping your other eye closed.

7. If your microscope has a mirror, adjust it so the light is reflected upward. You should see a circle of light when you look into the eyepiece.

8. Put the slide on the stage and put the clips over the slide to hold it in place. The onion should be in the circle of light.

9. Look into the eyepiece and turn the knob slowly so that is moves upward. BE CAREFUL: If you turn the knob downward, you may force the objective into the slide and break it.

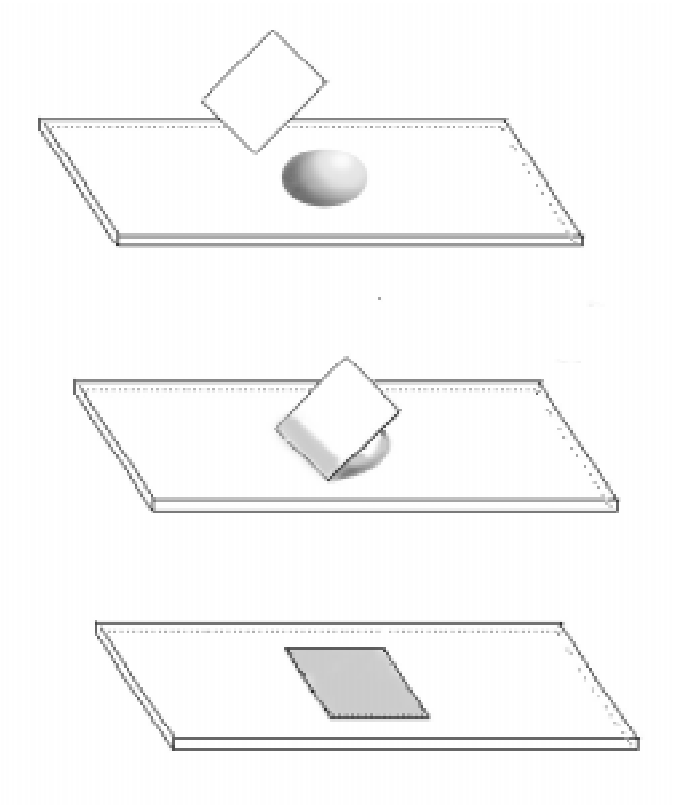
10. Move the slide slowly to the right and left. Notice how the image moves.

11. To look at the onion through the high power or longer objective, first turn the knob to raise the low power objective. Turn the nosepiece so that the high power objective is in place. Lower the objective until it is close to, but not touching, the slide. Focus by moving the objective slowly upward.

12. Repeat the steps above with the banana peel and the cheek cells you collected with the Q-tip.

MAKING WET SLIDES

Student Activity Sheet 2 (continued)



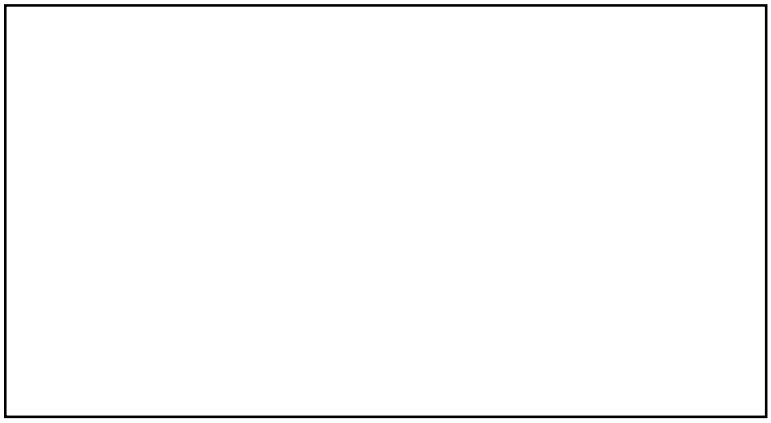
Questions

1. Draw what you saw when you looked at the onion with the shorter objective and record the magnification in the space provided.

Magnification: _____X

MAKING WET SLIDES
Student Activity Sheet 2 (continued)

2. Draw what you saw when you looked at the onion with the longer objective and record the magnification in the space provided.



Magnification: _____X

3. When you move the slide to the left, which way does the image move?

_____

4. When you move the slide to the right, which way does the image move?

_____

5. If you want to see an object in greater detail, which objective would you use?

_____

INSPECCIÓN DEL MICROSCOPIO

Actividades prácticas para el estudiante—Hoja 1

1. Observa tu microscopio y busca las partes que aparecen en el diagrama. Familiarízate con cada una de las partes.

2. Coloca el portaobjetos con la preparación ya lista.

3. Mueve el microscopio de manera que el brazo gire hacia ti.

4. Gira el tornillo de enfoque despacio y observa cómo se mueven los objetivos y el ocular.

5. Levanta el objetivo hasta donde llegue.

6. Sostén el brazo del microscopio con una mano y gira el portaobjetivo lentamente hasta que uno de los objetivos se enganche en el lugar correcto.

7. Observa la placa del cilindro. Verás dos inscripciones: 100X y 200X. Esto indica que el lente más corto agrandará 100 veces el tamaño original del objeto (se lo llama objetivo de 100 aumentos) y que el lente más largo agrandará el objeto a 200 veces su tamaño original. (Nota: La magnitud de la amplificación varía según el modelo del microscopio.)

8. Dibuja y coloca los nombres de los objetos amplificados en los portaobjetos que siguen.

PREPARACIÓN PARA EL PORTAOBJETOS
Actividades prácticas para el estudiante—Hoja 2

1. Coloca una gota de agua sobre tu portaobjeto usando un gotero.

2. Coloca un pedazo de cebolla sobre la gota de agua.

3. Haz que la superficie del cubreobjeto toque la superficie de la gota de agua.

4. Deposita con mucho cuidado el cubreobjeto sobre la gota de agua y el portaobjeto. Esto se llama preparación.

5. Engancha el lente más corto en su lugar.

6. Mira a través del ocular con un ojo y mantén el otro ojo cerrado.

7. Si tu microscopio tiene un espejo, ajústalo para que la luz refleje hacia arriba. Cuando mires por el ocular, verás un círculo de luz.

8. Coloca el portaobjetos en la platina y ajusta los sujetadores para que no se mueva. La cebolla debe estar ubicada dentro del círculo de luz.

9. Mira a través del ocular y gira el tornillo lentamente para que se mueva hacia arriba. PRECAUCIÓN: si giras el tornillo hacia abajo podrías forzar el lente objetivo sobre el portaobjeto y romperlo.

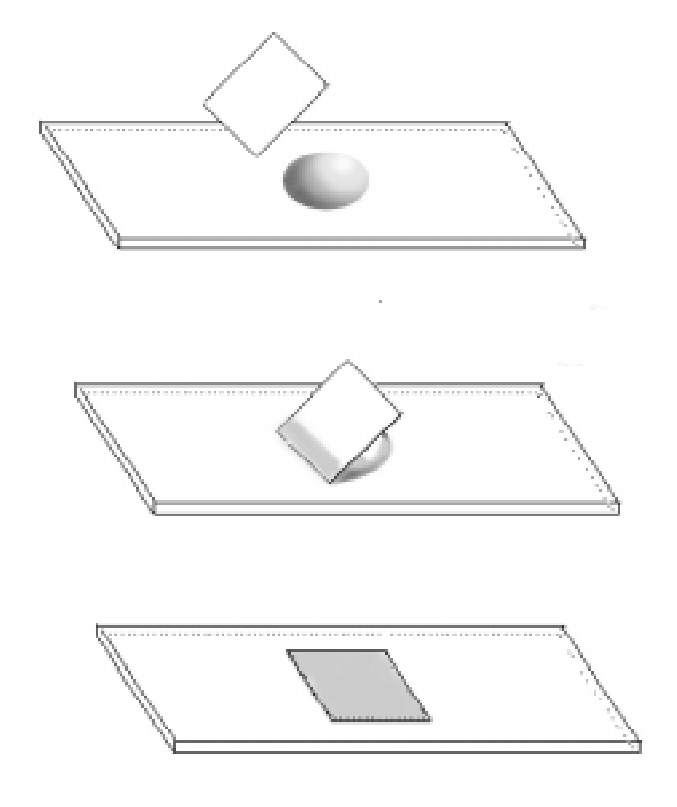
10. Mueve el portaobjetos lentamente hacia la derecha y hacia la izquierda. Presta atención al movimiento de las imágenes.

11. Para ver la cebolla a través del lente de alta potencia u objetivo largo, primero debes girar el tornillo para levantar el objetivo de menos potencia. Gira el portaobjetivo para que el objetivo de alta potencia se enganche en su lugar. Mueve el objetivo hacia abajo hasta que esté cerca del portaobjeto, pero sin tocarlo. Para enfocar debes mover el objetivo lentamente hacia arriba.

12. Repite todos los pasos anteriores usando la cáscara de una banana y las células de la mejilla que obtuviste con un hisopo.

PREPARACIÓN PARA EL PORTAOBJETOS

Actividades prácticas para el estudiante—Hoja 2 (continuación)



Preguntas

1. Dibuja lo que observaste al mirar la cebolla con el objetivo de baja potencia y anota en el espacio en blanco, el nivel de aumento que usaste.

Objetivo de _____X aumento

PREPARACIÓN PARA EL PORTAOBJETOS
Actividades prácticas para el estudiante - Hoja 2 (continuación)

2. Dibuja lo que observaste al mirar a la cebolla con el objetivo de alta potencia y anota en el espacio en blanco, el nivel de aumento que usaste.

Objetivo de
_____X aumento

3. Cuando mueves el portaobjeto hacia la izquierda, ¿hacia qué lado se mueve la imagen?

_____

4. Cuando mueves el portaobjeto hacia la derecha, ¿hacia qué lado se mueve la imagen?

_____

5. Si quieres ver un objeto más detalladamente, ¿qué lente usarías?

_____

CELL DANCE

La danza de la célula

Grades		
2–6	Whole Class	45–60 min.

Purpose

Students will learn about the components of cells and how they function. Students will compare and contrast the characteristics of different types of cells.

Materials

Part 1

Cell Roll Cards
Signs for students to wear during cell dance (optional)

Part 2

Light microscope (optional)
Protozoa or single-celled plant cultures (or pond water)
Student Activity Sheet

Concepts

- Living things are made up of cells.
- Cells are made up of different structures.
- Each cell structure has a different role in the cell's functioning.
- Not all cells look alike.

Conceptos

- Los organismos vivos están compuestos por células.
- Las células tienen estructuras diferentes.
- Cada estructura dentro de la célula cumple una función específica.
- No todas las células se parecen.

Safety

Students shouldn't push or shove during Part 1. For Part 2, students need to know how to use a microscope and should wash hands after handling organisms. Review rules for handling live organisms.

Vocabulary

Cell
Cell membrane
Cytoplasm
Nucleus
Mitochondria
Vacuole

Vocabulario

Célula
Membrana celular
Citoplasma
Núcleo
Mitocondria
Vacuola

In Advance

Clear an open space in the classroom or find an open space outside the classroom. Obtain protozoa, single-celled plant cultures, or pond water. Set up microscopes and make copies of Student Activity Sheet.

Procedure

Part 1

1. Set up the Cell Dance

Begin by describing what a **cell** is to the class. Tell students they are all going to work together to create the parts of a cell and see how a cell functions. As you select students for different roles, write the names of the roles on the chalkboard.

Select about a third of the students to form a circle by linking elbows or holding hands in the open space. These students will be the **cell membrane**. Explain that the cell membrane surrounds the outside of the cell and regulates the flow of chemicals going in and out of the cell. Tell older students this property is called semi-permeable.

Next, select another third of the students to go into the center of the circle. These students represent the **cytoplasm**, a viscous fluid that fills the cell and helps move food and other chemicals to other parts of the cell.

Now, select several remaining students to be **vacuoles**. As they enter the center of the circle, explain that vacuoles store water and digested food products. A few more students can be **mitochondria**, the cell's "power plants." The mitochondria turn food into energy that the cell can use. Any remaining students can be chemicals.

You will be the **nucleus**, or "brains" of the cell during the first cell dance. The role can be turned over to a student if you have time to repeat the dance later. Tell students the nucleus will be orchestrating the cell functions. Remaining students will be chemicals that enter and leave the cell through the cell membrane.

For younger students, you may want to prepare labels or signs for each student to wear when they are given their roles. That will avoid confusion when the "cell dance" begins.

2. Cell dance

Begin the cell dance by instructing the students playing the cytoplasm to slowly "flow" around the inside of the circle. They should not push or shove, but gracefully move within the cell membrane.

Now it is time for you, the nucleus, to begin orchestrating the cell's functions. Use the following instructions as a guide:

• First, tell the students that only some "chemicals" will be allowed to enter the cell through the cell membrane. This time only "chemicals" wearing white on their clothing will be entering. When you say "go," **all** the chemicals should try to get into the cell, but only the ones wearing white should be let in by the students playing the cell membrane. Unselected chemicals will need to stay outside the cell. (They can be let in at a later time, if you choose).

• Explain that only some of the chemicals let in are food for the cell. This time students wearing red will be food the cell can use. When you say "go," the chemicals wearing red should go to a "mitochondria" student and link elbows. Tell students this represents how the food chemicals change into energy that the cell can use.

• Explain to students that once the food chemicals change into energy, they become waste products. Tell students that all the food chemicals have now changed into waste products and they should find a vacuole to link elbows with. This represents how the vacuole stores waste products and water.

• Finally, tell students that the waste products need to leave the cell, but the vacuoles stay behind in the cytoplasm. When you say "go," the waste products should unlink arms with the vacuoles and pass out of the cell membrane.

The whole dance can be repeated using different students in different roles or allowing different chemicals into the cell's membrane. Repeating the dance will help reinforce the concepts and vocabulary.

Part 2

1. Look at Real Cells

Pass out copies of the Student Activity Sheet. Give students a moment to look at the cell diagram.

Next, have students place one or two drops of the single-celled plant culture, protozoa, or pond water onto a slide and place the slide under a microscope. Students should look at the sample through the microscope and record the organism's size, shape, color, internal structures, and "behavior" in the spaces provided on their activity sheet. There is also space to make a diagram of what they view through the microscope. Be aware that pond water may have several different types of organisms.

To wrap up, discuss students' observations and drawings with the class. Note how important a detailed diagram can be in relating information to others and for recording observations accurately.

Questions to Ask During the Activity

1. How do you think cells can live as independent organisms? (The cell membrane surrounds the cell and protects it from its environment, much like skin. The nucleus also helps to control the cell's functions.)

2. In the real cells you observed, what is the substance that moves around inside the cell and helps the cell move through the water? (Cytoplasm.)

3. As the cells move in the water, some structures seem to disappear and reappear. Why do you think this happens? (The organisms are 3-dimensional. As they move across the slide, they twist and turn, causing certain structures to come in and out of focus.)

4. Do all the cells you observed look the same? What were some of the differences?

Preguntas sobre el tema de la actividad

1. ¿Por qué crees que las células pueden vivir como organismos independientes? (La membrana celular rodea a la célula y la protege del medio ambiente, parecido a lo que sucede con la piel. El núcleo también ayuda a controlar las funciones de la célula.)

2. Toma como ejemplo las células reales que has observado. ¿Cuál es el nombre de la sustancia que se mueve en el interior de la célula y que ayuda a la célula a moverse en el agua? (Citoplasma)

3. Cuando las células se mueven en el agua, algunas estructuras parecen desaparecer y luego reaparecen. ¿Por qué crees que sucede esto? (Los organismos son tridimensionales. Al desplazarse a través del portaobjetos, las células giran y se dan vueltas. Por eso, algunas estructuras están fuera del campo visual pero luego reaparecen.)

4. ¿Son iguales todas las células que has visto? ¿Cuáles son las diferencias?

Modifications

For younger students, you may want to prepare the slides of the plant culture, protozoa, or pond water and focus the microscopes. Younger students may find it easier to draw pictures of the cells they see.

Extensions

Provide students with books that have photographs of different cell types. Have them make drawings of the cells, particularly paying attention to the differences between the cells. Tell students to trade their drawings with another student and see if they can identify the cell types based on the drawing.

References

Audesirk, Teresa, Gerald Audesirk, and Bruce E. Byers, eds. Life on Earth, 2nd Edition. Upper Saddle River, NJ: Prentice Hall, Inc., 2000.

Daniel, Lucy, Edward P. Ortleb, and Alton Briggs. Merrill Life Science, Teacher Wrap-Around Edition. Lake Forest, IL: Glencoe-Macmillan/McGraw-Hill, 1993.

CELL ROLL CARDS

Cell Membrane

The cell membrane surrounds the outside of the cell and regulates the flow of chemicals going in and out of the cell.

Cytoplasm

The cytoplasm is a fluid that fills the cell and helps move food and other chemicals to other parts of the cell.

Vacuoles

Vacuoles float around the cytoplasm, where they store water and digested food products.

Nucleus

The nucleus is the "brain" of the cell. It directs the activities of the other cell structures.

Mitochondria

The mitochondria are the cell's "power plants." They turn food into energy that the cell can use.

TARJETAS CON LOS NOMBRES DE LAS PARTES DE LA CÉLULA

Membrana celular

La membrana celular rodea la parte exterior de la célula y regula el flujo de sustancias químicas que entran y salen de la célula.

Citoplasma

El citoplasma es un fluido que ocupa el interior de la célula y que ayuda a que los alimentos y otros elementos químicos se muevan de un lugar a otro dentro de la célula.

Vacuolas

Las vacuolas flotan alrededor del citoplasma, donde acumulan agua y alimentos digeridos

Núcleo

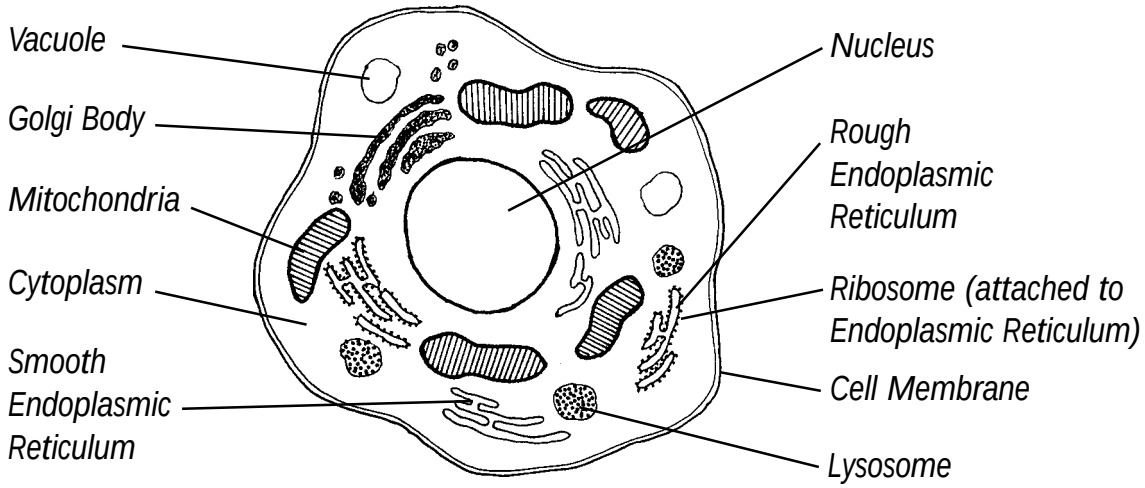
El núcleo es el "cerebro" de la célula. Dirige las actividades de las otras estructuras celulares.

Mitocondrias

Las mitocondrias son la "planta de energía" de la célula. Convierten los alimentos en la energía que utilizará esta planta.

THE CELL
Student Activity Sheet

The parts of a cell:



1. Using the chart below, describe the cell or cells you see in the microscope.

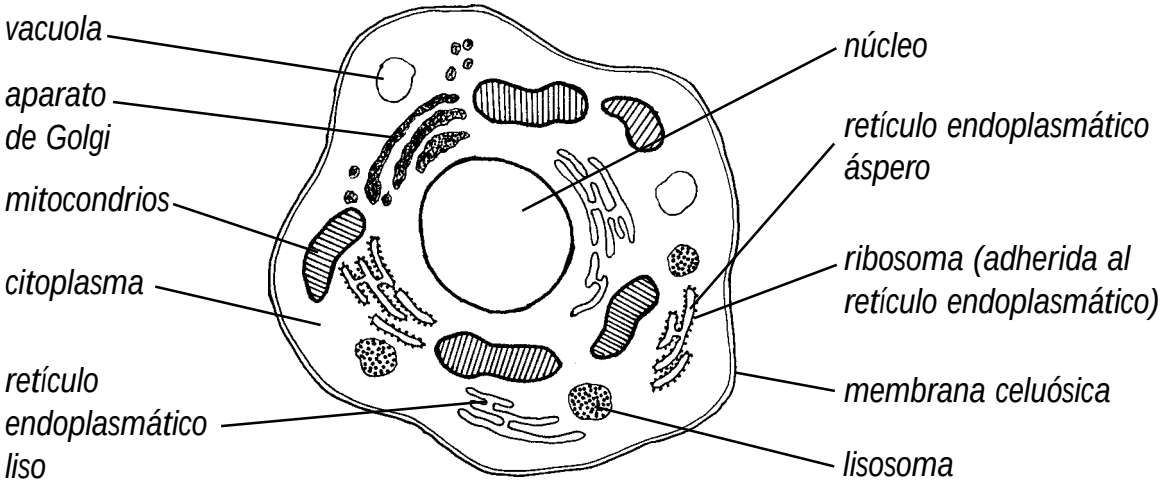
	CELL 1	**CELL 2**
Size		
Shape		
Color		
What is inside?		
What is it doing?		

THE CELL
Student Activity Sheet (continued)

2. Draw and label the cell or cells you see in the microscope. Be sure to include as much detail as possible.

LA CÉLULA
Actividades prácticas para el estudiante

Las partes de la célula:



1. Utiliza el cuadro que sigue para describir la célula o células que observaste a través del microscopio.

	CÉLULA 1	**CÉLULA 2**
Tamaño		
Forma		
Color		
¿Qué hay adentro?		
¿Qué está haciendo?		

LA CÉLULA

Actividades prácticas para el estudiante (continuación)

2. Dibuja y escribe el nombre de la célula o de las células que ves en tu microscopio. Incluye todos los detalles posibles.

LIFE CYCLES
Ciclo vital

Grades		
3–8	2–4	30 min. setup, 15 min./week for 1–4 mo.

Purpose

Students will learn about life cycles and metamorphosis by observing the larva (mealworm), pupa, and adult stages of a beetle named the Yellow Mealworm.

Materials

Mealworm larvae (from pet store or biological supply company)—5 per group
Clear jar or container with 2–3 air holes—1 per group
Grain (bran flour, corn meal, oatmeal)—enough to fill half of container
Apple or potato slice for moisture—1–2 per jar
Data sheets (provided)
Hand lens or dissecting microscope (optional)

Concepts

- Organisms have life cycles that include birth, growth, reproduction, and death.
- Some organisms go through a change in body form (metamorphosis) during their life cycle.

Conceptos

- Los seres vivos tienen un ciclo vital que incluye nacimiento, crecimiento, reproducción y muerte.
- Algunos seres vivos experimentan un cambio en la forma de sus cuerpos (metamorfosis) durante su ciclo vital.

Safety

Wash hands after handling organisms. Review rules for handling live organisms.

Vocabulary

Life cycle
Exoskeleton
Larva(e)
Pupa(e) or (s)
Nymph
Molt
Complete metamorphosis
Incomplete metamorphosis

Vocabulario

Ciclo vital
Exoesqueleto
Larva(s)
Pupa o capullo
Ninfa
Mudar
Metamorfosis completa
Metamorfosis incompleta

In Advance

Gather all materials (mealworms, jars, grain, apple or potato slices). Make a copy of the Student Activity Sheet for each student.

Procedure

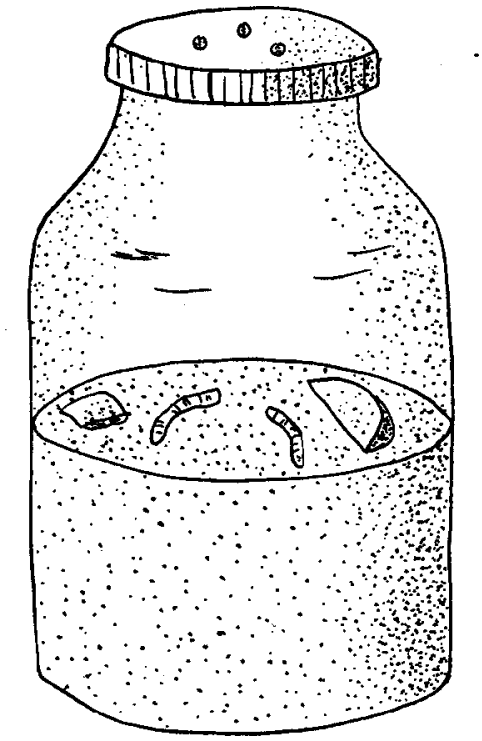
1. Introduce the activity

Begin by asking students if they know what a life cycle is. Explain that a life cycle is the process of change that an organism goes through during its lifetime. It includes birth, growth, reproduction and death. Organisms have different length life cycles and different ways of changing during those life cycles.

Tell students that some organisms go through dramatic changes during their life cycles. When an organism goes through a change of body form, it is called metamorphosis. Ask students if they can name a type of animal that goes through a metamorphosis. (Frogs and butterflies are good examples.) Using the "Why it Happens" section of this activity as a guide, explain the different types of metamorphosis in more detail. Tell students that over the next couple of months they will be observing the metamorphosis of the Yellow Mealworm.

2. Make the mealworm "homes"

Divide students into groups of 2-4. Give each student a copy of the Student Activity Sheet. Give each group a jar, some of the grain, and a piece of apple or potato. Tell students to fill their jars halfway with the grain and place the apple or potato slice in the jar. The apple or potato is for moisture. It will need to be replaced as it dries up or if it gets moldy. Finally, put the mealworm larvae into the jars. (The jars should be kept away from extreme temperatures.) Tell students the mealworms will eat the grain as



they grow and will also burrow into it. If the larvae have burrowed into the grain, students can see them by gently pouring the grain onto a clean white sheet of paper.

3. Observe the larvae

Using the Student Activity Sheet as a guide for observations, have students look at the larvae and record what they see. If you have hand lenses or dissecting microscopes available, students can use them to make their observations. They will be recording their observations weekly using the same Student Activity Sheet. The larval stage of the Yellow Mealworm should last from one to three months, depending on temperature (in warmer conditions this stage is shorter and in cooler conditions it is longer).

4. Observe the pupa

When the larvae are about to change into an adult beetle, they form a hard shell around them called the pupa. The larvae do not move around or feed while they are in the pupa. Students should observe the pupa stage and record their observations on the Student Activity Sheet.

The pupa stage of the metamorphosis should take from 10 to 20 days. Have students check their pupae more frequently around the two-week mark, so they won't miss seeing the adult beetles emerge from the pupa.

5. Observe the adult Yellow Mealworms

Have students look at the adult beetles (Yellow Mealworm) and write down their observations on the Student Activity Sheet. The adult beetles live about 5 to 10 days. During those days they mate, the female will lay about 300 eggs, and the life cycle will be completed.

6. Wrap up

Discuss the students' observations of the larvae, pupae, and adult beetles. Use the "Questions to Ask During the Activity" and "Why it Happens" sections to lead the

discussion. For younger students, you may want to draw and label a picture of the life cycle of the Yellow Mealworm beetle on the chalkboard. Older students can use the information on their Student Activity Sheet to draw and label the life cycle themselves. The beetles can be taken home or saved for other activities.

Questions to Ask During the Activity

1. What are the tough yellow fragments that you find in the jar as your mealworms grow? Where did they come from? (As the mealworms grow larger, their tough outer "skin" or exoskeleton does not grow. They must shed or molt this old skin.)

2. What happens to the color of the pupa shell as it ages? Why do you think this happens? (It grows darker as the larva changes to an adult beetle inside.)

3. What do you think is the benefit of a life cycle that involves such different body forms? (Life cycles, like that of the Yellow Mealworm beetle, divide the "work." The larva eats and grows, and the adult can fly to a new home and reproduce.)

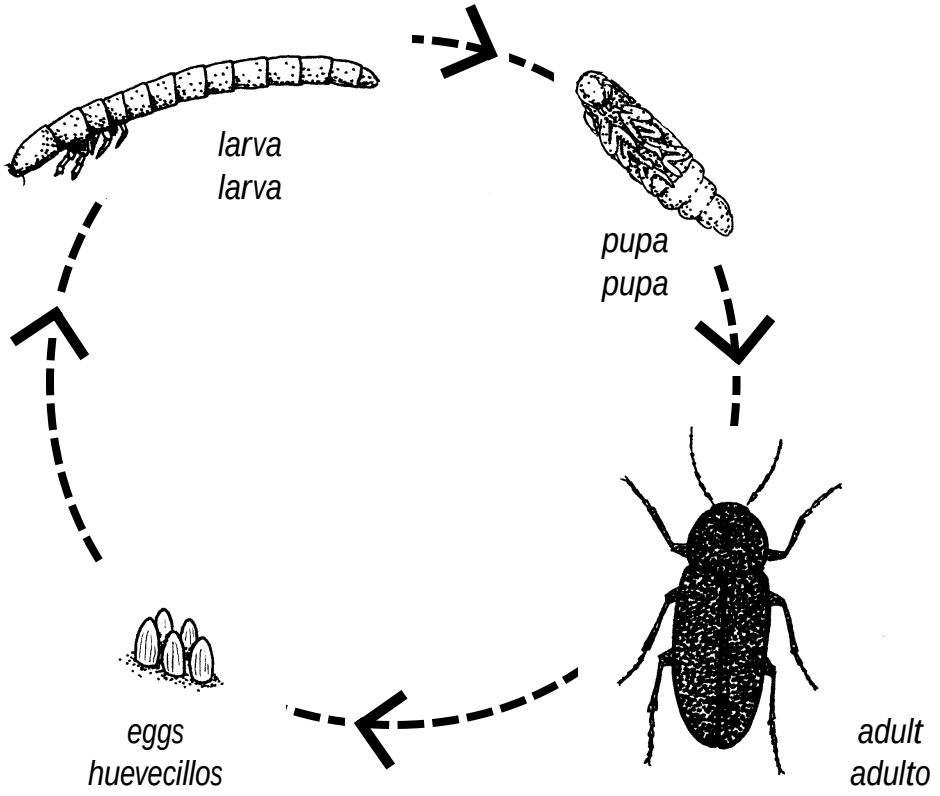
Preguntas sobre el tema de la actividad

1. ¿Qué son esos fragmentos duros, de color amarillo que aparecen en el frasco cuando los gusanos de harina están creciendo? ¿De dónde vienen? (La "piel" externa dura o exoesqueleto de los gusanos de la harina no crece al mismo tiempo que lo hace el gusano. A medida que crecen, deben mudar o cambiar su piel antigua.)

2. ¿Qué sucede con el color de la envoltura de la pupa a medida que ésta envejece? ¿Qué crees que sucede? (Se hace más oscura a medida que la larva se transforma en un escarabajo adulto en el interior de la envoltura.)

3. ¿Cuál crees que es el beneficio de un ciclo vital con tantas formas diferentes del cuerpo? (El ciclo vital, tal como el del escarabajo molinero contiene una división del "trabajo". La larva come y crece y el adulto puede volar hacia un nuevo hogar y reproducirse.)

Why It Happens/More on the Topic



During their life cycle, some organisms go through a change of body form called metamorphosis. Sometimes the change from one body form to the other can be dramatic and takes place inside a sac or case called a pupa. This is called complete metamorphosis and involves four stages: 1) egg, 2) larva, 3) pupa, and 4) adult. Examples of animals that go through complete metamorphosis are beetles and butterflies.

Other organisms go through an incomplete metamorphosis where there are fewer changes in body form. There is a nymph stage instead of the larva and pupa stages. A nymph hatches from an egg and is usually very similar to the adult. Grasshoppers grow and change this way. The grasshopper nymph is smaller and lacks the wings of an adult grasshopper.

Algo más sobre el tema...

Durante el ciclo vital, algunos organismos pasan por una transformación del cuerpo llamada metamorfosis. A veces el cambio, que se realiza en el interior de una bolsa o capullo llamado pupa, puede ser dramático. Este proceso se llama metamorfosis completa e incluye cuatro estados: 1) huevecillo, 2) larva, 3) pupa y 4) adulto. Ejemplos de animales que pasan por una metamorfosis completa son los escarabajos negros y las mariposas.

Otros organismos pasan por una metamorfosis incompleta, en la cual los cambios físicos son limitados. En este caso, hay un estado llamado ninfa en vez de los estados de larva y de pupa. Una ninfa sale de huevo y en general es bastante parecida a lo que será cuando llegue a la adultez. Los saltamontes crecen y se transforman de esta forma. Los saltamontes en el estado de ninfa son más pequeños y no tienen las alas que desarrolla un saltamontes adulto.

Modifications

With younger students, complete the Student Activity Sheet as a class.

Extensions

Have students compare butterfly, grasshopper, and frog metamorphosis with that of the Yellow Mealworm beetle. What are the similarities? What are the differences? What are the advantages of metamorphosis in frogs?

References

Mason, Adrienne. Mealworms: Raise Them, Watch Them, See Them Change. Toronto, Ontario: Kids Can Press Ltd.,1998.

Schaffer, Donna. Mealworms: Life Cycles. Mankato, MN: Bridgestone Books,1999.

STUDENT ACTIVITY SHEET

Yellow Mealworm Beetle Life Cycle

Date	*Stage (larva, pupa, or adult)*	*Color*	*Number of Legs*	*Other Observations*

ACTIVIDADES PRÁCTICAS PARA EL ESTUDIANTE

Ciclo vital del escarabajo molinero

Fecha	*Estado (larva, pupa o adulto)*	*Color*	*Número de patas*	*Otras observaciones*

CLASSIFYING
Clasificación

Grades		
3–8	Whole Class	45–60 min.

Purpose

Students will learn how to create a classification system, then use a dichotomous key to identify leaves.

Materials

Shoes
Copies of Student Activity Sheets: Leaf Drawings and Leaf Key

Concepts

- Classification is the process of grouping like objects into categories.
- Classification helps scientists organize large numbers of objects.
- A key can be used to identify an object or organism.

Conceptos

- Clasificar es el proceso de agrupar objetos similares en categorías.
- La clasificación ayuda a los cientificos a organizar una gran cantidad de objetos.
- Se puede usar un sistema de clasificación para identificar a un objeto o a un organismo.

Safety

Students shouldn't push or shove during Part 1. For Part 2, students need to know how to use a microscope and should wash hands after handling organisms. Review rules for handling live organisms.

Vocabulary

Classify
Key
Dichotomous key

Vocabulario

Clasificar
Sistema de clasificación
Sistema dicótomo o binomial

In Advance

Erase a large space on the chalkboard so you have plenty of room to draw a large classification key. Make a copy of the Student Activity Sheets (Leaf Key and Leaf Drawings) for each student.

Procedure

1. Introduce Classification

Begin by telling students that they will be learning about **classification**. Classification is the process of grouping like objects into categories. It is especially helpful when trying to organize huge quantities of things such as living organisms. Before practicing with a short classification system for leaves, the class will be developing their own classification system for their shoes.

2. Classify shoes

Have each student take off one of their shoes. Either put the shoes on a table where everyone can see them or have students form a circle around the shoes. On the top of the chalkboard write the word "shoes."

Ask students what characteristic they could use to divide the shoes into two groups. It may be the type of shoe (athletic shoes, dress shoes) or color (light colors, dark colors), etc. Once the characteristic is selected, hold up each shoe, and have students tell you which group the shoe belongs in. You should have two groups of shoes when you are finished. Draw two short lines on the board extending from the word "shoes." The lines should be drawn downwards like the branches of an upside down tree. Under each line, write the name of the category of shoes (light colored and dark colored, for example).

Starting with one group of shoes, ask students how they can divide that group into two more groups. Repeat the process, creating two groups each time, until each shoe is alone in its own category. Do the same for the second group of shoes the class created at the beginning. As students create new groups, write the characteristic for the groups on the board and draw branches from the broader classification to the more specific classification.

3. Use the shoe key

Put all the shoes back together making sure they are mixed up. Select a shoe at random and have students help you figure out which shoe it is using the shoe **key**. Return each shoe to its owner as you identify it.

4. Alternate methods for developing a sample classification system

If using shoes does not seem feasible in your classroom, the teacher can divide the class based on their **clothing** (perhaps coats or sweaters in cold months or t-shirts in warm months). You might start with light colors vs. dark colors and continue with categories such as prints vs. solids, buttons vs. zippers, short sleeves vs. long sleeves, with writing vs. without writing (e.g., t-shirts), etc.

Many teachers have **collections of items** that can also be used to develop a classification system (e.g., buttons): large vs. small, round vs. other shapes, white vs. colored, containing 2 or 4 holes, etc.

5. Use the leaf key

Hand out copies of the Leaf Key and the Leaf Drawings to each student. Using the drawings provided on both sheets, show students that there are many types of leaf shapes (bottom of leaf key) and leaf arrangements (leaf drawings sheet). These differences help scientists classify and identify the leaves and the plants they belong to.

Next, have students look at the Leaf Key. Explain that rather than a diagram like they used for the shoes, this key is all in writing. It is called a **dichotomous key**. The word dichotomous is derived from two Greek words that are combined to express "to divide into two parts." A dichotomous key is based on the idea of making a choice between two alternatives. Each pair of phrases describes different characteristics, but only one of the phrases will apply to the leaf being keyed out. Tell students that the "correct" phrase will either guide the student to the next pair of phrases or give the name of the tree the leaf grows on.

Have students begin to key out the leaves. As they identify each leaf, they should write the tree name under each leaf. When they are finished, review the answers with the class.

Questions to Ask During the Activity

1. Was there more than one way to classify the same objects? (Students should notice that there is more than one way to classify the same objects. Scientists often change classifications, especially as new information becomes available.)

2. Why is a key useful? (Even if you are not familiar with something, you can identify it correctly using a key.)

Preguntas sobre el tema de la actividad

1. ¿Se podrían haber clasificado los objetos de más de una manera? (Los estudiantes deben darse cuenta de que hay más de una manera de clasificar los mismos objetos. Los científicos, a menudo, cambian los sistemas de clasificación, especialmente cuando se da a conocer nueva información.)

2. ¿Por qué es tan útil tener un sistema de clasificación? (Aún en el caso de que no conozcas algo, lo puedes identificar correctamente si usas un sistema de clasificación.)

Why It Happens/More on the Topic

A dichotomous key is a "road map" used to identify an object's classification. At each decision point, the person has to decide which of two descriptions best fits the object. With each step, the descriptions become more specific until the object is identified. The system used to classify living organisms takes into account not only the features and behaviors of the organisms, but how the organisms might be related to one another. For instance, both butterflies and birds have wings and can fly, but they are not classified together. Unlike butterflies, all birds have feathers, are warm-blooded, and have two legs. Birds have more in common with each other than with butterflies and are grouped together for those reasons.

Algo más sobre el tema...

Un sistema dicótomo es un "mapa" que se usa para identificar la clasificación de un objeto. Cada vez que hay que tomar una decisión, existen dos posibilidades y la persona debe decidir cuál de las dos descripciones es la más adecuada para ese objeto. Cada vez, las descripciones se hacen más específicas, hasta que se identifica al objeto. El sistema que se usa para clasificar a los organismos vivos toma en consideración tanto las características y el comportamiento de los organismos como también las posibles relaciones entre ellos. Por ejemplo, tanto las mariposas como las

Algo más sobre el tema (continuación)

aves tienen alas y pueden volar, pero no están clasificadas en la misma categoría. Los pájaros, a diferencia de las mariposas, tienen plumas, son de sangre caliente y tienen dos patas. Las aves tienen más elementos en común entre ellas que con las mariposas, y por esa razón constituyen un grupo.

Modifications

This activity can also be used for younger students (K-2) by using procedure steps one through three only.

Extension

Have students classify and develop a dichotomous key for another set of objects (such as shells, pictures of animals, rocks, small toys, etc.). When they are finished, have students trade objects and keys to see if others can identify the objects using the key.

References

Daniel, Lucy, Edward P. Ortleb, and Alton Briggs. Merrill Life Science. Teacher Wrap-Around Edition. Lake Forest, IL: Glencoe-Macmillian/McGraw-Hill, 1993.

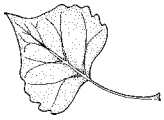
Weis, Jerry S., Christopher C. Smith, and Debra K. Welch. Laboratory Manual for Organismic Biology: Biology in a Nutshell. Adina, MN: Burgess Publishing, 1994.

STUDENT ACTIVITY SHEET

Leaf Key (Trees found in New Mexico)

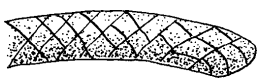
Start at number 1 and choose the option that best describes the leaves. (The diagrams at the bottom of the page will help to guide you.) Then identify the leaves on the next page.

1. If the tree has needles	go to 2
If the tree has scales	go to 4
If the tree has leaves	go to 5
2. If the needles are singular and flat, this leaf is from a	**Douglas Fir**
If the needles are in bundles	go to 3
3. If the needles are in bundles of 2, this leaf is from a	**Piñon Pine**
If the needles are in bundles of 3, this leaf is from a	**Ponderosa Pine**
4. If the branch is delicate and wispy, this leaf is from a	**Salt Cedar**
If the branch is stiff and thick, this leaf is from a	**Juniper**
5. If the leaves have lobes, this leaf is from an	**Oak**
If the leaves are without lobes, but are oval or heart-shaped	go to 6
6. If the leaves are heart-shaped with 'teeth', this leaf is from a	**Cottonwood**
If the leaves are oval, with or without 'teeth'	go to 7
7. If the leaves are oval with 'teeth,' this leaf is from a	**Siberian Elm**
If the leaves are oval without 'teeth,' this leaf is from a	**Russian Olive**



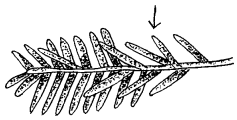
A leaf

A needle

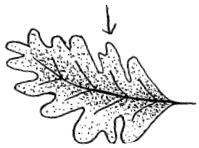


Scales

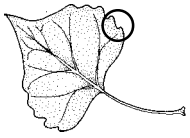
Needles in bunches



Singular needles



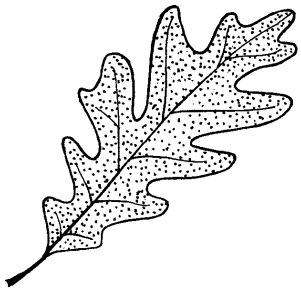
A lobe

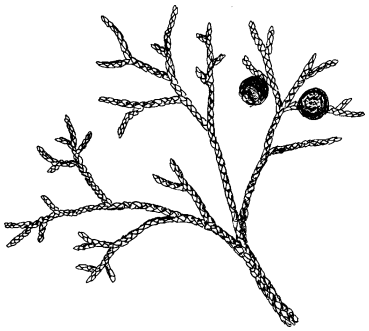


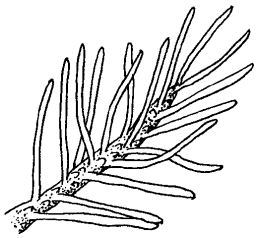
"Teeth"

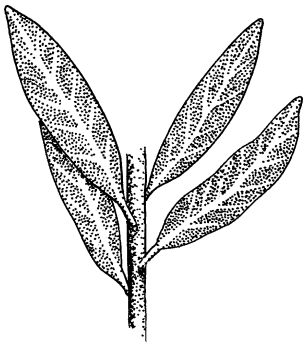
STUDENT ACTIVITY SHEET

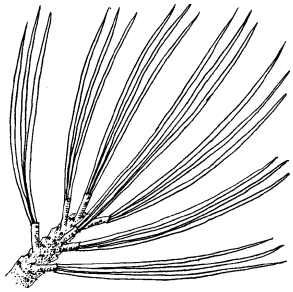
Leaf Drawings (Trees found in New Mexico)

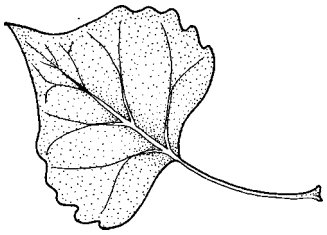


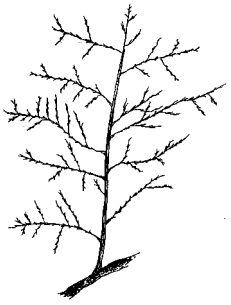






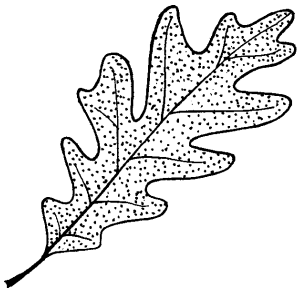




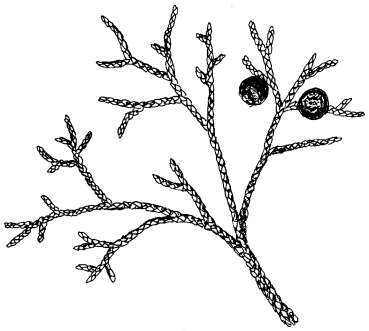


STUDENT ACTIVITY SHEET—Teacher Key
Leaf Drawings (Trees found in New Mexico)

Piñon Pine

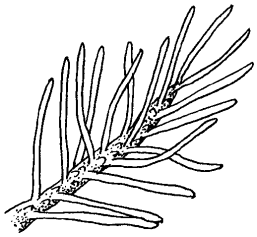


Oak

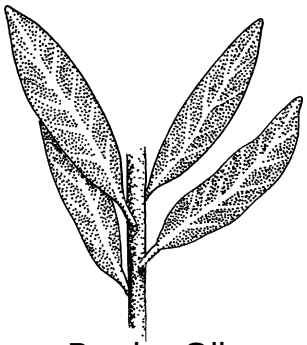


Juniper

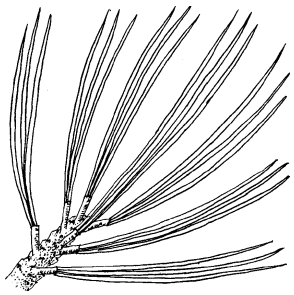
Siberian Elm



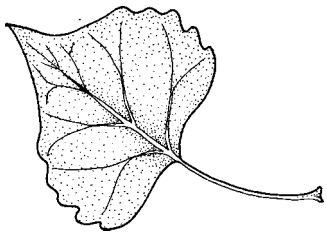
Douglas Fir



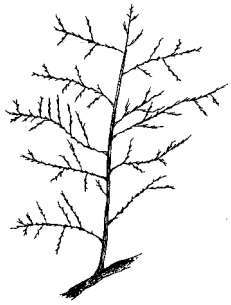
Russian Olive



Ponderosa Pine



Cottonwood



Salt Cedar

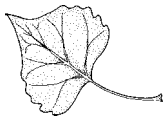
ACTIVIDADES PRÁCTICAS PARA EL ESTUDIANTE

Sistema de clasificación para las hojas

(Árboles que se encuentran en Nuevo México)

Comienza con el número 1 y elige la opción que describe mejor a tus hojas. (El diagrama al pie de página te servirá de guía.) Luego utiliza los dibujos de la siguiente página para identificar las respuestas.

1. Si el árbol tiene agujas	ir al punto 2
Si el árbol tiene escamas	ir al punto 4
Si el árbol tiene hojas	ir al punto 5
2. Si las agujas son simples y planas, esta hoja pertenece a un	**Pino de Oregón**
Si las agujas crecen en grupos	ir al punto 3
3. Si las agujas crecen en grupos de a 2, esta hoja pertenece a un	**Pino piñón**
Si las agujas crecen en grupos de a 3, esta hoja pertenece a un	**Pino ponderosa**
4. Si las ramas son delicadas y delgadas, esta hoja pertence a un	**Tamariz** (*Salt Cedar*)
Si las ramas son rígidas y gruesas, esta hoja pertenece a un	**Junípero**
5. Si las hojas tienen lóbulos, esta hoja pertenece a un	**Roble**
Si las hojas no tienen lóbulos, pero son ovaladas o acorazonadas	ir al punto 6
6. Si las hojas son acorazonadas y dentadas, esta hoja pertenece a un	**Álamo**
Si las hojas son ovaladas, ya sea dentadas o no	ir al punto 7
7. Si las hojas son ovaladas y dentadas, esta hoja pertenece a un	**Olmo de Siberia**
Si las hojas son ovaladas y no son dentadas, esta hoja es de un	**Olivo de Bohemia**

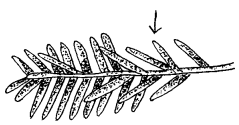


Una hoja

Una aguja

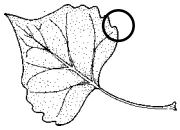
Una escama

Agujas agrupadas



Agujas simples

Lóbulos



Dentada

ACTIVIDADES PRÁCTICAS PARA EL ESTUDIANTE
(Árboles que se encuentran en Nuevo México)

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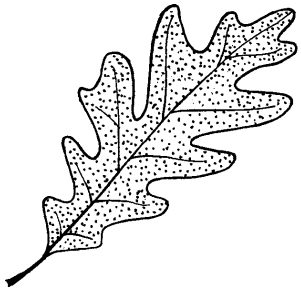

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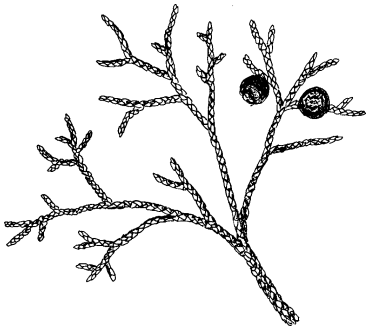

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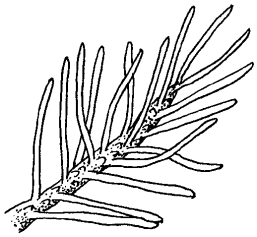

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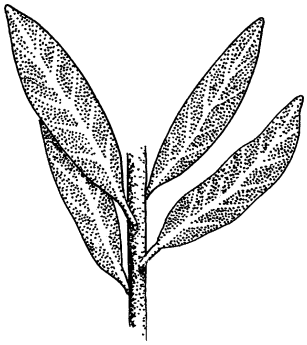

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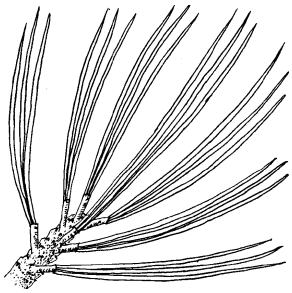

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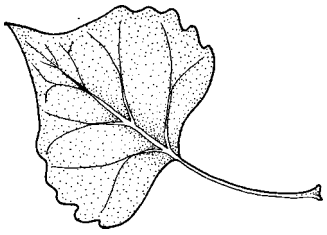

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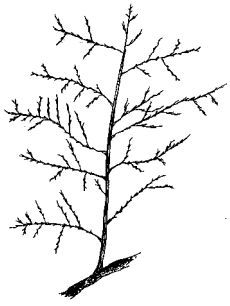

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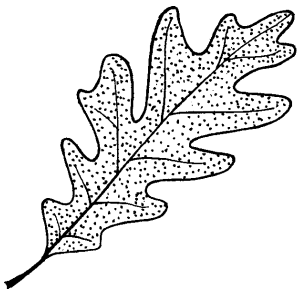
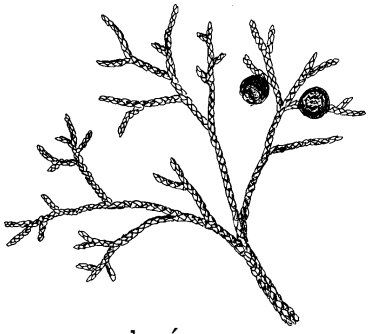
ACTIVIDADES PRÁCTICAS PARA EL ESTUDIANTE
(Árboles que se encuentran en Nuevo México)

Pino piñón

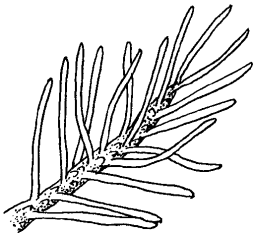


Roble

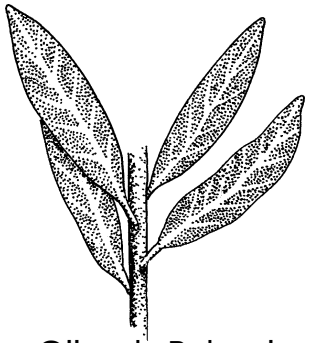


Junípero

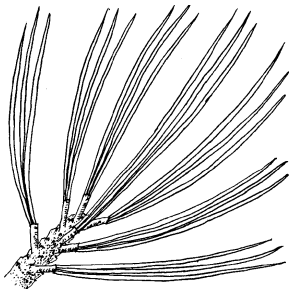
Olmo de Siberia



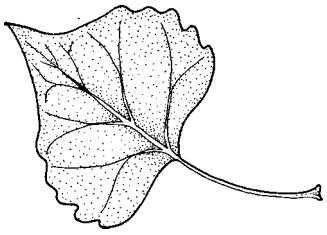
Pino de Oregón



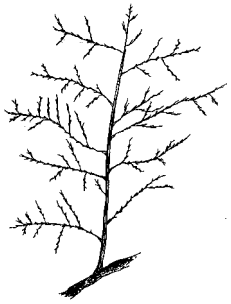
Olivo de Bohemia



Pino ponderosa



Álamo



Tamariz (*Salt Cedar*)