# SEE WHAT LIFE SCIENCE IS ALL ABOUT

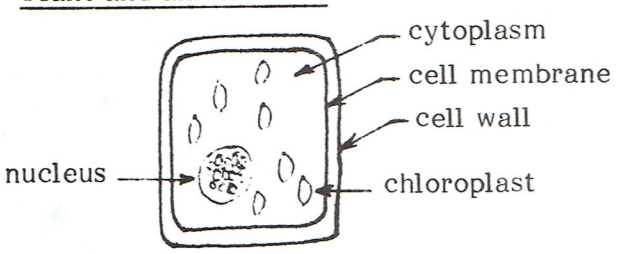
**4-6**

## CELLS / GENETICS

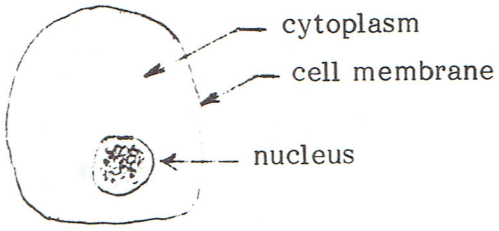
Parts of a cell

* **Review K-3 life science tapes:** [lesson]
  1. Introduction to plant and animal cells.
  2. Operation of microprojector.

Plant and animal cells



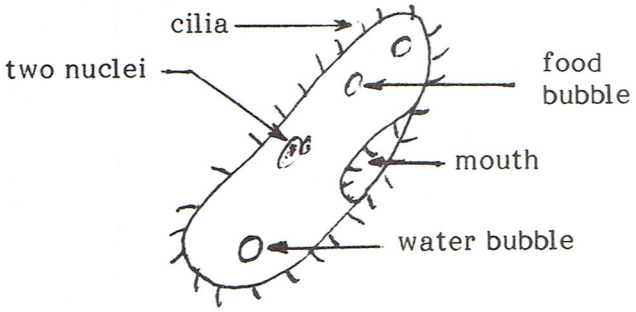

PLANT CELL



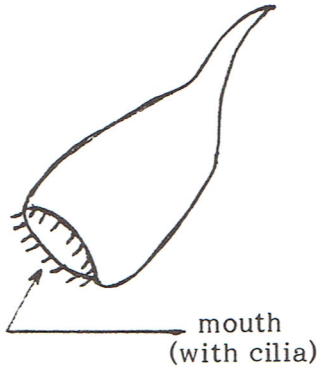

ANIMAL CELL

Characteristics of microorganisms and how cells reproduce

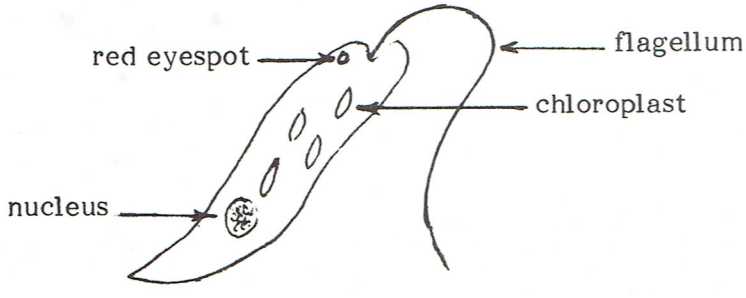
* **How microorganisms move and reproduce:** [lesson]
  1. Amoeba moves with a false foot (pseudopod).
     a.) Surrounds food and absorbs it through cell membrane. Has food and water bubbles.
     b.) Mitosis (how cells reproduce).
        1.) Chromosomes are duplicated.
        2.) Nucleus is duplicated.
        3.) Then cell splits into two cells with a complete nucleus in each new cell.
  2. Paramecium move with hair-like cilia.
     Inner parts are difficult to observe.




  3. Stentor sometimes resembles a ball (especially when disturbed). May anchor itself with narrow end.

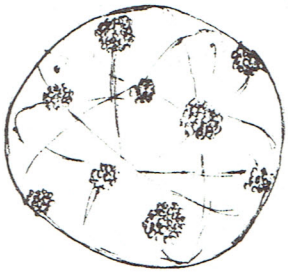



  4. Euglena move with a whip-like flagellum.
     Is a true protist - moves like an animal but can make food with sunlight like a plant.




  5. Spirostimum (not shown) looks like a worm. Also moves with cilia.

6. Volvox - colony of many single-celled protists with tiny whip-like flagellum (also have chloroplasts).



Life in a drop of water

* **Life in a drop of water:** [observational activity]

pond water
cheesecloth
5 grains uncooked rice
pinch of non-fat dry milk
timothy hay
bucket
piece of boiled lettuce

1. Preparing samples:
   a.) Collect pond water sample (include scum and sticks, etc.).
   b.) Add some timothy hay (regular hay will suffice). Cover with cheesecloth and fasten with rubberband. Keep in semi-lit area at room temperature for about 3 days.
   c.) After 3 days, add 5 grains of uncooked rice, 1 small piece of boiled lettuce and a pinch of non-fat dry milk. Cover again for 3 more days.
   d.) Look for life forms.
2. Collecting top and bottom water samples with a homemade pipette.
   a.) Place pipette in area where you want sample. Place thumb over end, remove sample. First drop should be sample from that area.
3. Hay infusion: Purpose is to make an environment in which a microorganism (when added) will thrive.
   a.) Boil a liter of water, add a handful of hay. Boil for 10 minutes.
   b.) Let cool and sit for 2 days (this is a sterile, nutrient-rich environment).
   c.) Innoculate with paramecium.
      1.) Use glass tube with very narrow end. When it touches liquid, water (and hopefully a microorganism or two) will automatically be drawn up the tube. Place tube on stage of microprojector to look for microorganisms.
      2.) Blow contents of tube into hay infusion.
      3.) You may add a pinch of non-fat dry milk if transferring paramecium.
      4.) After a week you should have a thriving colony.
4. Making pipettes:

glass tubing
safety goggles
wing-top (optional)
triangular file
burner
pliers

   a.) Cut glass tubing (score with a triangular file, snap with score mark away from you).
   b.) Heat up tube. Turn tube in fire and move it back and forth so that about 3 cm (1") of tube is heated. Note: You can put a "wing top" on the end of your burner to provide a broad, flat flame to make this process easier.
   c.) Pull two ends apart when glass melts. Let cool. Snap tip at desired point with pliers.
   d.) If the wide end of the tube is sharp, hold it in fire for a few seconds. It will melt and round out.

## Making permanent slides

* **Making permanent slides:** [observational activity]

rubbing alcohol
small containers
slide
tweezers
pipette (wide end)
water
specimen
cover slip
slide cement

1. Fix specimen:
   Pure alcohol coagulates protein on contact and produces a hard layer inside the cell wall so it is important to use water-alcohol mixtures of increasing concentrations.

   a.) 3 parts water + 1 part alcohol (10 min.)
   b.) 2 parts water + 2 parts alcohol (10 min.)
   c.) 1 part water + 3 parts alcohol (10 min.)
   d.) pure alcohol (10 min.)

   Water in cell is gradually replaced with alcohol. Specimen will stay preserved for many years.

2. Put specimen on slide. Add a drop or two of slide cement with pipette. Add cover slip.
3. For thick specimens you can put broken pieces of cover slip under edges of cover slip or use paper reinforcements with specimen in middle.
4. Cement hardens in 1-3 days. Label all slides (include date when prepared).

## Osmosis

The process by which water, food and waste moves into and out of a cell through the "skin" of the cell.

* **Float an old egg in water:** [observational activity]

  Conclusion: material inside the egg somehow escaped.

* **Observe potato cells with microprojector:** [observational activity]

  Cut a wedge. Look at the thinnest edge.

* **How does salt water affect the water content of potato cells?** [experiment]

  potato slices
  various salt solutions

  1. Mix salt solutions:

     a.) Control: pure water.
     b.) 1% salt solution: 1 gram salt + 99 ml water.
     c.) 5% salt solution: 5 grams salt + 95 ml water.

  2. Place slices of potato into various solutions. Let them soak for approximately 10 minutes.
  3. Remove samples. Notice which ones are most spongy. Hypothesize as to what has happened to the cells in the spongy ones (they have lost some of their water).

  Information: In osmosis, water goes from low concentration of salt (in this case, inside the cell) to high concentration (outside).

* **Osmosis demonstration:** [observational activity]

plastic bag
corn starch
water
dropper
beaker
tincture of iodine
test tubes

1. Put starch and water in plastic bag.
2. Put a few drops of iodine in beaker of water.
3. Place sealed bag into beaker.
4. Demonstrate how iodine indicates the presence of starch with test tubes, iodine and starch-water mixture.
5. Observe bag after 2 hours. The starch has changed color, the iodine in the beaker has not. Conclusion: Starch is too large to go through bag but iodine is not (it can go in and react with starch).
6. Starch is too large to pass through cell membrane but sugar can. Starch must first be broken down to sugar before cells can use it - this is done by enzymes (see 4-6 Life Science, part 2, "Humans").

Tissues, organs and organ systems

* **Tissues, organs and organ systems:** [lesson]

1. Cells in higher life forms are specialized.
2. Similar cells, when grouped together, are called "tissue" (i.e. blood, muscle, skin).
3. When two or more tissues work together it is called an "organ" (i.e. the heart is an organ composed of blood, muscle, nervous and connective tissue).
4. When two or more organs work together it is called an "organ system" (i.e. respiratory, circulatory, reproductive or root systems).

Characteristics of living things

* **Characteristics of living things:** [lesson]

1. Grow
2. Reproduce
3. React to stimuli
4. Use energy
5. Are made of cells

**Activities:**

1. Students identify objects around the room as living or non-living.
2. Have students bring some cells to class (it's the smart student who says, "I brought myself!").
3. Living crystals?

microprojector
slide
strands of copper wire
silver nitrate

Add drop of silver nitrate to copper wire on slide. Watch crystals grow (non-living).

Asexual and sexual reproduction

* **Asexual and sexual reproduction:** [lesson]

Asexual: Examples are amoeba (cell splitting) or a plant growing from a plant part. New life form is a clone of old one (since chromosomes are exactly the same).

Sexual: Special cells (sex cells) have only half the required number of chromosomes. When male and female sex cells unite we find the combination now has the required number to begin to divide (use a zipper as an example). Although a donkey and a horse can mate to make a mule most different species cannot successfully mate (zippers won't match).

Chromosomes

* **Chromosomes:** [lesson]

Chromosomes carry the biological blueprint of the cell. Since the new cell is a combination of the chromosomes of the male (1/2) and female (1/2), the new cell can have characteristics of each.
Although traits from dominant genes may be apparent, the recessive (dominated) genes may still be found within the cell and new traits may become apparent in a following generation.

Genetics

* **Observing inherited traits:** [observational activity]

Form groups of four students each. Investigate and record traits of group members:
1. Attached or unattached earlobes.
2. Tongue rollers.
3. Hitch-hiker's thumb.
4. PTC paper (Phenyl Thiocarbamide) tasters.

Evaluate data from all groups on the board.

Students can test immediate family members for these same characteristics and, perhaps, determine from which parent they acquired a trait. This is important in helping children to realize the great diversity in members of the human race.

Explain how one gene dominates (example: PTC tasters)

TT = taster (pure trait)
Tt = taster (hybrid)
tT = taster (hybrid)
tt = non-taster (pure trait)

Dominant gene prevails. But in the case of hybrids, even though it may not be apparent, the person still carries the recessive gene.

* **Using Punnett (pun′ it) squares:** [observational activity]

| | T | t |
|---|---|---|
| T | TT | Tt |
| T | TT | Tt |

Notes: Mother's genes are on the left, father's are on the top. The offspring possibilities are in the four boxes. Capital letters are always listed first.

In this case all offspring will be tasters. There is a 50-50 chance that a child will be a pure (taster) or a hybrid (taster). Working with these is valuable in developing skills in reading matrics and learning about probability. Let's look at another example: If mother and father are both "Tt", we get the following:

| | T | t |
|---|---|---|
| T | TT | Tt |
| t | Tt | tt |

There is a three out of four chance that the child will be a taster (one in four for non-taster).

Emphasize that "recessive" does not mean "inferior." For instance, near-sightedness is dominant over normal vision. If both parents are near-sighted, at best there is a one-in-four chance that offspring will have normal vision (mother and father both "Nn").
For some traits neither gene is dominant. In these cases the offspring will have a blend of the two traits (i.e. a pink flower from red and white ones). This is called "incomplete dominance."

* **The square of fortune:** [observational activity]

3 students per group — various Punnett square cards

1. All groups use similar cards each time.
2. Student #1 moves finger from one box to next in a uniform, orderly fashion.
   Student #2, who can't see the location of student #1's finger, says "stop."
   Student #3 records offspring's gene combination.
3. Each group makes 20 runs and groups data (frequency of occurrence of different combinations). Teacher collects data from all groups on blackboard. Which combination is the most probable? Why?

Probability: Tt = 50%
TT = 25%
tt = 25%

Sample #1 —>

| | T | t |
|---|---|---|
| T | TT | Tt |
| t | Tt | tt |

For sample #2, guess probable outcome
before doing activity (TT = 50%, Tt = 50%):

Sample #2 —>

| | T | T |
|---|---|---|
| T | TT | TT |
| t | Tt | Tt |

Discussion:
When we try this activity, why don't we get these exact results?
Explain probability with a coin toss (50-50 probability on each toss). You could possibly get three "heads" out of three tosses.
Skin and eye color is inherited and caused by a chemical called "melanin." One gene pair directs the making of melanin and other pairs of genes determine the quantity that is made. Blue eyes are characteristic of a lack of melanin, hence the common occurrence of blue eyes and fair skin (likewise, brown eyes and dark skin).

Variations among plants and animals

* **Measure and compare hand spans (in mm):** [observational activity]

Collect data from all class members and graph with histogram:
"Number of students" on vertical axis, "hand span" on horizontal axis (by 5 mm increments, i.e. 150-154, 155-159, 160-164). Find high, low, average, etc.

* **Variations in the mass (weight) of lima beans:** [observational experiment]

  Each group weighs approximately 20 lima beans. Collect all data from class. Graph results.

* **Variation in the length of peanuts (in shell) or kidney beans:** [observational activity]

  metric ruler samples

* **Variation in the number of peas in a pod:** [observational activity]

**PLANTS - Section 1**

Flowers - monocots and dicots

* **The difference between monocots and dicots:** [lesson]

  Monocot: one-part seed
  Dicot: two-part seed
  Cotyledons are the parts of the seed that the young plant uses for food before it is able to make food with sunlight.
  Venation in leaves: Monocot leaves have parallel veins.
  Dicot leaves have branched veins.
  Number of petals (and plant parts): Monocots - 3, 6, 9, etc.
  Dicots - 4 and 5 or multiples (i.e., 8, 10, 12, 15)

* **Investigating pollen:** [observational activity]

  small dish 1 flower with ripe pollen (lily works very well)
  magnifiers blotter paper
  10-20% sugar solution (1 c. water + 2 T. sugar -or- 100 ml water + 20 gms sugar)

  Moisten blotter paper with sugar solution
  Sprinkle pollen on moistened paper.
  Observe hourly with magnifiers over a three-hour period.
  Record results.

  Further investigations: "Does the concentration of sugar in water affect the rate of growth in pollen tubes?"
  Try various concentrations of sugar water. Use a control (no sugar in water). Compare results. This would be a good science fair project!

Parts of a flower

* **Flower dissection:** [observational activity]

  flowers (hibiscus, lily, gladiola) tweezers
  magnifiers construction paper
  clear shipping tape (2" wide)

  1. Observe flower first, note visible parts. Record observations (color, size, number of petals, etc.)
  2. Information: If flower doesn't have all four parts (sepals, petals, stamens, pistil) it is called an "incomplete" flower. Some are only male or female (have stamens or pistil but not both) and are called "imperfect" flowers. A "composite" flower (crysanthemum, zinnia, marigold, dandelion, daisy) has many tiny individual flowers within it.
  3. Remove and identify flower parts: sepals, petals, stamens (produce pollen), and pistil (long tube to ovary). Inside the ovary are ovules (eggs) which, when fertilized, become seeds.
  4. Tape parts onto construction paper and identify each part.

* **Classifying plants:** [extra information]

One may begin to classify a plant as being "vascular" or "non-vascular."
The vascular plants have tubes (xylem and phloem) that carry materials from one part of the plant to another.

There are three main classes of vascular plants: the ferns, the flowering plants and the cone-bearing plants. The leaves of ferns are called "fronds" and ferns reproduce by means of spores and sex cells.
Flowering plants are called *angiosperms*, which means "covered" or "enclosed seeds." The two main groups of *angiosperms* are the monocots and the dicots.

Cone-bearing plants (conifers) are called *gymnosperms* which means "naked seeds." These plants have separate male and female cones. Pollen from the male cone reaches the female cone and, like pollen in a flower, it grows a pollen tube and fertilizes an egg cell in the female cone. When mature, the female cone opens up and the seeds, which sometimes have "wings", are scattered by the wind.

For an activity you may have students identify male from female cones. The male cones are smaller and softer then the female cones.

Germination

* **Effects of different variables on germination:** [experiment]

seeds
containers
other materials (depending on variables tested)

1. Guide students in designing the experiment. Which variables will they test? How will they test them? What will they use for a control?
   a.) Possible variables: amount of water, effects of salt water, temperature, light, air.
   b.) You can only test one variable at a time.
   c.) When testing the effects of air, the control can be dampened and exposed to air. Experimental samples can be submerged in water (no air).
   d.) When testing temperature, control samples can be at room temperature in a dark box and experimental samples can be in the refrigerator. To cancel the possible effects of light we place our control in a dark box because it is dark inside a refrigerator, too.
   e.) Be sure that everything is kept the same except the one variable being tested.
   f.) Different groups can test different variables and present findings (in a germination symposium) to the rest of the class.

Importance of cotyledons

* **How important are cotyledons to the growth of the embryo?** [experiment]

5 lima beans per student
paper towel
sugar
2 dishes
water
glass or plastic wrap

1. Soak lima beans for a few hours.
2. Split seeds open and carefully remove the whole embryo from the cotyledons (discard the cotyledons).
3. Germinate control samples on a paper towel dampened with plain water (no sugar). Germinate experimental samples on a paper towel with sugar water ($\frac{1}{2}$ t. sugar + 1 c. water -or- 5 gms sugar + 150 ml water).
4. Cover each and observe for three days.

Starch and sugar in cotyledons

* **Is starch in a cotyledon?** [observational experiment]

pea seeds
iodine
toothpick
dropper

1. Germinate pea seeds at three-day intervals for 12 days.
2. Give each group a sample from each batch.
3. Pry seeds open with a toothpick, add 1 drop of iodine to the cotyledon of each. Observe for indication of starch. Record results. Which cotyledons have more starch, those from young or old plants? Why?

Observing plant cells/ Osmosis

* **Investigating plant cells:** [observational activity]

Elodea (genus: *Anachris)*
microprojector
cover slip
10% salt solution (10 gms salt + 90 ml water)
slide
dropper

1. Observe elodea under microprojector. Students can file by and look at chloroplasts.
2. Add 1 drop of the 10% salt solution (review CELLS/GENETICS "Osmosis," if necessary). Salt water draws liquid out from within the cell. The cell membrane shrinks down, the cell wall remains rigid.
3. Soak up salt water with a piece of paper towel. Add 1 drop of fresh water. Cells may return to their original shape.

Photosynthesis

* **Photosynthesis:** [lesson]

Energy transfers from sun energy into chemical energy (like winding up a spring, the plant is storing sun enery in the form of sugar and starch).

$CO_2$ + $H_2O$ + sun energy ——> sugar + oxygen. Most of the oxygen in our air is produced by plants, most of which live in the ocean (diatoms).

A plant also uses some sugar to grow and survive. This process is called "respiration" and is also common in animals (burning the energy or "unwinding the spring").

Sugar + oxygen ——> energy + $CO_2$ + $H_2O$.

"Transpiration" is the process by which plants give off excess water.

* **Importance of light to a green plant:** [observational activity]

geranium plant
construction paper cut-out
paper clips

1. For best results place plant in the dark for 24 hours prior to experiment.
2. Place paper cut-out on a leaf. Place plant in sunny location for a few days.
3. Remove paper and observe leaf.

* **Demonstrate that plants give off a gas:** [observational activity]

test tube
light source
elodea
water
bowl

1. Place elodea in test tube, fill with water. Invert and place in a bowl of water. Turn on light source (Note: You can add a pinch of baking soda to the water for better results. This increases the amount of available $CO_2$).
2. After a few hours you may see a tiny bubble in the top of the test tube and/or lots of tiny bubbles on the leaves (it's difficult to collect enough oxygen to actually test).

## Light and photosynthesis

* **How does light intensity effect oxygen production?** [hypothetical experiment]

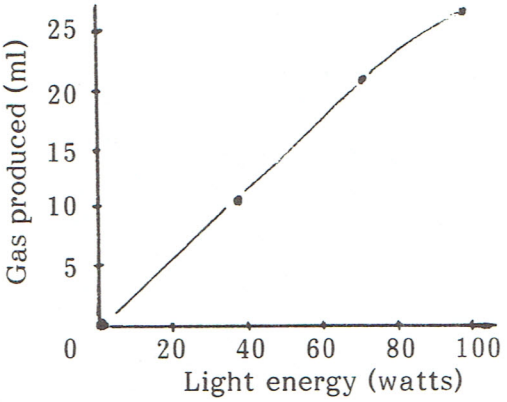
no materials required

In a hypothetical experiment you don't actually do an experiment but, rather, you work with hypothetical data. This is sometimes called a "dry-lab" experiment and has occasional value. The readings which follow would not be observed in an actual experiment.

Data:

| | |
|---|---|
| 0 watts (dark) | - 0 ml |
| 40 watts | - 10 ml |
| 75 watts | - 20 ml |
| 100 watts | - 25 ml |

To add more data and give students more experience plotting points, read information off the graph (i.e. 60 watts = 15 ml )




## Carbon dioxide, water and leaves

* **Plants use carbon dioxide:** [demonstration]

2 test tubes & stoppers — elodea plants
Bromothymol blue (BTB) — straw

1. Have a student blow into BTB solution to add $CO_2$ and change the color from blue to yellow.
2. Fill 2 test tubes with yellow BTB. Add elodea to one of them. Stopper both tightly.
3. Place both in sunlight for one hour. Compare colors (plant uses $CO_2$ and BTB turns blue, control stays yellow).

Variation: Use three test tubes. Cover the third one with foil so no light gets in. You can successfully do this indoors in front of a 60 watt light bulb.

* **Plants give off water vapor:** [activities]

1. Use two jars (same size) with paper barrier between each, leaf in top jar and stem reaching down to water in bottom jar. Mist will appear in a few hours.
2. Use small cups with plants. Seal around plant stem with plastic. Place in larger jar (seal jar). Control can be a stick in a cup (instead of a plant).
   Note: This works best using plants with large leaf surface area.

* **Plants breathe from the bottom of the leaf:** [observational activities]

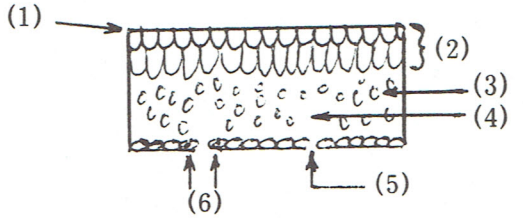
1. Rub petroleum jelly or shortening on top, bottom or both sides of leaves on a plant. Observe and record results daily (leaves appear to breathe through the bottom of the leaf).
2. Pinch leaf stem. Immerse leaf in very hot water. Air inside leaf expands and must escape through breathing holes (located on underside of leaf).

* **Leaf cross-section:** [observational activity]

prepared slide of leaf cross-section — microprojector

1. Observe veins, top of leaf (with chloroplasts), (1) epidermis, (2) palisade layer, (3) spongy cells, (4) air pockets, (5) stomata (breathing holes) and (6) guard cells.

Information: c.s. = cross-section
l.s. = longitudinal section
w.m. = whole mount



**PLANTS - Section 2**

Stems

* **Teaching by objectives:** [teacher information]

When planning science lessons, list your objectives. The example below is for a lesson on stems. Following this section the students should be able to satisfy the following objectives:

1. Students should be able to identify the main functions of the stem (two reasons why the stem is important to the plant).
2. Students should be able to explain what causes plants to grow toward the sun.
3. Students should be able to differentiate between monocot and dicot stems when looking at microscopic cross-sections.
4. Students should be able to name two parts of a stem and the function of each.
5. Students should demonstrate proper use of magnifiers and be able to correctly observe and describe what they see.

Woody vs. herbaceous stems

* **Woody vs. herbaceous stems:** [observational activity]

Woody stems have rigid, rough outer surfaces (bark). Plants with these stems are "perennials" (live from one year to the next).

Herbaceous stems are smooth, green and flexible. Herbaceous plants are "annuals" (they die off in winter).

1. Students can identify plants at different stations as having either a woody or herbaceous stem (use vegetables at some stations).

Auxins and plant growth

* **Why plants grow toward the sun:** [lesson]

Auxins (growth hormones) migrate to the shady side of the stem and promote greater cell growth on the shady side. Plant stem bends.

Ask students why they think it's important for plants to be able to do this.

Function and parts of the stem

* **Dissect a celery stalk:** [observational activity]

1. Place celery in blue water for a few days.
2. Make cross cuts and longitudinal cuts and observe "tubes" in the celery.
3. Look at the veins in the leaves with magnifiers.

Function of the stem:

1. To transport water and nutrients from roots to leaves.
2. To move food from leaves throughout the rest of the plant.
3. To give the plant strength.

* **Observe the stem of a corn stalk (monocot):** [observational activity]

1. Make a thin cross cut from corn stalk.
2. Stain with marking pen or ink.
3. Look closely for tiny tubes with magnifiers. Record observations.
4. Take a closer look by using the microprojector and a prepared slide (corn c.s. or *Zea mays* prepared slides).

   a.) Corn is a monocot. Notice that the bundles (tiny faces) are scattered throughout the stem (memory aid: "corn is scattered in a field" - monocots have scattered bundles).

   b.) Large tubes are called "xylem" (zi/ lem) and carry water throughout the plant. Tiny tubes are called "phloem" (flow/ em) and carry the food (memory aids: "food flows"; "w - x = water - xylem").

* **Observe a dicot stem with the microprojector:** [observational activity]

Sample shown is pumpkin c.s. slide. Notice that, in comparison to monocots, the bundles are in an orderly, circular arrangement.

* **Observe a woody stem:** [observational activity]

prepared slides (i.e. pine c.s., hibiscus c.s.)

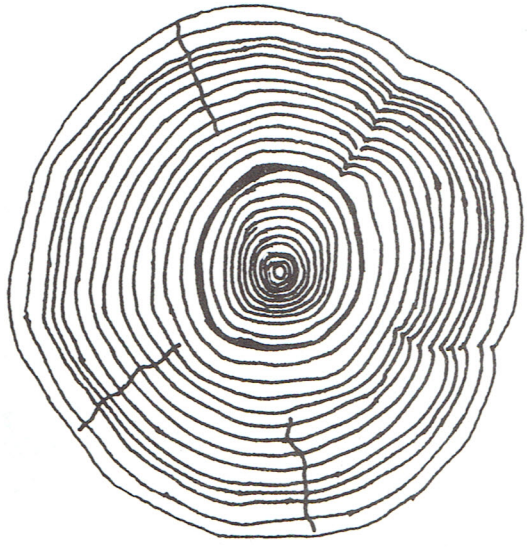
1. Cambium layer is where growth occurs (this layer is characteristic of a woody stem).
2. Phloem cells are on the outside of cambium layer, xylem cells are on the inside.

Tree rings

* **Observe tree ring growth:** [observational activity]

Samples of tree rings -or- photocopies of these samples

1. In summer, cells in the cambium layer are quite thick and make the dark, narrow rings. In spring the cell walls are quite thin and make the clear growth area between the dark rings.
2. Advanced tree ring observations:



1. First 10 years, rings close together. These narrow center rings tell us that other trees might have shaded it when it was young.
2. 5-10 years: Wider rings on top vs. bottom. This suggests that the tree was bent (wider bands tell of more growth on that side to straighten the tree out.
3. During the 11th year, we see a scar from a fire.
4. The "v" marks indicate where branches grew.
5. Cracks develop as the log dries.
6. Wider rings from 10-19 years tell of good growth. During the 20th and 21st years there was a drought which caused two narrow bands.
7. This tree is 24 years old.

## Roots

Functions:
1. Anchor plant in place.
2. Absorb minerals and water.
3. In some cases are necessary for reproducing new plants.
4. In some cases are used to store food for the plant.

* **Observing roots:** [activities]

1. Classify by location and structure:

   aerial roots (i.e. orchids)
   water roots (i.e. elodea)
   soil roots - subclassify as
   a.) Taproot system (i.e. carrot). Tiny roots that come off the side of the taproot are called secondary roots.
   b.) Fibrous (no main taproot). Have value in helping to prevent erosion.
   c.) Adventitious. Roots grow from a part of the plant (i.e. the stem) where you wouldn't expect them to grow.
2. Students can sequence similar plants according to the age or size of their roots.
3. Grow onion sets in water, vermiculite and soil. Compare roots.
4. Observe carrot slices with a magnifier. Look for three distinctive areas. Students draw what they see.
5. Grow a carrot top in vermiculite.

## Vegetative reproduction

* **Vegetative reproduction:** [lesson/activities]

Vegetative reproduction is a form of asexual reproduction. The new plant is grown from a part of another plant (not a seed). The new plant will be a clone of the parent plant and will have the exact same characteristics as the parent.

Examples: carrot, pothos, spider plant, African violet, potato, sweet potato.

## Plant adaptations

* **Plant adaptations:** [lesson]

Illustrate some plant adaptations in class. Ask students to look for plant adaptations in their neighborhood.

Examples:
Cactus: Spines to keep animals away. Spines are also tiny leaves which allow very little water loss (all desert plants have small leaves).
Succulents: Have waxy leaves to keep water in.
Philodendron: Large leaf in shady area of jungle. Needs large surface area to collect as much light as possible.

## Tropisims

Information: A tropism is the response of a plant to a particular stimuli. In a "positive" tropism the plant reacts toward the stimuli. In a "negative" tropism the plant moves away.

Examples:
Heliotropism or phototropism (sun)
Geotropism (gravity)
Chemotropism (chemicals)
Thigmotropism (touch)

* **Grow a plant upside down:** [observational activity]

1. Sprout a kidney bean seed in a small plastic pot.
2. Cover top of pot with screen, waxpaper or cheesecloth.
3. Hang upside down for about a week.

Importance of soil, value of agriculture

* **Investigate different soil samples:** [observational activity]

soil samples magnifiers

* **Value of agriculture:** [lesson]

Technological application of science for the benefit of society.
By applying the principals of genetics we can breed strains which may produce more food per plant, be more resilient to harsh conditions and ripen quicker.

Use of fertilizer and farm machinery help keep the soil productive and increase crop yield.

Homemade terrarium

* **Make a terrarium:** [activity]

2 liter clear plastic soda bottle scissors
small plants potting soil

1. Remove bottom part of bottle. Cut top section (spout) off. Use caution with cutting tools!
2. Fill bottom with damp soil and plants. Invert top over it. Place in semi-lit area.
3. This terrarium will require practically no water or maintenance.

## CLASSIFICATION / PROTISTS

The Classification Scheme

* **How we classify objects:** [observational activity]

1. Students record objects that we classify (i.e. library books, silverware, clothes, food, money).
2. Students can also list the characteristics by which we classify each.

* **Name the mystery student:** [observational activity]

Teacher picks a student in class and gives clues, one at a time, until someone correctly identifies the mystery student (clues should be as general as possible at first).

Variation: Student who guesses correctly can now take the teacher's spot and give clues for the next mystery person. Points can be awarded for the acceptable clues. The student with the greatest point score wins (unacceptable clues might be, "The student is in the room" or "The student is alive.").

Classification activities

* **Worksheet activities:**

1. Which are alike?

   a.) Students are given a list with three items per group. They circle two of the three that are most closely alike.

2. Classifying shapes:

   a.) Cut out objects on following page of this outline.
   b.) Classify into groups:

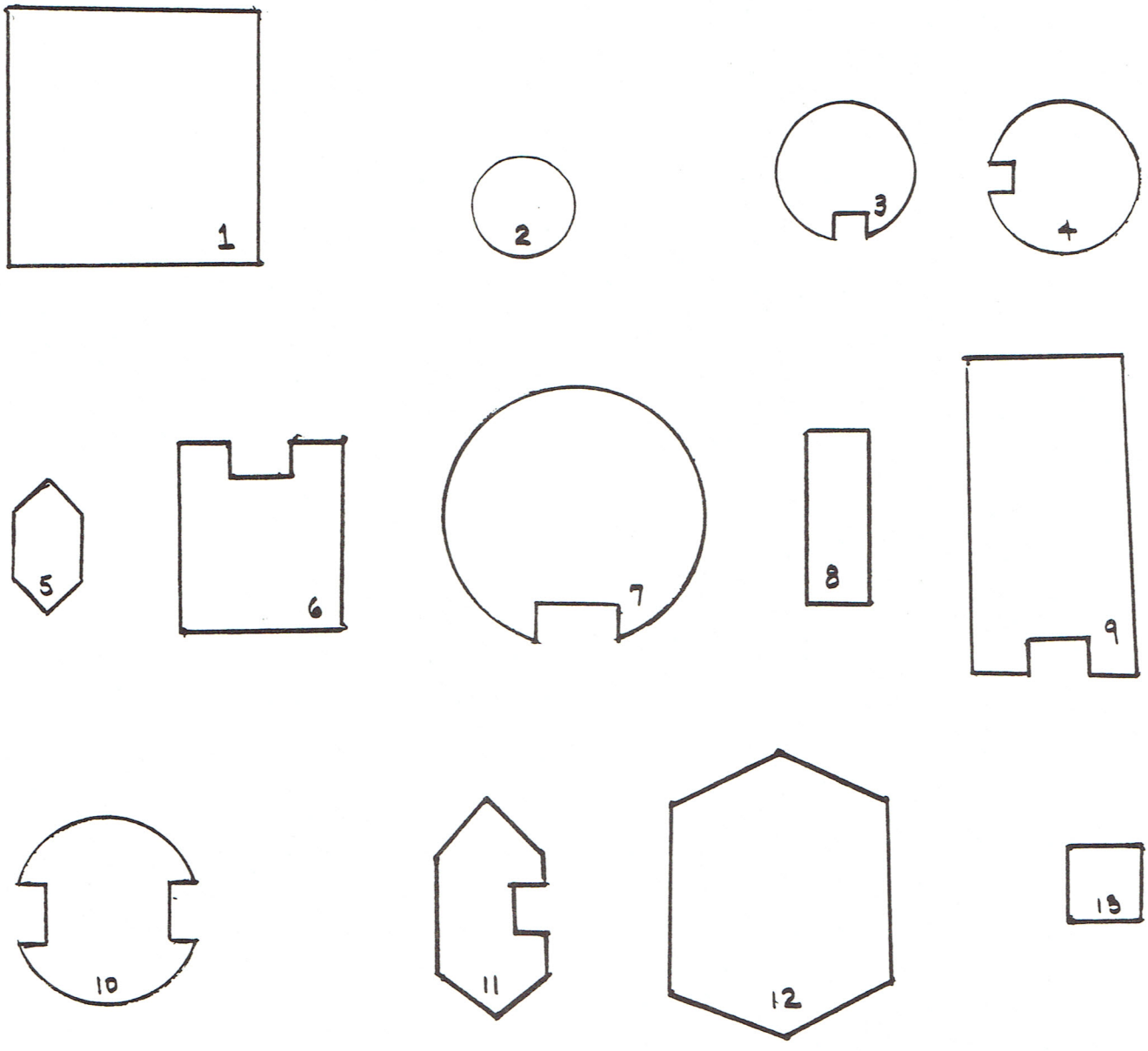
      1.) Kingdom A: 3,4,6,7,9,10,11 and Kingdom B: 1,2,5,8,12,13
      Students determine differences between the two kingdoms. They may also give each a name (i.e. "notched" and "no-notch").
      2.) Phyla from Kingdom A: 3,4,7,10, ("round-notch"); 6,9 ("square-notch"); 11 ("diamond-notch").
      3.) Classes from the "round-notch" phylum: 3,4,7 (can be called "round single-notch"); 10 (called "round double-notch").
      4.) Continue with Kingdom B.

* **The classification scheme:** [information / lesson]

We classify life forms by their characteristics. There are seven broad categories that we use. They are (from general to specific):

| | Memory aid: |
|---|---|
| 1. Kingdom | King |
| 2. Phyla | Paul |
| 3. Class | Cried |
| 4. Order | Out |
| 5. Family | For |
| 6. Genus | Good |
| 7. Species | Soup |

Analogy: It's like an address. We live in a country, state, and city, on a particular street with a particular number and, within that house, we are identified by a name (first and last). Rather than call someone Jane Smith of 465 Ocean Avenue, San Diego, California, U.S.A., we merely use the name Jane Smith. Likewise, we can identify plants and animals by two unique (genus and species) names.




The different shapes above are to be cut out and used in the classification activity. You may wish to expand this example and include a variety of other shapes (i.e. a three-notched circle).

* **Genus and species names:** [lesson]

Genus is a noun and is capitalized. The species name follows genus and is usually an adjective. Examples:

Cat = *Felis domestica*
Tiger* = *Felis tigris*
Lion* = *Felis leo*

* - Some sourcebooks place Tigers and Lions in the genus *Panthera*. The example above will suffice, however, in explaining the classification scheme.

Man = *Homo sapien* ("sapien" means "wise")

There is also some disagreement on the number of kingdoms that exist. Some list three - plants, animals and protists; others list five - plants, animals, fungi, bacteria and protozoans.

Protists - fungi, molds, mildew and yeast

* **What is a protist?** [information / lesson]

Examples of protists include:

protozoans
slime molds
fungi
lichens
blue-green algae
bacteria
molds

Most protists are unable to make their own food (many are parasites).

* **Fungi - mushrooms:** [information / activities]

Club fungi (mushrooms) look like a club.
Bracket fungi grow off the side of a tree or log.

Parts of a mushroom: cap, spores (in gills), stipe.

1. Observe mushroom parts with magnifiers.
2. Make spore prints:
   a.) Pick a mushroom with an open cap.
   b.) Snap off stipe. Place cap on paper, gills down. Cover with plastic cup for 24 hours.
   c.) Preserve print with art fixative or hair spray.

* **Molds:** [experiment]

2 pieces of bread (with and without preservatives)
8 plastic bags
water, dropper
tape

1. Cut each piece of bread into four pieces.
2. Place ten drops of water on each piece.
3. Place each slice in a plastic bag and place one preserved and one unpreserved sample in the following locations:
   a.) Warm, dark place with bag open
   b.) Warm, dark place with bag closed.
   c.) Sunlit place with bag closed.
   d.) Control sample in refrigerator with bag closed.
4. Observe samples daily for 12 days (Note: Keep bags sealed when observing as some people are allergic to mold spores).
5. Students can prepare samples at school and run the experiment at home. After 10-12 days they can bring their samples back to class for group observations. You may even wish to have a "mold symposium" with groups reporting their findings.

* **Mildew:** [activity]

2 socks
2 plastic bags

1. Wear one sock, get it dirty, etc. Sprinkle water on it, wring out and place in a plastic bag.
2. Control sock (clean): Sprinkle with water, wring out and place in bag.
3. Store both samples in a warm, dark place. Observe daily for a week. Make comparisons.

* **Yeast:** [experiment]

soda bottles
Bromothymol blue solution
yeast
water
fruit juices
#3 stopper (with 1 hole) or clay
glass tubing or aquarium air hose
sugar
graduated cylinder
balance (optional)
Tes-tape (sugar indicator available at pharmacy)

1. Put 100 ml (1/2 c.) warm water into each bottle.
2. Add sugar (various amounts, i.e. 5, 10, 15 grams - note: 5 gms = approx. 1 t.)
3. Add 2 grams of yeast per bottle (approx. 1/2 t.). Don't forget the control (2 grams yeast and no sugar).
4. Try apple or grape juice (100 ml) with 2 grams of yeast.
5. Place samples in a warm spot for 1 hour.
6. Visually compare samples for amount of froth. This release of gas is caused by the process of fermentation. The yeast is breaking down the complex sugar into simple sugar and then to alcohol and carbon dioxide. This process is important also in making bread as yeast turns starch to sugar and then breaks down the sugar into $CO_2$ and alcohol. The $CO_2$ puffs up the bread and makes it rise (the alcohol evaporates). Fermentation is also an important process in decomposing dead plant and animal material. It is important in making cheese, sauerkraut, chocolate and dill pickles, too.
7. How does the amount of sugar affect the amount of gas produced?
   a.) Connect up tube with stopper or clay. Bubble gas through BTB solution to demonstrate that the gas is $CO_2$.
   b.) Students can count bubbles per minute and compare results.
8. Speculate on the amount of sugar in the grape (or apple) juice by measuring its rate of gas production and compare it to the known samples (5, 10, 15 grams of sugar).
9. Test samples with Tes-tape for sugar (glucose) concentration.
   a.) Regular (complex) cane sugar will not show a reaction, but yeast breaks down complex sugar into simple sugar which reacts with Tes-tape. This shows that a bio-chemical reaction is taking place.
10. Observe samples under microprojector. With time you'll see the yeast (in sugar solution) reproducing by the hundreds.

## ANIMALS

Classroom pets

Check with your pet shop before making a commitment - don't forget about vacations. A pet store owner may loan animals for awhile or, perhaps, visit the school to display different animals.

Some teachers have a lottery for their pets in June. Students with interest (and parent permission) are eligible to enter the lottery.

Adaptations - natural selection

Adaptations are special characteristics that help animals and plants to survive. Color and camouflage are adaptations, gills on fish are adaptations as are ridges on our fingers (fingerprints).

* **Animal adaptations:** [activity]

  Each student is assigned an animal. They report back with the special adaptations that their animal has. Good examples may include: camel, giraffe, penguin, elephant, and turtle.

* **Natural selection:** [observational activity]

  paper punch
  paper cup with pinhole in bottom
  green and yellow paper

  Part 1:

  1. Sprinkle 25 green and 25 yellow dots on green paper.
  2. The "predator" looks through the viewer for 30 seconds and picks up dots one at a time.
  3. After 30 seconds, lab partner says, "stop" and records results. How many of each color are left?
  4. Put dots back on table, repeat process at least three times. Average results.

  Part 2:

  1. This time, at the end of first trial, allow the remaining dots to "reproduce" (double the amount of each remaining dot color).
  2. Continue with second trial. At the end of this trial, double the amount of each remaining color again.
  3. What happens to the "population?"

  Follow this up with a lesson on natural selection and cite actual examples. A classic is the story about the white and brown moths in England. When the people started using coal to heat their homes, the brown moths blended in better with the surroundings and soon all the white moths were gone.

* **Live frog lab:** [observational activity]

  grass frog (*Rana pipiens)*
  fish tank
  thermometer
  crickets
  gravel
  plastic water container

  1. Keep fresh water in tank. Feed frog live crickets or mealworms (5-10 per week).
  2. Observe frog:
     a.) Make measurements, if possible (length and weight). You can weigh an empty box then weigh same box with frog inside. Subtract weight of box to get frog's weight.
     b.) Notice ear membranes behind eyes.
     c.) Optional: See how far the frog can jump (this can get quite exciting!).
  3. Place frog in tank of water. Observe how it swims (frog kick, webbed feet). How has man learned to swim faster by watching a frog swim? Review adaptations with class.

* **How water temperature affects the respiration rate:** [experiment]

fish tank full of water  grass frog  ice

1. Stage one: 5-10° C (40° F). Record respiration rate.
2. Stage two: 20°C (68°F). Record respiration rate.
3. Stage three: up to 40°C (100°F) no higher! Record respiration rate.
4. Graph results. Nostril movements per minute on vertical axis, temperature (in °C) on horizontal axis.
5. Frog may lay very still on bottom. He/she is now using the other method of respiration - through his/her skin.
6. Students record their respiration rates for comparison.

Note: Always take frog through gradual temperature changes (don't go from ice to hot, etc.). Throat gulp rate may be four to five times the nostril movement rate.

* **Introduce concept of cold-blooded:** [lesson]

1. Graph different sets of hypothetical data on blackboard. Body temperature vs. water temperature.
2. Challenge students to decide which graph best represents the cold-blooded animal.
3. See if they can now guess what the graph of a warm-blooded animal would look like (constant at a specific temperature).

Goldfish observations

* **Goldfish observations:** [observational activity]

goldfish (borrow from pet store)
thermometers
cheesecloth
plastic cups
water conditioner

1. Student groups prepare the proper environment for a goldfish (dechlorinate water and maintain 65°-70°F [approx. 20°C] water temperature).
2. Make observations and drawings.

* **Observing the circulation of blood in a goldfish tail:** [observational activity]

1 small goldfish
slide
cheesecloth
microprojector
petri dish

1. Place wet cheesecloth in petri dish.
2. Wrap goldfish with cloth, leaving tail exposed.
3. Place microscope slide over tail. Note: This will be more functional with a broken piece of slide (about one-third the length of the slide) so that the tail can be closer to the edge of the petri dish.
   If the petri dish won't fit on the stage of the microprojector, you can lay the fish on a slide and put another piece of glass over its tail.
4. Allow students to file by the screen and observe the blood flow.
   Return fish to water within five minutes (water should be aeriated with an air stone).

Fish scales

* **Fish scales:** [observational activity]

microprojector  large fish scales

1. Use the polarizing filters on the microprojector. Winter growth rings are dark bands and close together. Summer growth rings are light bands and are further apart.
2. Count winter bands to determine the age of the fish.

Earthworm experiments

* **Earthworm experiments:**

When animals respond to a stimuli we call this a "taxis" (i.e. geotaxis, phototaxis, chemotaxis).

| | | |
|---|---|---|
| earthworms (*Lumbricus terrestris)* | large test tube | glass plate |
| various chemical solutions | black plastic | eyedroppers |
| paper towels | flashlight | sandpaper |
| plastic plates | | |

1. The day before the activity, solicit ideas from students concerning which variables they might test. Examples: water, sugar water, salt water, vinegar water, light, touch (using sandpaper or glass).
2. Logistics: Students work in groups of three. Each group has a plastic plate, a worm and a piece of damp paper towel.
   a.) They take their worm from one station to the next (all rotate at the same time) and follow instructions at each station.
   b.) Use a wet paper towel to clean the worm and keep it moist. Clean the plate before going on to next experiment.
3. Ideas:

   Phototaxis: Use test tube (cover half with black plastic) or shine flashlight on worm in dark area.

   Thigmotaxis: Touch worm at various places. Record results. Which end is most sensitive? Place worm near edge of table. Place worm on sandpaper and glass. Record which way it goes.

   Chemotaxis: (use safe dilute solutions) Make a line of chemical solution with eyedropper. How does worm react when it touches the chemical?

Reproduction

* **Reproduction:** [lesson]

Topics to review:

1. Difference between asexual and sexual reproduction (is the offspring produced by one or two parents).
2. Fission - how cells split apart to make two new cells.
3. Vegetative reproduction (asexual) that happens in some plants.
4. Reproduction in flowers - pollen from male part of flower fertilizes eggs in female part of flower to make seeds.

* **Earthworm reproduction:** [lesson]

1. A hermaphrodite, it has both male and female sex organs but does not fertilize itself.
   a.) Two worms line up head to tail. They secrete slime rings and both release sperm, which travels to a holding area (segment 9-10) for future use.
   b.) At a later date the clitellum once again secretes a slime ring. The worm deposits eggs and sperm in the ring and wiggles out from inside it leaving the fertilized eggs to hatch in the egg casing.

* **Contrasting sperm and egg cells:** [lesson]

Sperm cells are very small. They "swim" with a whip-like tail and greatly outnumber the egg cells. The egg cells are much larger and cannot move on their own. They usually contain yolk which is used as nutrient for the developing embryo.

* **Internal vs. external fertilization:** [lesson]

Internal: Sperm deposited internally (birds, fish, mammals).
External: Sperm deposited on eggs in the water (amphibians and fish).

* **Internal vs. external development:** [lesson]

Internal: Young develop inside the mother's body (i.e. mammals).
External: Young develop outside the mother's body (i.e. birds, fish, insects).

Survival is dependent on (1) the number of offspring produced and (2) the amount of care the parents give their young. In cases of external development there is usually a large number of eggs and little or no further care once the eggs are laid (i.e. fish, amphibians and insects). Young must rely on instinct for survival.

In the case of birds and mammals there are fewer offspring but more care from the parents. Some of their behaviors appear to be learned.

* **Activities:**

1. Assign an animal to each student. They report on that animal's method of reproduction. Classify each into one of three categories:
   a.) Internal fertilization / internal development.
   b.) Internal fertilization / external development
   c.) External fertilization / external development.

Life cycles - metamorphosis / Mealworms

* **Observing the life cycle of a mealworm:** [observational activity]

mealworms (from bait store)
containers
chick starter mash or bran
slices of carrot

The mealworm is not really a worm but an insect and belongs to the phylum Arthropod. Complete metamorphosis has the following states:

Sequence: egg —> larva —> pupa —> adult

1. Eggs hatch.
2. Larva grows and sheds its skin for about 4-6 months (temperature dependent).
3. Pupa stage (1-3 weeks). Here mealworm has very little movement and goes through great physical changes as it becomes an adult.
4. Adult beetle has vestigial wings but cannot fly. They live from 1-3 months. During this time male and female mate. One female may lay up to 500 eggs.

Mealworms require very little moisture (an adaptation). Their waste is in the form of a dry pellet. Beetles need more moisture and may cannibalize the pupa for water (use slices of carrot to appease them).

Food chain

* **Daphnia and hydra:** [observational activity]

sample of daphnia (water flea)
sample of hydra
magnifiers
microprojector
well slide

The hydra is a coelenterate that lives in fresh water. It is a relative of the sea anemone and jellyfish. You will find them attached to the bottom or side of your sample jar. They are large enough to observe with a magnifier and fun to watch.

Students may look at their own specimens with a well slide and a magnifier or you can use the microprojector. You may notice better results by using the top polarizing filters and thereby reduce the light output at the slide (hydra don't like the intense light from a microprojector).

1. Feed your hydra a water flea. The tentacles will sting the daphnia and the hydra will then swallow it whole through its mouth (near the tentacles). You'll then see a lump in the body.
2. Look for young in the brood pouch of the water flea. Use a straight pin to stimulate birth.
3. You may notice a smaller hydra growing from the side of a larger one. This is how this animal reproduces. It's called "budding" and is a form of asexual reproduction.

This activity is excellent for developing the students observational skills.

Another interesting animal to observe is the planaria (flat worm). It's about 1 cm ($\frac{1}{2}$") long and can be easily observed on a well slide with a magnifier.

Brine shrimp experiments

* **Experimenting with brine shrimp:** [experiment]

brine shrimp eggs *(Artemia salina)* — salt water — ice
eyedroppers — 2 test tubes with stoppers — clay
microscope slides — battery, wires — magnet
various chemicals

1. Prepare a $3\frac{1}{2}$% salt solution (similar to sea water) by combining $96\frac{1}{2}$ ml of distilled water with $3\frac{1}{2}$ grams of non-iodized salt (or fake it with $\frac{1}{2}$ c. water and $\frac{1}{2}$ t. salt).
2. Add brine shrimp eggs.
3. Students can observe a sample in an eyedropper after 24-and 48-hour periods (use microprojector for a better view).
4. As in the earthworm experiment, encourage students to help with the experimental design: What will they test? How will they test it?
5. Student groups can make several "brine shrimp pools" with clay and microscope slides and either go from station to station and run particular tests or remain at one location and try several. Don't forget to include a control with each individual experiment. Students can test the effects of cold with ice in a plastic bag, different chemicals with thread, light with a piece of dark paper, electricity, magnetism and gravity (as a demonstration). One sample can be re-used as long as no chemicals are added.
6. Students record results on a lab sheet. Have "before" and "after" drawings with dots representing the location of the brine shrimp.
7. Post-lab and discuss results. There are no wrong answers. Look for the most probable response of the brine shrimp to different stimuli.

Animal footprints

* **Homemade animal cages:** [activity]

hardware cloth, wire — tuna fish cans — cake pans

Show students how to make their own animal cages.

* **Make a bird feeder:** [activity]

$\frac{1}{2}$ gallon milk carton — string
2 sticks — bird feed

* **Make casts of animal footprints:** [demonstration / activity]

cookie tin with soil and print (cat) — plaster of Paris
water — plastic bag

Demonstrate how to make a cast of an animal footprint (in the classroom). Mix 2 parts plaster + 1 part water. Let it set for 30 minutes.

Give interested students a bag of plaster for their use. They find a print in their neighborhood, make a cast of it, bring it to school and identify it. They can write a short story about the animal who made that footprint. Good places to look are near streams or rivers or just about anywhere following a rain.

## HUMANS

Classifying - characteristics

* **Classifying humans:** [lesson]

Kingdom - Animal
Phylum - Chordata
Class - Mammal
Order - Primate
Family - Hominidae
Genus - *Homo*
Species - *Sapien*

Using a torso - investigating body systems

* **Using a torso to investigate body systems:** [demonstration / lesson]

Check with your district office or the secondary school to borrow or check out a torso.

Main parts: head, neck, thoracic cavity, abdominal cavity.

1. Thoracic cavity: lungs with alveoli, collarbone and ribs, heart, trachea, esophagus.
2. Diaphragm separates thoracic cavity from abdominal cavity.

The digestive system

* **The abdominal cavity - how our bodies process food:** [demonstration / lesson]

1. The mouth mechanically breaks down food. Saliva from six glands begins to turn starch into sugar.
2. Cells need amino acids to make new cells and sugar for energy. Amino acids can be derived from protein.
3. Food travels through the esophagus to the stomach. Muscles churn food and enzymes break it down further.
4. The liver produces bile (gall bladder) which helps digest food.
5. The pancreas also adds enzymes to the small intestine. The intestines themselves secrete enzymes which help digest the food.
6. Amino acids, fatty acids and glucose (sugar) are the primary products transmitted through the intestinal wall to the bloodstream.
7. Left over material loses water in the large intestine and becomes a more solid waste (excretory system).
8. Wastes generated by the cells are carried via the blood and are filtered out by the kidneys. The kidneys also regulate the concentration of dissolved minerals (saltiness). The spleen (gray object upper right of kidneys) also helps to filter the blood.
9. Excess water is passed out of the system via two tubes and the bladder.

* **Body parts / cut and paste:** [activity]

Have students use a wall chart or torso as a reference and cut and paste drawings of the organs onto a body picture.

Reproduction

Consult your principal or the district for appropriate guidelines. Place the topic of human reproduction in perspective with reproduction of other life forms.

Reaction timer

* **Reaction timer:** [experiment]

yardstick or piece of moulding — masking tape
distance/time table — ruler

1. Put masking tape on a yardstick. Mark off single-centimeter increments (0-40 cm), with a heavy mark at the zero line.
2. Students work in groups of two: One drops the yardstick, the other tries to quickly catch it between the thumb and index finger.
3. Define "reaction time" (solicit ideas from the class). In this case, it is the time from when the eye sees the yardstick falling until the fingers can stop it.
4. Each student can try this with each hand five times. Is one hand quicker than the other? What is the average for each hand? What is the average of both?
5. Teacher collects the average time from each student and graphs the data (histogram: number of students on vertical axis, reaction time on horizontal axis). Explain the results (which will probably look like a bell-shaped curve).

Teacher information:

The table was derived using an equation similar to $D = 16t^2$ (which we discussed in 4-6 Physical Science, part 1, "Mechanics"). In this case, we are using metric units (not feet), so the equation is $D = 490t^2$ where D = distance an object falls (in cm) and t is the time of fall.

Solving for t, we get $t = \sqrt{\frac{D(cm)}{490}}$

| Distance (cm.) | Reaction Time (sec.) |
|---|---|
| 1 | 0.045 |
| 2 | 0.064 |
| 3 | 0.078 |
| 4 | 0.090 |
| 5 | 0.101 |
| 6 | 0.110 |
| 7 | 0.120 |
| 8 | 0.128 |
| 9 | 0.136 |
| 10 | 0.143 |
| 11 | 0.150 |
| 12 | 0.157 |
| 13 | 0.163 |
| 14 | 0.169 |
| 15 | 0.175 |
| 16 | 0.181 |
| 17 | 0.186 |
| 18 | 0.192 |
| 19 | 0.197 |
| 20 | 0.202 |
| 21 | 0.207 |
| 22 | 0.212 |
| 23 | 0.217 |
| 24 | 0.221 |
| 25 | 0.226 |
| 26 | 0.230 |
| 27 | 0.235 |
| 28 | 0.239 |
| 29 | 0.243 |
| 30 | 0.247 |

The eye

* **Investigating the eye:** [information / lesson]

1. Have students move their eyes up, down, left, right, clockwise and counterclockwise. Explain (with a model, if available) how the six muscles attached to each eye enable us to do this.
2. Cones and rods:
   Cones help us to see colors and to see sharp images. The rods are used at night. They amplify the amount of available light (but only work in black and white). Some animals (i.e. owls and bats) only have rods. Others (i.e. canaries and chickens) only have cones and are night blind. Memory aid: "night fishing" - the rods are out at night.
3. All receptors tie in at a central point in the retina called the "optic nerve." At this point, there are no receptors. This is called the "blind spot."

* **Observing our blind spot:** [activity]

paper with a dot and an "X" separated by 10 cm (4")
meter stick

1. Cover one eye and hold the card out about an arm's length away. Stare at the "X". Move it closer until the dot disappears.
2. Students can measure distance from their chin to the paper (keep rulers away from eyes!). Is this distance the same for all students? Try it at home. Do adults have their blind spot the same distance away?

Squeeze power

* **Arm strength using a bathroom scale:** [activity]

Students can squeeze the scale to measure the strength of their hand muscles or push down on it to measure arm strength.

Pulse detector

* **Pulse detector:** [activity]

clay
clock
balsa wood strip
(a straw from a broom works much better!)

Students make pulse detectors and count the number of "ticks" in a ten-second time interval. Multiply this number by 6 to get the pulse rate per minute.

Try again after heavy exercise. Compare the results.

Teeth and bones

* **X-rays:** [observational activity]

Ask a doctor for some X-rays to show in class. They'll work great on an overhead projector!

* **Teeth:** [observational activity]

Ask a dentist for some samples of teeth. Perhaps you can get an explanation about each tooth to go with it. Show different types, cavities, etc., in class.

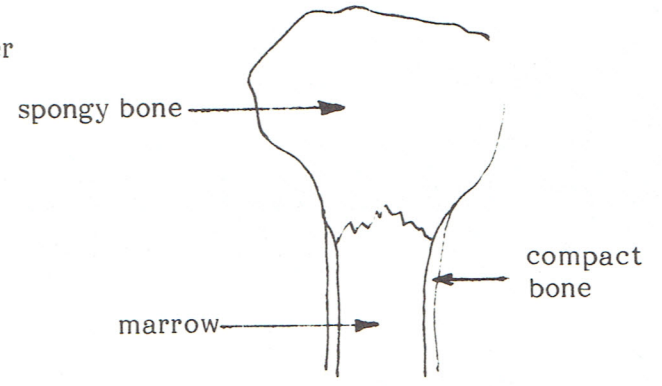
* **Bones:** [observational activity]

large beef leg bone cut lengthwise by butcher
(do not attempt to cut it yourself!)

Show students what is inside a bone.
There are three main parts:

Two types of marrow:

Red - found in flat bones (ribs)
Yellow - found in leg bone (example)



Investigating carbon dioxide production

* **How does exercise affect the amount of $CO_2$ produced?** [experiment]

diluted household ammonia (1 part to 3 parts water)
beaker or clear cup
eyedropper — Bromothymol blue solution (BTB)
straw — graduated cylinder

1. Place exactly 100 ml of BTB solution in a beaker.
2. Using a straw, blow breath through it for one minute (resting state). BTB should turn yellow.
3. Add drops of ammonia and stir until solution turns blue again. Record the number of drops used in the "titration."
4. Try the experiment again after heavy exercise. The second sample may look just as yellow but there will be more $CO_2$ disolved in it. Find out how much more by running another titration (one drop at a time and stir).

**As with all experiments, test this before trying it in class.**

Nutrition - measuring vitamin C

* **Measuring the amount of vitamin C in various fruit juices:** [experiment]

test tube rack — vitamin C tablet — iodine
test tubes — various fruit juices — water
corn starch — eyedropper — straw

1. Prepare indicator solution: add pinch of cornstarch to 100 ml water, stir. Add iodine one drop at a time until it just turns to a purple-blue color.
2. Fill four test tubes with exactly 10 ml of indicator solution.
3. Add 1 drop of a juice (i.e. orange juice) to one test tube, stir with a straw. Add more, one drop at a time, stir each time a drop is added until the liquid is clear. Record the number of drops required (the fewer the drops, the more vitamin C in the juice).
4. Stress the importance of rinsing eyedroppers between tests to avoid contamination.

**ECOSYSTEMS**

Animal communities

* **Animal communities:** [information]

1. An ecosystem is the interaction of groups of living organisms with the physical environment.
2. Important factors: food, water, air, shelter and space.
3. Different communities: Aquatic: creeks, ponds, rivers, oceans.
   Terrestrial: desert, grasslands, chaparral, forest.

Producers, consumers and decomposers

* **Producers, consumers and decomposers:** [information]

Energy flow in an ecosystem:

1. Sun energy goes to plants (producers), and becomes chemical energy (sugar).
2. Animals (consumers) eat plants.
3. Animals eat other animals. Predators are animals that kill and eat other animals (prey). Scavengers (like vultures) are animals that eat dead plant and animal material and parasites feed off a plant or animal "host."
4. Animals and plants die and bacteria and fungi get their energy by decomposing the once-living material. These decomposers return nutrients to the soil.

Food chains and food webs

* **Food chains / web boards:** [activity]

boards
nails
handout sheets
yarn

1. Using a template, teacher makes boards with similar nail patterns.
2. Students punch out holes on handout sheet and place on food chain board.
3. They connect yarn from one nail to another depending on the order of the food chain or web pictured.
4. Examples:
   a.) Sun, water, food, shelter, fish, plants, insects, people, worms.
   Discussion: What happens if we cut off the water supply? Who will it affect?
   b.) Food chain: Sun, spinach, man, mosquito, dragonfly, frog, snake, hawk, bacteria/fungi.
   c.) Food web (like a supermarket of food sources): Sun, grass, shrubs, deer, sheep, rabbits, wolves, mountain lion, man.
   Students will realize the complexity of a food web and what may happen if one member disappears.

Thickness of an egg shell

* **Measuring the thickness of an egg shell:** [observational activity]

egg shells
ruler
magnifiers
glue

1. Present the problem to the students as if they were scientists employed by a company (Egg Shells, Inc.). Their task is to measure the thickness of an egg shell. How would they do it? Allow time for brainstorming.
2. Guide students along different paths of inquiry. You may direct them with the following approach:
   a.) Knowing how tall a stack of 10 pennies is, how might you determine the total amount of pennies you have in a large pile? (count by measuring height)
   b.) If we had a stack of egg shell fragments as tall as the stack of 10 pennies, would there be more or less than 10 egg shell fragments? (The probable answer is "more" and we have just determined that an egg shell is thinner than a penny)
   c.) What if we made a stack of egg shells that was exactly 1 cm high? Example: 20 shells per centimeter. Wouldn't each shell be 1/20th of a centimeter? (This is how we will solve the problem.)
   d.) Compare results from all groups on the board. Are egg shells consistent? Are some thinner than others?
   e.) Lesson: Pesticides (i.e. DDT) can get into the food chain (a grasshopper might eat leaves and a bird might eat the grasshopper). Certain pesticides can cause very thin egg shells in wild birds. Eggs break and no young birds are born. What will happen? Discuss extinction with your students. Cite other examples that may promote extinction among a particular species.

Investigating owl pellets

* **Owl pellets investigation:** [observational activity]

owl pellet
magnifier
plate
probe (optional)

1. Students observe complete pellet. Measure length and width.
2. Carefully break a pellet up into equal pieces (one piece for each student in the group to work on). Note: keep contents of each pellet together.

3. The most valuable parts are the skull and jawbones (2 per jaw).
4. Students should attempt to identify individual bones and determine the type and number of animals in their pellet (use information below).
5. Scientists use the owl as the collector. By evaluating owl pellets they can estimate the population of various animals in a particular area.

Animals found most frequently in owl pellets studied at random from among those provided in this kit are listed below:

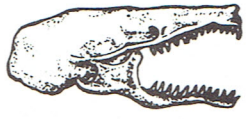
| Common Name | Genus | Frequency Found |
|---|---|---|
| Vole | *Microtus* | 70% |
| Shrew | *Sorex* | 20% |
| Mole | *Scapanus* | 5% |
| Deer Mouse | *Peromyscus* | 2% |
| House Mouse | *Mus* | 2% |
| Rat | *Rattus* | 1% |
| Swallow (small bird) | *Hirundo* | Rare |

Illustrations of the skulls and other identifiable bones of these small animals, birds and others are illustrated below and on the student worksheet.

**Shrew** – *Sorex*

**Vole** – *Microtus*

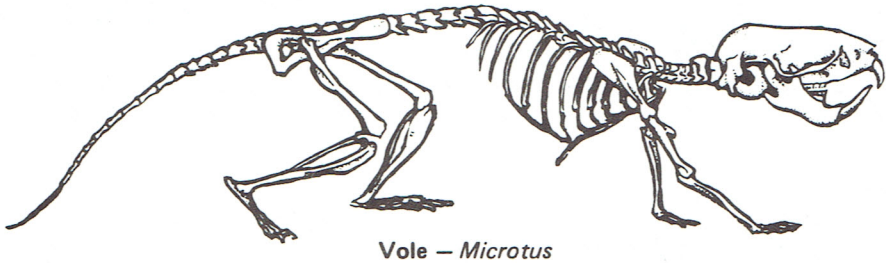
**House Mouse** – *Mus*



**Mole** – *Scapanus*

**Deer Mouse** – *Peromyscus*

**Rat** – *Rattus*



**Vole** – *Microtus*

Drawings courtesy of Lab-Aids, Inc.

Other activities on ecosystems: [not shown]

* **How much water do you use?** [activity]

  Water cycle: Water is in the air for an average of nine days. It has been frozen in the ice cap for up to 10,000 years.

  1. Students estimate how much water they use in one day. Put guesses on the board.
  2. Students monitor their water usage for one day and total amount used (approximate: toilet flush = 3 gal., shower = 12 gal., bath = 15 gal., etc.).
  3. Add all gallons used, divide by the total number of students for the average use per day.
  4. Discuss ways we could reduce water usage. Help your students to become more water conscious.

* **Populations and population sizes:** [information]

  Population sizes often vary according to seasons, available food, number of predators or reproductive patterns and are directly affected by births, deaths, move in and move out rates.

* **Endangered species:** [activity]

  Students report on an extinct or endangered species and speculate on the cause of its extinction/endangerment.

* **School population:** [activity]

  Graph the population of your school over the last 10 years. Discuss causes for increases or decreases (try it by grade level).

* **Classroom density:** [activity]

  1. Measure the room size.
  2. Find the area of the room (length X width).
  3. Density equals the number of students in the room divided by the area.

  Relate this idea of density to other applications (i.e. animals in the wild, people in India vs. those in Alaska, etc.).