Irregular Jeans
(Teacher Notes)

Lab Time: 60-90 minutes

Background:
Make sure students have an understanding of Mendelian genetics, pedigree analysis, and biochemical pathways. Discuss the cause of Alcaptonuria and its symptoms. Alcaptonuria is caused by a defect in the enzyme homogentisic acid oxidase. This enzyme converts homogentisic acid into the next substrate. If defective, this enzyme carries out this conversion slowly and inefficiently, leading to high concentrations of homogentisic acid in body fluids. Archibald Garrod, a turn-of-the-century English physician interested in heredity, first described Alcaptonuria. Most of the clinical features of Alcaptonuria are due to the fact that homogentisic acid turns black when oxidized. Diapers of the Alcaptonuric tend to stain black as the homogentisic acid in the urine oxidizes. A high pH increases oxidation so that washing diapers in alkaline soap makes the stains even darker. Later in life, deposits of oxidized products of homogentisic acid may cause connective tissues to become gray or black. Sometimes dark spots may even form on the cartilage of the ear or on the sclera of the eye. Arthritic conditions and degeneration of the spinal disks may also occur later in life. None of these symptoms are life-threatening, and alcaptonurics appear to have normal life spans. Alcaptonuria is rare worldwide with probably the highest incidence of this disease occurring in Northern Ireland. Here, three to five people per million are Alcaptonurics. It is also more common in parts of the world where inter-family marriages and inbreeding occurs.

Materials: See student handout.
Artificial “urine” is prepared by adding yellow food coloring to water.
Spiked “urine” is prepared by adding starch solution to the artificial “urine.”
Iodine serves as the Alcaptonuria test solution
ACOS Standard 7

Pre-Activity: (12-20 minutes)

Figure 2: Inheritance of the Genetic Condition Alcaptonuria

I. 1 □ 3 □
   2 □ 4 □

II. 1 □ 3 □
    2 □ 4 □

III.

IV.
The accompanying diagrams are illustrations of pedigrees of four different families (Figure 2). Darkened symbols represent individuals who, using the urine test, have been shown to have Alcaptonuria. Make copies of these diagrams for the students as well as a transparency that can be used to review pedigrees. In Example I, Individual 1 must be (Aa) in order for his son, Individual 2, to have the disease (aa). The daughter, Individual 4, must also be (Aa) meaning that she inherited the (A) allele from her father and the (a) allele from her mother. In Example II, only the daughter, Individual 4, has the disease. This means that she must have inherited the (a) allele from both of her parents even though neither of them has the disease. This means they both must be carriers (Aa). In the family of 8 in Example III, it is possible to determine the genotype of every individual except the two paternal grandparents by reasoning back from the two (aa) individuals. Even then, both of the paternal grandparents must be (Aa), or one is (AA) and the other is (Aa). In Example IV, the situation is different. We do not know the genotype of the daughter “?” in the third generation. She is out of the country, which means that a urine sample is not available for her. Working backward from the three (aa) individuals, it is possible to arrive at the genotypes of all the other family members. In the role of genetic counselors, students can assert that the likelihood of the daughter “?” having Alcaptonuria (aa) is 50% and being a carrier (Aa) is 50%.

1. Prepare the artificial “urine” in the following way: Drop several drops of yellow food coloring into water until desired color is reached. Or simulated urine from biological supply companies can be purchased if preferred.
2. Label 12 test tubes per group with the following information: PGF, PGM, MGF, MGM, F, M, PA, PU, MA, MU, B, and S.
3. Pour artificial “urine” into all test tubes.
4. Choose the following family members that you want to test positive for Alcaptonuria: MGM and F. Spike the urine in those test tubes in this way: Dissolve starch in water by heating it until it dissolves clear. Add the starch water to the MSG and F test tubes. Be sure to fill all test tubes to the same level.
5. Prepare several bottles of Alcaptonuria test solution (iodine). These can be shared among the groups.

Activity: (30 minutes)
Circulate among groups as they follow the student-procedure steps. Ask questions to determine their understanding of the pedigree labeling and the urine testing.

Post-Activity: (10-15 minutes)
Discuss any differences in group pedigrees and answers to questions on student handouts.
Figure 1
Family pedigree—Study of Alcaptonuria

I.

II.

III.
ACOS Standard 7

Student Questions and Answers:
1. Could a genetic disease “suddenly” show up in a family? Explain the answer. Yes. A recessive gene could be “carried” for many generations and never be expressed until another carrier marries a recessive carrier in the family.
2. What is another genetic disease that you know? Albinism, Huntington disease, cystic fibrosis, sickle cell anemia, muscular dystrophy, hemophilia.
3. Why are most recessive trait diseases not common in human populations? Because they are recessive, it takes two recessive traits (alleles) getting together for the disease to show up. Both parents must be carriers, and then there is only a 25% chance of the disease showing up in an offspring.
4. Why would marriages between family members increase the likelihood of genetic diseases showing up? If a genetic disease runs in a family, then the chances of two carriers marrying each other are much greater when members of that family intermarry. This is the reason hemophilia was so prevalent in royal European families.

Extensions:
Students in groups may research a particular genetic disease and report back to the class. Reports should include history, symptoms, defects, dominant or recessive inheritance, and frequency among births. In particular, the continued occurrence of sickle cell anemia in Africa and Asia is of interest since the heterozygous condition (carrier) confers partial immunity to malaria.

Resources:
Books:
Irregular Jeans?
(Student Handout)

**Purpose:** To recognize how genetic diseases are passed from one generation to the next

**Background:**
Genes are passed from one generation to the next. The inheritance of the disease being studied in this activity can be explained by using the principles that were first discovered by Gregor Mendel in his garden pea experiments. Laws of probability and pedigree analysis will be used to study the inheritance of a recessive gene that leads to a disease called Alkaptonuria. This activity will trace the inheritance of Alkaptonuria through two to three generations of a family. By using information provided, you will be able to determine the genotypes of past and present family members as well as be able to predict the possible inheritance of this disease in the next generation. Alkaptonuria is classified only as a mild genetic disease because it does not cause fetal damage, physical defects, or mental retardation. Normally, amino acids, such as phenylalanine and tyrosine, are broken down into the waste products, water and carbon dioxide, that can be seen in the following pathway:

Tyrosine - P-hydroxyphenylpyruvic Acid - Homogentisic Acid - Maleylacetoacetic Acid - Additional Steps - Water and Carbon Dioxide

The enzyme homogentisic acid oxidase helps break down homogentisic acid into the next substrate maleylacetoacetic acid. In a normally functioning pathway, homogentisic acid is almost undetectable in body fluids. But in a person with Alkaptonuria, this enzyme is defective. The defective enzyme carries out the conversion slowly and inefficiently leading to high concentrations of homogentisic acid in body fluids such as urine and blood serum. Currently, the gene location for this mutated gene is unknown; however, it is believed to be located on one of the 22 autosomes (non-sex chromosomes) since it appears both in males and females with about equal frequency. The normal allele is dominant (A), and the Alkaptonuria allele is recessive (a). Only individuals who inherit the recessive gene from both parents and are homozygous recessive (aa) have Alkaptonuria. Individuals who are homozygous dominant (AA) or heterozygous dominant (Aa) are both normal and do not have Alkaptonuria.

**Materials: (per group)**
- Test tube rack
- Safety goggles
- 12 test tubes
- Drovers
- Artificial “urine”
- Spiked “urine”
- Alkaptonuria test solution

**Safety Considerations:**
Safety goggles must be worn at all times during this lab. The Alkaptonuria test solution is poisonous and will stain clothing, skin, and paper products. Be careful not to spill it.
ACOS Standard 7

Procedure:
1. Obtain the test tube rack containing the labeled urine samples of family members.
2. Label the pedigree symbols (Figure 1) with the following information that corresponds to the labels on the urine samples (Females are circles, and males are rectangles).
   - PGF - paternal grandfather
   - PGM - paternal grandmother
   - F - father
   - PA - paternal aunt
   - PU - paternal uncle
   - B - brother
   - MGF - maternal grandfather
   - MGM - maternal grandmother
   - M - mother
   - MA - maternal aunt
   - MU - maternal uncle
   - S - sister
3. Test the urine of each person by placing two drops of the Alcaptonuria test solution into each sample.
4. Carefully agitate the test tubes and look for positive tests (formation of dark color).
5. Determine which family members have the disease and mark them on the pedigree (Figure 1) by coloring in their symbol.
6. Using the genetic information about this disease, write in the genotype on the two lines below each person's symbol on the pedigree (Figure 1).
7. Describe the phenotype for each person in the space provided below the pedigree (normal or Alcaptonuria).
8. Return the Alcaptonuria test solution to the teacher.
9. Dispose of the urine according to the teacher's instructions.
10. Clean all glassware.

(adapted from Alabama Science in Motion lab)
ACOS Standard 7

Name: ______________________
Name: ______________________
Name: ______________________

Pedigree:

Figure 1
Family Pedigree-Study of Alcaptonuria
ACOS Standard 7

Describe the phenotype of each individual.

PGF  
PGM  
MGF  
MGM  
F  
M  
PA  
PU  
MA  
MU  
B  
S  

Questions:
2. What is another genetic disease that you know?
3. Why are most recessive trait diseases not common in human populations?
4. Why would marriages between family members increase the likelihood of genetic diseases showing up?
It's A Toss Up
(Teacher Notes)

Lab Time: 1-day activity/1- day post-activity/extension

Background:
Heredity is the passing of traits from parent to offspring. The units of heredity are genes found
on chromosomes. The combination of genes for each trait occurs by chance. When one gene in
a pair is stronger than the other, it is the dominant gene and is designated with a capital letter.
The masked or hidden gene is recessive and is written as lowercase. If both genes in a gene pair
are the same, the trait is said to be pure or homozygous. If the genes are not similar, the trait is
said to be hybrid or heterozygous. Sometimes genes are neither dominant nor recessive and
result in a blending of traits.

The genetic makeup of the individual is known as its genotype and is designated with letters that
represent the gene pair. The observable physical trait of the individual that results from this
genotype is known as its phenotype.

In humans the sex of the individual is determined by the combination of two sex chromosomes,
one from the male parent and one from the female parent. Individuals can inherit only an X
chromosome from the female parent. If that X is combined with an X from the male parent, the
offspring will be female (XX). If the X is combined with a Y from the male parent, the offspring
will be male (XY). Thus the male parent determines the sex of the offspring.

Materials:
2 coins or disks marked “H” on one side and “T” on the other
Facial Features Charts (one for every 3 students)

Pre-Activity: (15 minutes)
Since this activity reinforces basic genetic principles, it is important to have firmly established
student understanding of monohybrid (single trait) crosses. A pre-lab review/quiz of inheritance
laws might include assessing student mastery of these prerequisite skills and concepts. The use
of the group discussion and responses in the background of the student sheet is such an approach.

Activity: (30-40 minutes)
1. Give each group a Facial Features Chart and two coins (or small disks with H on one side
   and T on the other) to follow the procedures.
2. As the tossing begins, reinforce the idea of each parent contributing one half (an allele) for
   each trait (gene).
3. Instruct groups to answer questions following third offspring. Circulate among the groups to
   check their progress. Ask further guiding questions when necessary.
Post-Activity:
Some human genetic disorders are caused by a change in either a single recessive gene or a single dominant gene. Have student groups accept responsibility for researching some of the most common of these to report to the class including such information as cause, symptoms, possible benefit or harm, segment of the population affected, possible treatment, prognosis.

Sample Data and Calculations:
Sex of the offspring = XX (Female)
Chart (GT= genotype)

<table>
<thead>
<tr>
<th>TRAIT</th>
<th>GT</th>
<th>PHENOTYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face shape</td>
<td>Rr</td>
<td>round</td>
</tr>
<tr>
<td>Chin cleft</td>
<td>cc</td>
<td>absent</td>
</tr>
<tr>
<td>Widow’s peak</td>
<td>ww</td>
<td>absent</td>
</tr>
<tr>
<td>Hair</td>
<td>Hh</td>
<td>wavy</td>
</tr>
<tr>
<td>Eye size</td>
<td>Ll</td>
<td>medium</td>
</tr>
<tr>
<td>Eye shape</td>
<td>aa</td>
<td>round</td>
</tr>
<tr>
<td>Eye position</td>
<td>SS</td>
<td>straight</td>
</tr>
<tr>
<td>Eye space</td>
<td>Ee</td>
<td>normal distance</td>
</tr>
<tr>
<td>Eyebrow position</td>
<td>Nn</td>
<td>not connected</td>
</tr>
<tr>
<td>Eyebrow shape</td>
<td>Bb</td>
<td>fine</td>
</tr>
<tr>
<td>Eyelash length</td>
<td>LL</td>
<td>long</td>
</tr>
<tr>
<td>Mouth size</td>
<td>Ll</td>
<td>medium</td>
</tr>
<tr>
<td>Lip shape</td>
<td>Tt</td>
<td>normal</td>
</tr>
<tr>
<td>Dimples</td>
<td>Dd</td>
<td>absent</td>
</tr>
<tr>
<td>Nose size</td>
<td>Ll</td>
<td>small</td>
</tr>
<tr>
<td>Ear size</td>
<td>Ll</td>
<td>normal</td>
</tr>
<tr>
<td>Freckles</td>
<td>FF</td>
<td>present</td>
</tr>
</tbody>
</table>

SKETCH OF OFFSPRING

Student Questions and Answers:
1. Why was it appropriate for the male parent to flip for the sex of the offspring? Males contribute the sex-determining X or Y chromosome. If the male contributes X, the child will be female. If the male contributes Y, the child will be male.
2. What percent chance was there for producing a male offspring? A female? Explain. There is a 50% chance of either since there is also a 50% chance of heads or tails. There are only two possible outcomes to flipping the coin and only two possible types of genes that determine gender.
3. What do the coins represent? The coins with heads and tails represent the possible genes (alleles) of that trait that each parent could contribute.
4. What determined the observable physical characteristics of the offspring? The combinations of tosses represent the chance results of genes (genotype) contributed by each parent.
5. Were all three offspring in your group alike? Would you expect other groups to have offspring very similar to yours? Explain. Not likely. Not likely. Chance plays such an important role, and there are many combinations of genes.
6. What are the possible genotypes for the parents of a child who has wavy hair? HH x Hh, or Hh x Hh, or Hh x hh
7. Which traits in this activity do not show simple dominance but a blending of traits? *Mouth size, nose size, ear size, lip shape, hair type, eye spacing*

8. How would it be possible for the offspring to show a trait that physically neither of the parents shows? *If both parents are heterozygous genotype for the trait, they can each pass on the hidden recessive. The recessive phenotype is only seen if it is homozygous.*

**Extensions:**
This would be a good opportunity to practice genetic probability problems. Example: If a woman who was homozygous for curly hair (HH) married a man who was heterozygous, wavy-haired (Hh), what would be the possible genotype and phenotype ratios for their children?

**Resources:**

**Books:**

**Internet:**
University of Kansas Medical Center - genetics directory
http://www2.kumc.edu/instruction/sah/med_tech/mt705/mendelian/

**Software:**
*Investigating Heredity.* Cyber Ed Inc. Order # 0991128HY.
*Mendel’s Principles of Heredity.* Cyber Ed Inc. Order # 0991102HY.

**Videos:**
*Hand-Me-Down Genes – An Introductions to Genetics.* Films for the Humanities and Sciences. Order # BTW 8449.
**It's A Toss Up**  
(Student Handout)

**Purpose:** To explore how traits are passed from parent to offspring

**Background:**
Heredity is the passing of traits or characteristics from parent to offspring. The units of heredity are the genes that are found on chromosomes in the cells. In this activity, you will observe the results of how different gene combinations produce certain traits. Before starting, discuss these ideas with the group and write the answers in your own words:

1. What do the terms *dominant* and *recessive* mean?
2. Explain the difference between the *genotype* and the *phenotype* of an individual.
3. How are dominant and recessive genes written or abbreviated in a *genotype*?
4. How can you tell by looking at the genotype of the individual if he/she is *homozygous* or *heterozygous* for that trait?

**Materials/Equipment:**
2 coins
Facial Features Chart
Pencil

**Safety Considerations:** Always follow lab safety procedures.

**Procedure:**
1. Work in teams of three. Assign one group member to toss for the female parent, one for the male, and one to be the offspring. The offspring will record the traits that result from the tosses and sketch the facial features that he or she has inherited from the parents on the observation sheet.
2. Have the team member who is representing the male parent flip a coin to determine the sex of the offspring. If the coin lands heads, the offspring is female. If it land tails, the offspring is male. Record the sex of offspring 1 in the sketch box provided.
3. From now on, heads will represent a dominant gene, and tails will represent a recessive gene. Both coins should be flipped at the same time but only once for each trait. Record the genotype and phenotype that result from the coin toss for the first trait.
4. Continue to flip both coins for each facial trait. Use the completed list of phenotypes to sketch the resulting offspring.
5. Next, each team member should be assigned a different role and repeat Steps 1-4 so that a different member will sketch the next offspring. Finally, switch roles a final time using Steps 1-4 to determine traits for the third offspring.
## Facial Feature Chart

<table>
<thead>
<tr>
<th>Traits</th>
<th>Homozygous Dominant (both heads)</th>
<th>Heterozygous Hybrid (one head, one tail)</th>
<th>Homozygous Recessive (both tails)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FACE SHAPE</td>
<td><img src="round.png" alt="Round" /> (RR)</td>
<td><img src="round.png" alt="Round" /> (Rr)</td>
<td><img src="square.png" alt="Square" /> (rr)</td>
</tr>
<tr>
<td>CHIN CLEFT</td>
<td><img src="absent.png" alt="Absent" /> (CC)</td>
<td><img src="absent.png" alt="Absent" /> (Cc)</td>
<td><img src="present.png" alt="Present" /> (cc)</td>
</tr>
<tr>
<td>WIDOW'S PEAK</td>
<td><img src="present.png" alt="Present" /> (WW)</td>
<td><img src="present.png" alt="Present" /> (Ww)</td>
<td><img src="absent.png" alt="Absent" /> (ww)</td>
</tr>
<tr>
<td>HAIR TYPE</td>
<td><img src="curly.png" alt="Curly" /> (HH)</td>
<td><img src="wavy.png" alt="Wavy" /> (Hh)</td>
<td><img src="straight.png" alt="Straight" /> (hh)</td>
</tr>
<tr>
<td>EYE SIZE</td>
<td><img src="large.png" alt="Large" /> (LL)</td>
<td><img src="medium.png" alt="Medium" /> (Ll)</td>
<td><img src="small.png" alt="Small" /> (ll)</td>
</tr>
<tr>
<td>EYE SHAPE</td>
<td><img src="almond.png" alt="Almond" /> (AA)</td>
<td><img src="almond.png" alt="Almond" /> (Aa)</td>
<td><img src="round.png" alt="Round" /> (aa)</td>
</tr>
<tr>
<td>EYE POSITION</td>
<td><img src="straight.png" alt="Straight" /> (SS)</td>
<td><img src="straight.png" alt="Straight" /> (Ss)</td>
<td><img src="slant.png" alt="Slant Upward" /> (ss)</td>
</tr>
<tr>
<td>EYE SPACE</td>
<td><img src="close.png" alt="Close Together" /> (EE)</td>
<td><img src="normal.png" alt="Normal Distance" /> (Ee)</td>
<td><img src="far.png" alt="Far Apart" /> (ee)</td>
</tr>
<tr>
<td>Traits</td>
<td>Homozygous Dominant (both heads)</td>
<td>Heterozygous Hybrid (one head, one tail)</td>
<td>Homozygous Recessive (both tails)</td>
</tr>
<tr>
<td>----------------</td>
<td>----------------------------------</td>
<td>-----------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>EYEBROW POSITION</td>
<td>[Illustration of connected eyebrows] (NN)</td>
<td>[Illustration of not connected eyebrows] (Nn)</td>
<td>[Illustration of connected eyebrows] (nn)</td>
</tr>
<tr>
<td>EYEBROW SHAPE</td>
<td>bushy (BB)</td>
<td>bushy (Bb)</td>
<td>fine (bb)</td>
</tr>
<tr>
<td>EYELASH LENGTH</td>
<td>long (LL)</td>
<td>long (Li)</td>
<td>short (ll)</td>
</tr>
<tr>
<td>MOUTH SIZE</td>
<td>large (LL)</td>
<td>medium (Li)</td>
<td>small (ll)</td>
</tr>
<tr>
<td>LIP SHAPE</td>
<td>thick (TT)</td>
<td>normal (Tt)</td>
<td>thin (tt)</td>
</tr>
<tr>
<td>Dimples</td>
<td>present (DD)</td>
<td>present (Dd)</td>
<td>absent (dd)</td>
</tr>
<tr>
<td>NOSE SIZE</td>
<td>large (LL)</td>
<td>medium (Li)</td>
<td>small (ll)</td>
</tr>
<tr>
<td>EAR SIZE</td>
<td>large (LL)</td>
<td>normal (Li)</td>
<td>small (ll)</td>
</tr>
<tr>
<td>FRECKLES</td>
<td>present (FF)</td>
<td>present (Ff)</td>
<td>absent (ff)</td>
</tr>
</tbody>
</table>
Dork DNA
(Teacher Notes)

Lab Time: 50-60 minutes

Background:
Genes on chromosomes are sections of DNA that determine the structure of polypeptides (building blocks of proteins) that cells make. The code in the sequence of nucleotides of DNA determines the sequence of amino acids in those polypeptides. However, three types of RNA must carry out those DNA instructions since DNA does not leave the nucleus.

Materials: See student handout.

Pre-Activity: (15 minutes)
Prepare flash cards (construction paper or index cards) in advance for modeling protein synthesis:
- 3 Red (amino acids), Glycine, Glutamic acid, Alanine
- 6 Blue (DNA) - GGC, CTT, CGT/CCG, GAA, GCA (complementary)
- 3 Yellow (mRNA) - CCG, GAA, GCA
- 3 Orange (tRNA) - GGC, CUU, CGU
- 1 Green (enzyme)

Add more cards to each category to provide distractors.
This activity should follow and reinforce student discussion of protein synthesis and the role of transcription and translation. To model these processes, a pre-lab activity could include using the prepared flash cards to allow students to role play as a DNA triplet, an mRNA codon, a tRNA anticodon, or matching amino acid.

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amino Acid</td>
</tr>
<tr>
<td>Alanine</td>
</tr>
<tr>
<td>Glutamine</td>
</tr>
<tr>
<td>Glutamic Acid</td>
</tr>
<tr>
<td>Leucine</td>
</tr>
<tr>
<td>Lysine</td>
</tr>
<tr>
<td>PhenylAlanine</td>
</tr>
<tr>
<td>Glycine</td>
</tr>
<tr>
<td>Serine</td>
</tr>
<tr>
<td>Tyrosine</td>
</tr>
<tr>
<td>Valine</td>
</tr>
</tbody>
</table>

1. Display Table 1 as a transparency or poster or on the board. Identify the amino acids that make up a protein, such as Proline, Glutamic acid, and Alanine, and the area of the room that will represent the “nucleus.” Call on the students with blue DNA triplets to form a double-stranded DNA molecule to represent the proper code for those amino acids. Hands placed on the shoulders across can represent bonds between complementary strands.
2. The student with the green enzyme card “unzips” the DNA strands to allow the students with yellow mRNA codons to step in and pair up with the complementary DNA strand.
3. Those mRNA codons join hands and move out of the nucleus as the DNA strands rejoin.
4. Designate the area that represents the ribosome where mRNA codons line up.
5. Students with orange tRNA anticodon flash cards should then bring matching students with red amino acid flash cards to the ribosome area.
6. As proper pairing of mRNA codon and tRNA anticodon occurs (hands on shoulders), peptide bonds (joined hands) should form between amino acids.
7. When this simple protein has formed, the mRNA, tRNA, and polypeptide chain leave the ribosome. If further practice is necessary, try these amino acid sequences (short protein): lysine, glutamine, valine : leucine, , tyrosine. Be sure to prepare additional flash cards for the synthesis of each particular protein.

**Activity:** (45 minutes)
1. Instruct student groups to follow the procedures of “Dork DNA” to practice the relationships among DNA, genes, and chromosomes.
2. As groups complete Data Tables, check for accuracy and reinforce the idea that the Part B Dork can only inherit one form of each trait (i.e., cannot have both blue skin and green skin).
3. Question groups concerning their understanding of the sequence of events in protein synthesis.

**Post-Activity:** (15 minutes)
Use discussion format to allow each group to respond to the questions posed in the student observation section.

**Sample Data:**
**Part A**
**Data Table 1:**

<table>
<thead>
<tr>
<th>Gene A</th>
<th>Gene B</th>
<th>Gene C</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNA - ACC GGT TAT</td>
<td>DNA - AGC CGA</td>
<td>DNA - TTT AAC</td>
</tr>
<tr>
<td>MRNA - UGG CCA AUA</td>
<td>MRNA - UCG GCU</td>
<td>MRNA - AAA UUG</td>
</tr>
<tr>
<td>TRNA - ACC GGU UAU</td>
<td>TRNA - AGC CGA</td>
<td>TRNA - UUU AAC</td>
</tr>
<tr>
<td>Amino Acid</td>
<td>Amino Acid</td>
<td>Amino Acid</td>
</tr>
<tr>
<td>Sequence - 20-12-13</td>
<td>Sequence - 16-2</td>
<td>Sequence - 9-4</td>
</tr>
<tr>
<td>Trait - hairy</td>
<td>Trait - four-legged</td>
<td>Trait - spots</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gene D</th>
<th>Gene E</th>
<th>Gene F</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNA - GGA CGC CGA</td>
<td>DNA - GGG AGG AAA CCC</td>
<td>DNA - ATC ATC CTA</td>
</tr>
<tr>
<td>MRNA - CCU GGC GCU</td>
<td>MRNA - CCC UCC UUU GGG</td>
<td>MRNA - UAG UAG GAU</td>
</tr>
<tr>
<td>TRNA - GGA CGC CGA</td>
<td>TRNA - GGG AGG AAA CCC</td>
<td>TRNA - AUC AUC CUA</td>
</tr>
<tr>
<td>Amino Acid</td>
<td>Amino Acid</td>
<td>Amino Acid</td>
</tr>
<tr>
<td>Sequence - 11-3-2</td>
<td>Sequence - 5-7-8-1</td>
<td>Sequence - 6-6-10</td>
</tr>
<tr>
<td>Trait - blue skin</td>
<td>Trait - short nose</td>
<td>Trait - male</td>
</tr>
</tbody>
</table>
Part B (will vary with student-created lists)

**Student Questions and Answers:**

1. Explain the roles of transcription and translation. *Transcription is the process where information in one strand of DNA specifies a complementary sequence of bases in mRNA.* *Translation is the process by which a strand of mRNA directs the sequence of amino acids during protein synthesis.*

2. What would happen to the protein for Dork skin color if the last DNA triplet was CGC instead of CGA? *The skin color would change to green due to this point mutation.*

3. Is it likely that a change in a single nucleotide in DNA could cause the protein that results in plump Dorks to be mutated into the one for skinny Dorks? Why? *No, the amino acid sequences for those traits are not closely related and unlikely to be affected by such a point mutation.*

**Additional Questions:**

Suppose you knew the specific proteins in a cell. How would you determine the particular DNA code that formed them?

**Extensions:**

This lab lends itself well to extensions such as genetic diseases or genetic engineering.

**References:**

Books:
Dork DNA
(Student Handout)

**Purpose:** To show how traits on a chromosome determine the characteristics of an organism

**Background:**
Genes are the units on chromosomes that determine inherited traits or characteristics. Actually, genes are segments or lengths of DNA molecules that carry the information in code form for building a protein. Together, DNA and its assistant RNA are responsible for making the proteins that build cell structures, cause cell movement, and act as enzymes in the chemical reactions that support the cell’s life. In this activity, you will simulate the assembly of protein molecules (made up of amino acids) to determine the traits inherited by a fictitious organism called a Dork. Dork cells have only one chromosome made up of six genes. Each gene is responsible for a particular trait (protein).

**Materials:**
- Blue pencils
- Green pencils
- Construction paper
- Index cards

**Safety Considerations:** Always follow lab safety procedures.

**Procedure: Part A**
1. The first step in determining the trait for Gene A is to notice the sequence of DNA nucleotides given in Data Table 1. On the line provided, list the sequence of nucleotides of mRNA that would be complementary to that DNA. A always corresponds to T (U in RNA), and G always corresponds to C. This process called transcription would take place in the nucleus.
2. The mRNA carries this information as triplet codons to the ribosomes in the cell’s cytoplasm. However, another type of RNA called transfer (tRNA) is needed to bring mRNA and amino acids together to build that specific protein. On the line provided for Gene A, write the sequence of tRNA anticodons that are complementary to the mRNA.
3. To determine the sequence of amino acids, match each tRNA triplet with the particular amino acid in Chart 1. Separate each amino acid number with a hyphen as you record it on the next line of Data Table 1.
4. Using Chart 2, match the amino acid sequence to the trait this protein controls. The process by which the information from DNA has been transferred into the language of proteins is known as translation.
5. Repeat Steps 1 through 4 to find the traits for Genes B through F.
6. Using all the inherited traits, sketch your Dork.
### Chart 1

<table>
<thead>
<tr>
<th>TRNA triplet</th>
<th>Amino Acid Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACC</td>
<td>20</td>
</tr>
<tr>
<td>AGC</td>
<td>16</td>
</tr>
<tr>
<td>CGA</td>
<td>2</td>
</tr>
<tr>
<td>AAC</td>
<td>4</td>
</tr>
<tr>
<td>CGC</td>
<td>3</td>
</tr>
<tr>
<td>GGG</td>
<td>5</td>
</tr>
<tr>
<td>AGG</td>
<td>7</td>
</tr>
<tr>
<td>AAA</td>
<td>8</td>
</tr>
<tr>
<td>UUU</td>
<td>9</td>
</tr>
<tr>
<td>GGU</td>
<td>12</td>
</tr>
<tr>
<td>UAU</td>
<td>13</td>
</tr>
<tr>
<td>CCC</td>
<td>1</td>
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<td>CUA</td>
<td>10</td>
</tr>
<tr>
<td>GGA</td>
<td>11</td>
</tr>
<tr>
<td>GUU</td>
<td>21</td>
</tr>
<tr>
<td>GCU</td>
<td>14</td>
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<tr>
<td>AUG</td>
<td>18</td>
</tr>
<tr>
<td>UGU</td>
<td>15</td>
</tr>
<tr>
<td>CAA</td>
<td>17</td>
</tr>
<tr>
<td>UGG</td>
<td>19</td>
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</table>

### Chart 2

<table>
<thead>
<tr>
<th>Amino Acid Sequence</th>
<th>Trait</th>
</tr>
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<tbody>
<tr>
<td>20-11-13</td>
<td>Hairless</td>
</tr>
<tr>
<td>20-12-13</td>
<td>Hairy</td>
</tr>
<tr>
<td>20-21-21</td>
<td>Plump</td>
</tr>
<tr>
<td>13-14-15</td>
<td>Skinny</td>
</tr>
<tr>
<td>16-2</td>
<td>Four-legged</td>
</tr>
<tr>
<td>16-5</td>
<td>Three-legged</td>
</tr>
<tr>
<td>12-7-8-1</td>
<td>Long nose</td>
</tr>
<tr>
<td>5-7-8-1</td>
<td>Short nose</td>
</tr>
<tr>
<td>9-8</td>
<td>No spots</td>
</tr>
<tr>
<td>9-4</td>
<td>Spots</td>
</tr>
<tr>
<td>11-3-2</td>
<td>Blue skin</td>
</tr>
<tr>
<td>11-3-3</td>
<td>Green skin</td>
</tr>
<tr>
<td>6-6-10</td>
<td>Male</td>
</tr>
<tr>
<td>6-6-14</td>
<td>Female</td>
</tr>
</tbody>
</table>

### Data Table 1:

<table>
<thead>
<tr>
<th>Gene A</th>
<th>Gene B</th>
<th>Gene C</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNA - ACC GGT TAT</td>
<td>DNA - AGC CGA</td>
<td>DNA - TTT AAC</td>
</tr>
<tr>
<td>MRNA -</td>
<td>MRNA -</td>
<td>MRNA -</td>
</tr>
<tr>
<td>TRNA -</td>
<td>TRNA -</td>
<td>TRNA -</td>
</tr>
<tr>
<td>Amino Acid</td>
<td>Amino Acid</td>
<td>Amino Acid</td>
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<tr>
<td>Sequence -</td>
<td>Sequence -</td>
<td>Sequence -</td>
</tr>
<tr>
<td>Trait -</td>
<td>Trait -</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Gene D</th>
<th>Gene E</th>
<th>Gene F</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNA - GGA CGC CGA</td>
<td>DNA - GGG AGG AAA CCC</td>
<td>DNA - ATC ATC CTA</td>
</tr>
<tr>
<td>MRNA -</td>
<td>MRNA -</td>
<td>MRNA -</td>
</tr>
<tr>
<td>TRNA -</td>
<td>TRNA -</td>
<td>TRNA -</td>
</tr>
<tr>
<td>Amino Acid</td>
<td>Amino Acid</td>
<td>Amino Acid</td>
</tr>
<tr>
<td>Sequence -</td>
<td>Sequence -</td>
<td>Sequence -</td>
</tr>
<tr>
<td>Trait -</td>
<td>Trait -</td>
<td>Trait -</td>
</tr>
</tbody>
</table>

Sketch your Dork on your own paper.


**Procedure: Part B**

1. Now your group will challenge another group to determine original DNA code from a Dork's traits that you have selected. On an index card, simply list the six traits (Genes A-F) you have chosen for this new Dork. Exchange that list with someone in another group.

2. As you receive a new list of traits, fill in Data Table 2 by finding the amino acid sequence, the tRNA triplets, mRNA codons, and finally the original DNA for each trait.

3. Sketch the new Dork you inherited.

<table>
<thead>
<tr>
<th>Gene A</th>
<th>Gene B</th>
<th>Gene C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trait -</td>
<td>Trait -</td>
<td>Trait -</td>
</tr>
<tr>
<td>Amino Acid</td>
<td>Amino Acid</td>
<td>Amino Acid</td>
</tr>
<tr>
<td>Sequence -</td>
<td>Sequence -</td>
<td>Sequence -</td>
</tr>
<tr>
<td>TRNA -</td>
<td>TRNA -</td>
<td>TRNA -</td>
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<td>MRNA -</td>
<td>MRNA -</td>
<td>MRNA -</td>
</tr>
<tr>
<td>DNA -</td>
<td>DNA -</td>
<td>DNA -</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Gene D</th>
<th>Gene E</th>
<th>Gene F</th>
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</thead>
<tbody>
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<td>Amino Acid</td>
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<tr>
<td>Sequence -</td>
<td>Sequence -</td>
<td>Sequence -</td>
</tr>
<tr>
<td>TRNA -</td>
<td>TRNA -</td>
<td>TRNA -</td>
</tr>
<tr>
<td>MRNA -</td>
<td>MRNA -</td>
<td>MRNA -</td>
</tr>
<tr>
<td>DNA -</td>
<td>DNA -</td>
<td>DNA -</td>
</tr>
</tbody>
</table>

Sketch your Dork here:

**Questions:**

1. Explain the roles of transcription and translation.

2. What would happen to the protein for Dork skin color if the last DNA triplet was CGC instead of CGA?

3. Is it likely that a change in a single nucleotide in DNA could cause the protein that results in plump Dorks to be mutated into the one for skinny Dorks? Why?
Create a Flower
(Teacher Notes)

Lab Time: 105 minutes

Background: See student handout.

Materials/Equipment: See student handout.
Real lilies work best and can be obtained from a local florist. It may be necessary to substitute a real one with a silk flower.
Floral wire comes in two-foot cut lengths or in rolls. Walmart has both kinds, and it is inexpensive ($2.00 or so for enough to do several classes).
If only the large-sized sheets of white construction paper are available, cut them in half.

Pre-Activity: (15 minutes)
Have the students follow the instructions on the student handout to become familiar with the names and functions of the flower’s reproductive structures.

Activity: (45 minutes)
1. Give each group two flowers. The teacher or a group leader will take one flower apart and give each student in the group one part to draw and color. Since the sepals and pistil are easier, give some students more than one of these if needed. The group will be responsible for drawing and coloring all of the parts of the lily. Keep the other lily in one piece so that students can see what it looks like all together.
2. As the students begin assembling their flowers, walk around and offer suggestions if needed. Usually they will observe each other and correct assembly problems.
3. Make sure that each group member gets a chance to name the parts and explain their functions.
4. Display them around the room. Since the wire will hold the flower’s form, they can be put on the wall, ceiling, or anywhere.

Post-Activity: (45 minutes)
Have the students write a short story about their journey through a flower. They can pretend they have shrunk and are crawling around inside, or they can be an insect closely examining each structure as they encounter it. They can include the weather condition, the mood they are in, the colors and textures they see, the nectar they smell. Where would this flower be best suited to live? (dry, wet, cold, warm, hot) Why would it need such an area? After students finish writing, they can read the short stories aloud.
Student Questions and Answers for Diagram:

1. Flower parts and their functions.

- Sepals — protect the petals before the flower opens
- Petals — attract insects and birds
- Stamen — male reproductive structure
  - Anther — contains the pollen
  - Filament — hold up the anther
- Pistil — female reproductive structure
  - Stigma — sticky part that pollen sticks to
  - Style — long tube the pollen travels down
  - Ovary — contains the ovules that become seeds

2. Label the parts of the flower below.

![Diagram of flower parts]

Resources:

Books:
Create a Flower
(Student Handout)

Purpose: To identify the names and functions of the parts of a flower

Background:
Angiosperms or flowering plants are the most modern type plants. They reproduce by producing flowers and seeds. (The seeds are enclosed in a structure.) Each part of the flower has an essential function. The reproductive organ in an angiosperm is the flower. Most flowers are complete and contain both the male and female reproductive parts. The flower shown below is a complete flower. Each flower part has a specific name and function.

1. Using the textbook or another source, write the function of each of the following flower parts.

Sepals
Petals
Stamen
Anther
Filament
Pistil
Stigma
Style
Ovary

2. Label the parts of the flower below.

![Diagram of a flower]

Materials/Equipment:
2 lilies per group
1 piece of foam board per group (12" X 12")
Clear tape
Crayons for each student
Floral wire
White construction paper

Safety Considerations: Always follow lab safety procedures.
ACOS Standard 1 & 10

Procedure:
1. Divide into groups. Each group should have about six members.
2. The teacher will give each group a flower. Carefully take the flower apart so that each part can be seen. The group leader will give each member a flower part to draw and color. A few students may need to draw two parts. Color both sides of the structure. Make them as large as possible on the paper. Each petal should be about the same size as the others in the group. Notice the different shades, colors, and spots contained on each structure. Try not to leave any white spaces showing.
3. After finishing the coloring of the flower part, tape a piece of floral wire to the back of it with clear tape. Leave about three inches of wire sticking out of the bottom end of the structure.
4. Next, take a piece of cardboard or foam board, punch a small hole on the middle, and begin assembling the 3-D flower. Begin with the petals, then the stamen, and finally the pistil. Tape the wire under the cardboard as you go. When everything is taped in, bend the wire to make the flower petals, sepals, stamen, and pistil look more realistic.
5. Have each group member identify the reproductive structures of the flower and discuss their function.
6. Display the flowers in the classroom.

Questions:
1. Which part of the flower is considered the female reproductive structure?
2. Which part of the flower attracts insects?
3. What role do insects play in flower reproduction?
4. Why is the pistil sticky?
5. To what part of a flower are most people allergic?
Gymnosperms and Angiosperms
(Teacher Notes)

Lab Time: Part A Gymnosperms - 30 minutes; Part B Angiosperms - 30 minutes

Background: See student handout.

Materials: See student handout.

Sample Drawings:
Part A - Gymnosperms
1. Draw a picture of the pollen cone in the space below.

2. Observe the grains through the microscope and sketch them below. If a microscope is not available, use a magnifying glass.

3. Draw a picture of the seed cone below.

4. Observe the seed and scale and draw them below.

Part B - Angiosperms
1. Draw a picture of the bean from each view and color it with crayons or colored pencils.

2. Break the bean seed open. If it does not open easily, use a scalpel or scissors. Observe and identify the parts of the seed. Compare it to the diagram below.

Embryo
Seed coat
Food supply
Student Questions and Answers:

Part A - Gymnosperms
1. In nature, how does the pollen grain get to the seed cone? wind pollination
2. How does the shape of the pollen help with this process? It has little wings on each side to help it fly in the wind.
3. How does the shape of the seed relate to the way it is dispersed? It is winged to help it fly in the wind.
4. Is the seed enclosed in a fruit or is it naked (exposed). naked
5. Name three kinds of plants that are gymnosperms. pine, redwood, spruce, fir or Ginkgo

Part B - Angiosperms
1. Why is it advantageous for the seeds to be enclosed in a fruit? a. protection, b. aids in seed dispersal (The fruit, seeds and all, is eaten by other organisms and leaves the digestive tract ready to grow. Also some fruits have barbs that attach to animal fur.), c. fruit decomposes and becomes nutrients for the plant.
2. Name three fruits and the way they are dispersed. a. Maple fruits – wind, b. Mulberry fruits – bird digestive tract, c. Cocklebur – animal fur
3. Why is it an advantage for flowers to have such varied shapes, sizes, colors, and odors? These are all used to attract animals that aid in pollination and seed dispersal.
4. Fill in the following chart comparing gymnosperms to angiosperms. Check the box for the characteristics that apply.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Gymnosperms</th>
<th>Angiosperms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naked seeds</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Seeds inside a fruit</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Flowering plants</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Produce cones</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Produce fruits</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Wind Pollination</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Insect Pollination</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Examples</th>
<th>Gymnosperms</th>
<th>Angiosperms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Grasses</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Ginkgo</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Rose</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Pine</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Tomatoes</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Apples</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Redwood</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
ACOS Standard 1 & 10

Resources:

Book:

Internet:
Christopher J. Earle’s - Gymnosperm Database
http://home.earthlink.net/~earlecj/
Encyclopædia Britannica, Inc - on-line search engine
http://www.eb.com/cgi-bin/g?keywords=
ACOS Standard 1 & 10

**Gymnosperms and Angiosperms**
(Student Handout)

**Purpose:** To observe and record differences in the seeds of two major groups of plants.

**Materials:** (Set up for every two students.)
- 1 male or pollen cone
- 1 female or seed cone (Try to use some that still contain seeds.)
- 1 pod with the beans or peas inside
- 1 microscope (If a microscope is not available, use a magnifying glass.)

**Safety Considerations:** Always follow lab safety procedures.

**Part A - Gymnosperms**

**Background:**
Both gymnosperms and angiosperms produce seeds. Gymnosperm means “naked seed,” and the seeds are not encased in a fruit. Conifers such as pine trees, produce cones as you will observe in this lab. Spruce, redwood, fir, and ginkgo are all examples of gymnosperms. Most gymnosperms are evergreens with needlelike or scalelike leaves.

The pine tree produces two different types of cones. The pollen cone produces pollen that contains sperm cells. The pollen is carried by the wind and lands on the sticky female (seed) cone. It takes about 15 months for the pollen to unite with the egg cell in the female cone. An enormous amount of pollen is produced, and some of it lands on ovules. This yellow pollen can be seen on the sidewalks, puddles, and lakes in the springtime in Alabama.

**Procedure:**
1. Begin by observing the pollen cone. Describe the male cone. Some things to consider are size, texture, smell, shape, color, etc.

2. Draw a picture of the pollen cone in the space below.

3. Dust some of the pollen grains onto a microscope slide. Put a drop of water and a coverslip on it.

4. Observe the grains through the microscope and sketch them below. If a microscope is not available, use a magnifying glass.
ACOS Standard 1 & 10

5. Now observe the seed cone. Write a description of the seed cone including how the scales are arranged, their texture, shape, color, etc.

6. Draw a picture of the seed cone below.

7. Gently shake the cone. Remove one of the scales and examine its base. Perhaps some seeds will be present. However, even if they aren’t, there are usually impressions of the seed on the scale.

8. Observe the seed and scale and draw them below.

Questions:
1. In nature, how does the pollen grain get to the seed cone?

2. How does the shape of the pollen help with this process?

3. How does the shape of the seed relate to the way it is dispersed?

4. Is the seed enclosed in a fruit, or is it naked (exposed)?

5. Name three kinds of plants that are gymnosperms.

Part B - Angiosperms

Background Information:
The word angiosperm means “flowering plants.” This group of plants produce flowers and seeds encased in a fruit. Angiosperms make up the largest group of plants. They include grasses; corn; daisies; tomatoes; and apple, orange, and pear trees. These plants rely on many different insects, birds, and mammals for pollination. Some are self-pollinated or wind-pollinated. The fertilization of flowers and production of a seed take place quickly when compared to gymnosperms.

Procedure:
1. Observe the bean pod from the outside, then open it up, and examine it from the inside.
   Describe it in writing from each view.

   Outside:  
   Inside:
ACOS Standard 1 & 10

2. Draw a picture of the bean from each view and color it with crayons or colored pencils.

3. Break open the bean seed. If it does not open easily, use a scalpel or scissors. Observe and identify the parts of the seed. Compare it to the diagram below.

Questions:
1. Why is it advantageous for seeds to be enclosed in a fruit?

2. Name three fruits and tell how the seeds of each are dispersed.

3. Why is it an advantage for flowers to have such varied shapes, sizes, colors, and odors?

4. Fill in the following chart comparing gymnosperms to angiosperms. Check the box for the characteristics that apply.

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<td></td>
<td></td>
</tr>
</tbody>
</table>
Animal Classification

Purpose: Classify animals according to skeletal structure, method of fertilization and reproduction, body coverings, and locomotion.

Background:

Classification of animals is a way to group them based on similar traits. This is an important way to see how animals are related to each other. They are separated into groups using traits or characteristics (like whether they have a backbone or not). The way we classify animals and plants was created by a scientist named Linnaeus.

The Linnaeus system classifies plants and animals on seven levels, using Latin and Greek words. With the development of genome science, the biological connection between animals is beginning to alter and animals are being more accurately classified. The classic Linnaeus system which can be shown in the following way.

All living things are classified on the seven levels:
Kingdom
Phylum
Class
Order
Family
Genus
Species

An example of how this works in an Eastern Chipmunk is:

Kingdom Animalia animal
Phylum Chordata has backbone
Class Mammalia has backbone, nurses young
Order Rodentia has backbone, nurses young, long, sharp front teeth
Family Scuridae has backbone, nurses young, long, sharp front teeth, bushy tail
Genus Tamias has backbone, nurses young, long, sharp front teeth, bushy tail, climbs trees
Species striatus has backbone, nurses young, long, sharp front teeth, bushy tail, climbs trees, stripes
Animal Classification Activity

Directions:
1. Study the twelve animals pictured on the handout.
2. Number your notebook paper 1-12.
3. Describe each animal next to its corresponding number on your notebook paper based on its characteristics you observed.
4. Answer the following questions on your notebook paper:
   - How are these animals similar?
   - How are these animals different?
   - How can these animals be classified into groups?
5. Use the Dichotomous Key to identify each of the twelve animals in the pictures.
6. Write the name of the animal on your notebook paper next to its corresponding number and descriptions from #3.
ACOS Standard 11

Dichotomous Key

1. Do you have a backbone? 
   Yes - wait for number 3 
   No - you are an insect - wait for number 2

2. Do you change (metamorphosis) from a caterpillar to your adult form? 
   Yes - you are a butterfly! 
   No - you are a grasshopper!

3. Do you have gills and scales? 
   Yes - you are a fish! 
   No - wait for number 4

4. Do you lay eggs? 
   Yes - wait for number 5 
   No - wait for number 10

5. Do you have feathers? 
   Yes - you are a bird! 
   No - wait for number 6

6. Do you lay eggs in the water? 
   Yes - wait for number 7 
   No - wait for number 8

7. Do you live on land but come back to the water to lay your eggs. 
   Yes - wait for number 9 
   No - you are a pickerel frog!

8. Do you have a protective shell? 
   Yes - you are a turtle! 
   No - you are a snake!

9. Do you have lots of warty bumps and no tail? 
   Yes - you are a toad! 
   No - you are a newt (red eft)

10. Are you a carnivore (eat meat)? 
    Yes - you are a fox 
    No, wait for 11

11. Are you an omnivore? 
    Yes - you are a raccoon! 
    No - you are a herbivore - wait for number 12

12. Are you a rodent? 
    Yes - you are a squirrel! 
    No - you are a moose!