Objectives of the Packet

Content Knowledge Learning Objectives

1. What is an ape?
   Where do apes fit in primate taxonomy? Why?
   How can we describe ape species in terms of physical, behavioral and environmental characteristics?
2. What are the relationships between physical, behavioral and environmental characteristics in ape species?
   What is the significance of these relationships?
3. What is the status of wild ape populations?
   What factors influence wild ape populations?
   What can we do to help?

Skills Objectives

- Design and conduct inquiry-based scientific investigations
- Collect and analyze observational data from natural world
- Present research conclusions
- Make connections between physical, behavioral and environmental phenomena on species level and family level
- Develop and refine ethogram
- Create and interpret graphs
- Problem-solving and tool invention
- Collaborative inquiry
- Application of scientific knowledge to moral and ethical issues
- Role-play to assess implications of moral and ethical issues

How does this packet satisfy science education reform?

By using the information and activities provided in this packet, you can facilitate the growth of your middle-grade students as scientists. The national and state standards for middle-grade student scientific literacy include not only the ability to understand scientific processes, but also the ability to recognize the nature of scientific development, and the application of science to our lives. Using zoology in the classroom, students can expand their understanding of the scientific process to include not only experimental research conducted in a typical school laboratory, but also observational research as it relates to the natural world. Further, the exploration of the values, vision and implications of wildlife conservation provides an opportunity for middle-grade students to use content information and acquired skills to reflect on and assess the impact of these issues on their world. Finally, this packet encourages the integration of science and other disciplines in order to demonstrate the application of science to students' lives, as well as to provide a diversity of opportunities to practice and process science.

How to use this packet

The curriculum is divided into six sections, and each section contains background information for teachers and accompanying class activities. Glossary words found in the background information are bolded.

At the end of Sections 2 through 4, there is a "Thinking Ahead" prompt. Discuss each prompt with your class to begin the process of connecting the information between sections.

All inquiry-based activities are titled with a question to model inquiry-based teaching.

Activities titled "Interactivity" are designed to illustrate concepts using fun, active demonstrations. The Interactivities are all marked with the following icon:

All activities that are zoo-based are marked with the following icon:

If you are planning a class unit or a zoo visit using this packet, see the following page for suggested unit plans and options.

Suggested Unit Plans

Suggested Five-Day Unit Plan

Day One: Introduction
- 1.1: What is an ape? A preliminary concept map
- 1.4: How can we test the usefulness of opposable thumbs to primates?

Day Two: Environment
- 2.3: How does environmental disturbance affect an ape population?
- Library Time: Begin research for 6.1: How are the environmental, physical, and behavioral characteristics of a primate species related to each other?
- Thinking Ahead

Day Three: Physical
- 3.2: How can we use dentition to classify primates?
- 3.1: Interactivity: Apes in Arms
- Thinking Ahead

Day Four: Behavior
- 4.1: How do I develop an ethogram for the subject of an observational study?

  OR
- 4.6: What is a tool?
- 4:3: Interactivity: Ape Relay
- Thinking Ahead

Day Five: Conservation
- 5.1: What are the different human perspectives on the issue of ape conservation?
- Library Time: Continue research for 6.1: How are the environmental, physical, and behavioral characteristics of a primate species related to each other?

Final Project for Assessment:
- 6.1: How are the environmental, physical, and behavioral characteristics of a primate species related to each other?

Visiting the Zoo

Another way to use the curriculum in this packet is in conjunction with a visit to the zoo. The following are suggestions for some activities to do with your class before the zoo visit, during the zoo visit, and after the zoo visit:

Before the Zoo
- 1.1: What is an ape? A preliminary concept map
- 1.2: How can we use genetic evidence to classify evolutionary relationships?
- 2.1: Where do apes and other primates live?

At the Zoo
- 4.1: How do I develop an ethogram for the subject of an observational study?
- 4.2: What is the percent of time a focal ape subject exhibits selected behaviors?
- 4:3: Interactivity: Ape Relay (use North Meadow)
- 4.4: How can I communicate without using words?

After the Zoo
- 4.6: What is a tool?
- 5.1: What are the different human perspectives on the issue of ape conservation?
- 5.2: How can zoos educate visitors on the bushmeat trade crisis?
- 6.1: How are the environmental, physical, and behavioral characteristics of a primate species related to each other?

Alternative Unit Plans

There are many alternative themes within this curriculum around which a unit plan can be based. The following is a brief example of a five-day unit designed to encourage students to practice the skills and understand the work of wildlife scientists. Other alternative themes may include "Humans as Primates" or "Apes in Africa" for example.

Becoming Wildlife Scientists five-day unit plan
- Day One: 1.1, 2.2
- Day Two: 1.2
- Day Three: 3.3
- Day Four: 4.1
- Day Five: 4.2
- Final Assessment: 6.1

ACTIVITY FORMAT

Below is a format template for the activities included in this curriculum. All of the activities have been developed for students of grades 6 through 9, but may be adapted for students of other grades.

Section Number. Activity Number: Title of Activity **(EALR Subject Codes)**

Materials: All materials needed for the activity

Objective: The student will be able to achieve a certain behavior under conditions to a defined degree of acceptable performance.

Procedure: How to conduct the activity with your class.

Assessment Criteria: Indicators that student has understood and accomplished the objective of the activity.

Extensions: Suggested ideas for further discussion or procedures related to activity

Skills used in this activity

- List of skills practiced and used

We encourage you to adapt activities to the interests and abilities of your class. The subject codes list the different core subjects covered by the activity. These codes are based on core subjects outlined in Washington State's Essential Academic Learning Requirements (EALRs). Codes are as follows:

A = arts

C = communication

E = social studies: economics

F = health and fitness

G = social studies: geography

H = social studies: history

K = social studies skills

M = math

R = reading

S = science

V = social studies: civics

W = writing

Section 1 — Introduction to apes as primates

OVERVIEW

Primates are a mammalian order made up of prosimians, monkeys, apes and humans. The prosimians are more primitive, retaining more ancestral mammalian traits such as a heavier reliance on olfaction (sense of smell). Monkeys are broadly divided into New World and Old World Monkeys. The apes are divided into lesser apes (gibbons and siamangs) and great apes (bonobos, chimpanzees, gorillas, and orangutans). The apes live in Asia and Africa, and are known for their complex social behavior and enhanced cognitive abilities. They are also our closest living relatives.

Today, there are approximately 330 primate species living in approximately 92 countries across the world. The apes are considered a "super family" within the taxonomic order of primates (see chart below). To understand the apes as primates, it is important to consider their place in primate taxonomy, and review the significance of the taxonomic classifications.

Primate Taxonomy

Taxonomy is the science of classifying organisms. It is important for researchers because it provides a common, universalized scientific language. The science of taxonomy considers not only physical structure when classifying organisms, but also genetics. As the study of genetics continues to advance our knowledge of evolutionary relationships, taxonomic systems continue to grow and change.

There are two major models of primate taxonomy. The major difference between them hinges on the classification of the tarsier (family: Tarsiidae). The tarsier exhibits some **primitive** (present in ancestral form) characteristics, but also some **derived** (modified from ancestral form) characteristics. Thus, its classification has been questioned—do tarsiers sit better with the more primitive **prosimians**, or the more derived monkeys and apes?

The two major models are replicated below. Both are in common use today, and both are acceptable. The older model counts tarsiers with prosimians. The newer model separates tarsiers from prosimians, classifying all non-tarsier prosimians as **strepshirrini**, which means "wet nose." Tarsiers are instead grouped with the true **simians**, monkeys and apes, as **haplorrhini**, which means "simple nose" (referring to the dry nose).

Table 1. Older Primate Classification

Order	Sub Order	Infra Order	Super Family	Family	Common Name	Primates at WPZ*
Primates	Prosimii	Lemuriformes Lorisiformes Tarsiiformes			Prosimians, including: Lemur Loris Tarsier	Galago (Senegal bushbaby); Slow loris; Red ruffed lemur
	Anthropoidea	Platyrrhini	Ceboidea	Callitrichidae Atelidae Cebidae	New World Monkeys	Grey-legged douroucouli; Pygmy marmoset; Golden lion tamarin
		Catarrhini	Cercopithecoidea	Cercopithecidae	Old World Monkeys	Patas monkey, Lion-tailed macaque; DeBrazza's guenon; Black and white colobus
			Hominoidea	Hylobatidae	Gibbons Siamangs	Siamang
				Pongidae	Bonobos Chimpanzees Gorillas Orangutans	Western lowland gorilla; Orangutan
				Hominidae	Humans	

Table 2. Newer Primate Classification

Order	Sub Order	Infra Order	Super Family	Family	Common Name	Primates at WPZ*
Primates	Strepsirrhini	Lemuriformes Lorisiformes			All prosimians, excluding tarsiers	Galago (Senegal bushbaby); Slow loris; Red ruffed lemur
	Haplorrhini	Tarsiiformes		Tarsiidae	Tarsiers	
		Platyrrhini	Ceboidea	Callitrichidae Atelidae Cebidae	New World Monkeys	Grey-legged douroucouli; Pygmy marmoset; Golden lion tamarin
		Catarrhini	Cercopithecoidea	Cercopithecidae	Old World Monkeys	Patas monkey, Lion-tailed macaque; DeBrazza's guenon; Black and white colobus
			Hominoidea	Hylobatidae	Gibbons Siamangs	Siamang
				Pongidae	Bonobos Chimpanzees Gorillas Orangutans	Western lowland gorilla; Orangutan
				Hominidae	Humans	

* The list of primates at Woodland Park Zoo is current as of March 2007. For information on where to find these primates, see the "Pre-visit Sheet" in this packet.

What is a Primate?

Primates have retained many primitive mammalian traits. They survive as generalists, unlike many other mammals that are specialists, such as the giant panda, which feeds almost exclusively on two species of bamboo. Though primates are generalists, there are characteristics that are particular to the primate evolutionary trends. These characteristics include:

- Generally erect posture (for sitting, leaping, standing, and bipedalism)
- Flexible, general limb structure (allowing for more than one form of movement)
- Prehensility in hands and feet (grasping ability)
  a) Five digits on each limb
  b) Opposable first digit on hands and feet
  c) Nails instead of claws (exception: prosimians, some New World Monkeys)
- Generally omnivorous
- Color vision for **diurnal** species (useful for identifying ripe fruit, for example)
- Forward-facing eyes (provides stereoscopic vision for better depth perception)
- Decreased reliance on **olfaction** (sense of smell)
- Increased complexity of brain
- Longer gestation periods, reduced offspring, longer life span, slower maturation
- Tendency towards social groups

Who are the primates?

Primates are generally divided into the prosimians and the simians (monkeys and apes).
General characteristics of each group follow:

Dennis Dow

Red ruffed lemur

Prosimians

- Primitive primates
- Primarily nocturnal
- More reliance on olfaction than simians
  a) Moist **rhinarium** (nose)
  (exception: tarsiers)
  b) Long snout
  c) Scent-marking behavior
- **Dental comb** (dental specialization for grooming)
- Grooming claw on second toe for lemurs and lorises
- Includes lemurs (Madagascar), lorises (Asia), pottos (Africa), bushbabies/galagos (Africa) and tarsiers (Asia)

Ryan Hawk

Patas monkey

Simians

Monkeys

- Found in the Neotropics as well as Africa and southeast Asia
- Primarily diurnal
- Have some form of tail
- Fore and hind limbs similar in length
- Usually live in large social groups
- Two distinct groups:
  a) Old World: native to Africa and Asia; do not have prehensile tails; nostrils close together; toughened rump patches (**ischial callosities**)
  b) New World: inhabit the Neotropics (new tropics) in Mexico and South and Central America; some have prehensile tails; wide, sideways facing nostrils

Dennis Conner

Orangutan

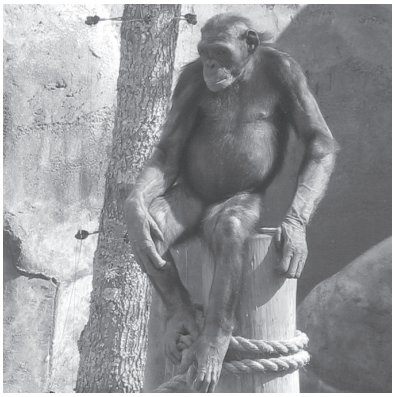
Apes

- Found only in Africa and southeast Asia
- Larger body size (exception: gibbons and siamangs)
- No tails
- More complex behavior
- Enhanced cognitive abilities
- Longer arms relative to leg length
- Increased infant development period
- Usually live in small family groups
- Two groups of apes:
  − Lesser apes: gibbons and siamangs
  − Great apes: bonobos, chimpanzees, gorillas, and orangutans

Who are the Apes?

The apes are the closest living relatives to humans. Human and chimpanzee DNA are over a 98% match. In fact, even as genetically close as chimpanzees and gorillas are to each other, DNA evidence suggests that chimpanzees and humans are more closely related to each other than either is to the gorilla.

Apes generally occupy tropical forests and grasslands. The Asian apes are represented by lesser apes and orangutans. The African apes are represented by bonobos, chimpanzees, and gorillas. Ape ranges often overlap with other primate ranges, and there is a resultant interaction and competition. Ape ranges often overlap with human-settled areas, as well. In fact, ape ranges frequently align with sites of human industry and development, resulting in a significant loss of habitat, hampering the ability for apes to survive.



Courtesy of Jacksonville Zoo

Bonobo *(Pan paniscus)*

The bonobo is also sometimes known as the gracile or pygmy chimpanzee. Unlike the widely dispersed common chimpanzee, the bonobo is found only in the Democratic Republic of the Congo (DRC) in Central Africa. Bonobos live in a societal structure called fusion-fission in which a large social group splits into small groups during daily activities. Bonobos are primarily frugivorous, feeding mostly on fruits.
Status: ENDANGERED

Courtesy of Oregon Zoo

Chimpanzee *(Pan troglodytes)*

There are four species of chimpanzee that are commonly recognized: Central chimpanzee (*P. t.troglodytes*), Western chimpanzee (*P. t. verus*), Eastern chimpanzee (*P. t. schweinfurthii*), and Nigeria-Cameroon chimpanzee (*P. t. vellerosus*). Wild populations exist today in diverse habitats in approximately 20 countries in equatorial Africa. Chimpanzees live in the fusion-fission social structure. They are primarily frugivorous, but also feed on leaves, insects, and some meats.
Status: ENDANGERED

Dennis Conner

Gibbon and Siamang (Family Hylobatidae)

All 11 species of gibbons and siamang belong to the lesser ape family called Hylobatidae. Gibbons are found in Asia and Southeast Asia. They live in small families headed by bonded pairs. Gibbon diets are primarily made up of fruit and plant materials.
Status: ENDANGERED

Mat Hayward

Gorilla (*Gorilla* spp.)

There are three recognized subspecies of gorilla, the western lowland gorilla (*Gorilla gorilla gorilla*), eastern lowland gorilla (*Gorilla gorilla graueri*) and the mountain gorilla (*Gorilla gorilla beringei*). Gorillas are found in Equatorial West Africa through eastern central Africa, living in primary and secondary tropical rain forests. They are polygynous, with one male leading a group of multiple females. Gorillas are **folivorous**, feeding primarily on leaves and other vegetation.
Status: ENDANGERED

Dennis Conner

Orangutan *(Pongo* spp.*)*

There are two distinct species of orangutans living on the Indonesian islands of Borneo (*P. pygamaeus*) and Sumatra (*P. abelii*). These **arboreal** (tree-living) apes spend most of their time in the lower and middle canopy levels of mature lowland tropical rain forests. Unlike the other gregarious apes, orangutans are semi-solitary. They are primarily **frugivorous**, feeding heavily on fruits.
Status: ENDANGERED

> For more information on **ape behavior**, see "Section Four — Ape Behavior" in this packet.

> For more information on **ape conservation status**, see "Section Five — Ape Conservation" in this packet.

> For more information on **bonobos, chimpanzees, siamangs, gorillas, and orangutans**, see the "Animal Fact Sheets" in this packet.

> For fact sheets on **other primates at Woodland Park Zoo**, see www.zoo.org.

Figure 9. Map of world showing where apes live in the eastern hemisphere.

1.1: What is an ape? A preliminary concept map **(S,W)**

Materials: Per student: paper, pen/pencil.

Objective: The student will be able to demonstrate and connect his or her ideas about the subject, in order to summarize and reflect on his or her prior knowledge about the subject, regardless of accuracy or merit of such knowledge.

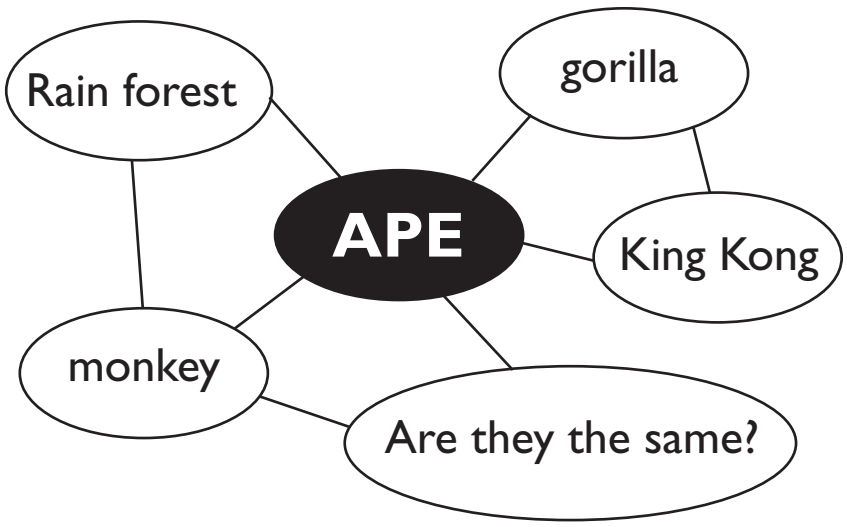
Procedure:

- If students have never completed a concept mapping exercise before, you may want to demonstrate the technique by doing an example concept map with the class. The following are suggestions for practice concept map topics: Winter, Ocean, Forest, United States.
- Making the concept map: Ask students to take out one sheet of paper and a pen or pencil. Have them write the word "APE" in the center of their page, and draw a circle around it. Now, allow them at least five to 10 minutes to construct a concept map of their ideas and connections about the topic "APE." They can write down factual information they believe to know about the subject, memories about the subject, questions about the subject, or impressions about the subject. Encourage students to draw thoughtful connections between the sections of their concept map.
- Remind students that the accuracy of the information is not important. They are not being tested on what they know. Rather, this type of exercise is a way to reveal to ourselves our preconceptions and sometimes misconceptions about a topic.
- Have students write their names and the date on their pages and turn them in to you. You will hold onto these concept maps until the end of the unit. See below for possible extensions.

Assessment Criteria: The student is able to express and reflect on his or her preconceptions and ideas, and draw connections between them.

Extension: At the close of the unit, return the concept maps to your students. Have them redraw their concept map on the backside of their page, following the above procedure. Ask students to reflect on if and how their concept map has changed. Discuss as a class what ideas were confirmed or possibly changed or corrected for students as a result of this unit.

Example of a concept map for "APE":



Skills used in this activity

- Identifying and recollecting information
- Ordering, grouping, and inferring connections
- Relating knowledge from several areas
- Reflecting on personal knowledge

1.2: How can we use genetic evidence to classify evolutionary relationships? (S,M)

Materials: Per student group: set of 1/2" x 1/2" squares of paper in four different colors (35 of each color); clear tape; one copy per student of "How can we examine the evolutionary relationships among the apes?" worksheet

Objective: The student is able to create a genetic model and make comparisons to other genetic models in order to determine evolutionary relationships based on genetic evidence.

Procedure:

- Before class begins, prepare the handout by filling in the appropriate colors for your key. A different color should be assigned to each of the four amino acid bases: A (adenine), C (cytosine), G (guanine), and T (thymine).
- In class, begin by discussing the importance of taxonomy, the science of classification, with students. Ask students to think of the taxonomic order Primates. Why are the primates grouped together? Students may have ideas about shared characteristics among the primates. Introduce the concept of genetics as an additional way to determine evolutionary relationships among organisms when classifying.
- Students may need background information on the concept of evolution. Some important points to stress in relation to this activity:
  - Humans did not evolve from apes, but instead, humans share a common ancestor with apes.
  - The more similar two organisms are with respect to genetic makeup, the more recently they diverged from a common ancestor.
  - While physical characteristics can be helpful in determining classifications of organisms, not all physical similarities indicate an evolutionary relationship between organisms. Sometimes physical similarities exist between unrelated organisms because the characteristic shares a similar function (e.g. bat, insect, and bird wings) or developed in an unrelated, but similar way.
  - DNA is the blueprint of life. It is a large polymer that contains information encoded in sequences of amino acids. The particular sequence of this information in an individual is what makes an individual unique.
- The goal of the activity is for students to form a hypothesis about the evolutionary timeline of divergence from a common ancestor for chimpanzees, gorillas and humans. They will then test this hypothesis by creating and comparing genetic models for these species.
- Divide the class into groups of four. Give each student a handout, and each group a set of four different colored paper squares. Each group will need at least 35 of each color.
- Student groups must start by developing a group hypothesis for the possible evolutionary relationships between humans, chimps, and gorillas. Did they all diverge from a common ancestor at the same time? Did chimps and gorillas diverge together, and later humans diverged? They are given three possible hypotheses in the form of a cladogram (a branching chart that shows evolutionary relationships based on derived similarities). Students must interpret the cladograms, select one, and then describe the cladogram as a hypothesis sentence.

HYPOTHESIS 1

HYPOTHESIS 2

HYPOTHESIS 3

- After developing a hypothesis, each of the students will create a model for one of the four DNA sequences provided. The sequence contains 20 amino acids, and will be made by taping together the colored paper squares according to the color key in order to match the amino acid sequence provided. Instruct your students to tape the squares evenly together, without overlapping any squares. Students should number the squares in each chain, starting with number one on the left-hand end of the chain.

- Once the models are made, have students lay out their chains of paper on the gaps of space on their worksheets, with position one of each chain at the left hand side.
- Students must now count the matches and differences between human DNA bases and chimp DNA bases. They can record this in the first data chart on their handout. Have students repeat this for human DNA bases compared to gorilla DNA bases, and finally chimp DNA bases compared to gorilla DNA bases.
- Now ask students to count the number of matches and differences for humans, chimps and gorillas compared to the common ancestor. Students will use their data to answer the worksheet questions.
- Discuss as a class the results of their research. Which hypothesis was best supported? What is the significance of using genetic comparisons when studying taxonomy and evolutionary timelines?

Assessment Criteria: The student formulates a hypothesis, makes accurate comparisons between the DNA sequence examples, and considers the evidence in order to judge the validity of the original hypothesis.

Extension: Some scientists have proposed that due to the genetic closeness of humans to the African apes, all apes and humans should be placed into the same taxonomic family—Hominidae. Currently, humans are the only living species classified in the hominid family. Discuss with your class what they think the implications might be if taxonomy were revised to include humans and apes in the same family. How might societies react to this change? Could it have an affect on ape conservation?

Answer Key:

1. Which two DNAs had the most matched bases between them? **Human and chimpanzee**
2. Which DNA is most similar to the common-ancestor DNA? **Gorilla**
3. Which two DNAs were most similar in the way that they compared to the common-ancestor DNA? **Human DNA and chimpanzee**
4. Do your findings support your hypothesis? Why or why not? **Answers will vary**
5. What conclusions can you make regarding the evolutionary relationships between humans, chimps, and gorillas based on your findings? **Answers may vary, possibly including that gorillas are more closely related to the common ancestor, humans and chimpanzees are more closely related to each other than either is to the gorilla, humans and chimpanzees diverged later from the common ancestor than the gorilla, etc.**

Skills used in this activity

- Collaborative inquiry
- Conducting inquiry-based science, including formulating and testing hypothesis
- Synthesizing genetic evidence to draw conclusions related to evolution and common descent
- Creating and comparing genetic models

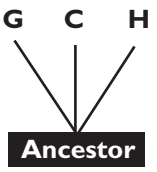
Name _____ **Date** _____

Worksheet: How can we examine the evolutionary relationships among the apes?

As a group, you are going to examine the evolutionary relationships between humans and the African apes by looking at their genetic similarities.

To begin, work as a group to develop a hypothesis regarding the evolutionary relationships among humans and the African apes. Three possible evolutionary relationships are shown below. Consider what you already know about the shared characteristics of these subjects (you might consider physical characteristics, behavior, or other information). Select one of the hypotheses below, and as a group, create a sentence that describes your hypothesis based on your selection.

HYPOTHESIS 1



HYPOTHESIS 2

HYPOTHESIS 3

HYPOTHESIS _____

_____

_____

_____

A small section of the DNA of each of the species subjects is recreated on the next page. Using the color key provided, each student must "synthesize" one of these gene sections by taping together the provided colored paper squares in order of the provided sequence, following the color key.

Color Key

Adenine (A) =

Cytosine (C) =

Guanine (G) =

Thymine (T) =

Name _____ **Date** _____

Student 1: Using the colored paper squares, "synthesize" and label a human DNA strand using the following sequence:
A-G-G-C-A-T-A-A-A-C-C-A-A-C-C-G-A-T-T-A

Student 2: Using the colored paper squares, "synthesize" and label a chimpanzee DNA strand using the following sequence:
A-G-G-C-C-C-C-T-T-C-C-A-A-C-C-G-A-T-T-A

Student 3: Using the colored paper squares, "synthesize" and label a gorilla DNA strand using the following sequence:
A-G-G-C-C-C-C-T-T-C-C-A-A-C-C-A-G-G-C-C

Student 4: Using the colored paper squares, "synthesize" and label a theoretical common ancestor DNA strand using the following sequence:
A-G-G-C-C-G-G-C-T-C-C-A-A-C-C-A-G-G-C-C

Tape your DNA strands into place under their respective sequences above. Now as a group, compare the human strand to the chimpanzee strand. Count the number of bases (represented by the colored paper squares) that match and that do not match, and record this in your chart.

Repeat this comparison and data-recording for humans and gorillas, and finally for chimpanzees and gorillas.

Data for Ape DNA comparisons

Human DNA compared to:	Number of matched bases	Number of unmatched bases
Chimpanzee DNA		
Gorilla DNA		
Chimpanzee DNA compared to:		
Gorilla DNA		

Name _____ **Date** _____

Next, compare each of the strands to the common ancestor strand, recording the number of matched and unmatched bases.

Data for common ancestor DNA comparisons

Common Ancestor DNA compared to:	Number of matched bases	Number of unmatched bases
Chimpanzee DNA		
Gorilla DNA		
Common Ancestor DNA compared to:		
Gorilla DNA		

1. Which two DNA strands had the fewest unmatched bases between them?

2. Which DNA strand is most similar to the common-ancestor DNA?

3. Which two DNA strands were most similar in the way that they compared to the common-ancestor DNA?

4. Do your findings support your hypothesis? Why or why not?

5. What conclusions can you make regarding the evolutionary relationships between humans, chimps and gorillas based on your findings?

1.3: How can we create a model to represent the taxonomic relationships of primates? **(C,R,S)**

Materials: Per student: One index card with the common name of a unique primate; pen; access to research materials, including computer, Internet, library. Per class: one roll of masking tape; red, blue, green, and black markers; several yards of string or ribbon

Objective: The student will be able to contribute to the cooperative development of a taxonomic model in order to represent relationships in the primate classification system.

Procedure:

- Before class begins, prepare one index card for each student. On one side of the card, fill in a name of a primate species. Make sure that no two students are assigned the same primate. Select primates across all taxa, including prosimians, monkeys, and apes.
- To start the lesson, discuss the concepts of grouping and classification with students. Let them wonder about their own experiences and identities in terms of the classifications that they see used and use themselves every day. Discuss openly the idea of grouping and ask students to produce example groups using items or people in the classroom. Lead students to question and discover the relevance of grouping for scientists.
- Next, give each student a card. They must use appropriate and available resources to research taxonomic information about their primate. On the blank side of their card, students must fill out the following, including subdivisions such as superfamily or suborder whenever appropriate and possible: **Kingdom, Phylum, Class, Order, Family, Genus, Species**
- Now, have students use the colored markers to label their cards on the common name side according to where their species lives. Students will draw a yellow circle if their primates live in South America, a red circle if in Asia, and a blue circle if in Africa.
- Students must now work together as a class to create a taxonomic tree for their primates. Have students start by marking at the front of the room the highest level of the classification hierarchy that they can identify. This will be marked with masking tape, and the name of this level should be written onto the tape with black marker. Now students will use string to connect to the next level in the hierarchy, and mark it with masking tape as well. The model will eventually extend to the floor.
- As students continue to use the information on their index cards, they will come across classification levels for which there are more than one branch. At this point, students must work together to create the appropriate amount of branches per level and continue to connect levels so that the hierarchy remains accurate.
- Eventually, students will work their way down to the species level. Each individual student must now find the right placement for his or her unique primate. (See photo of completed activity).
- Remind students that scientists must often revise their work as new information comes along. To this end, students may find themselves making changes to the branches or moving levels to make more room as they add more information throughout the process.

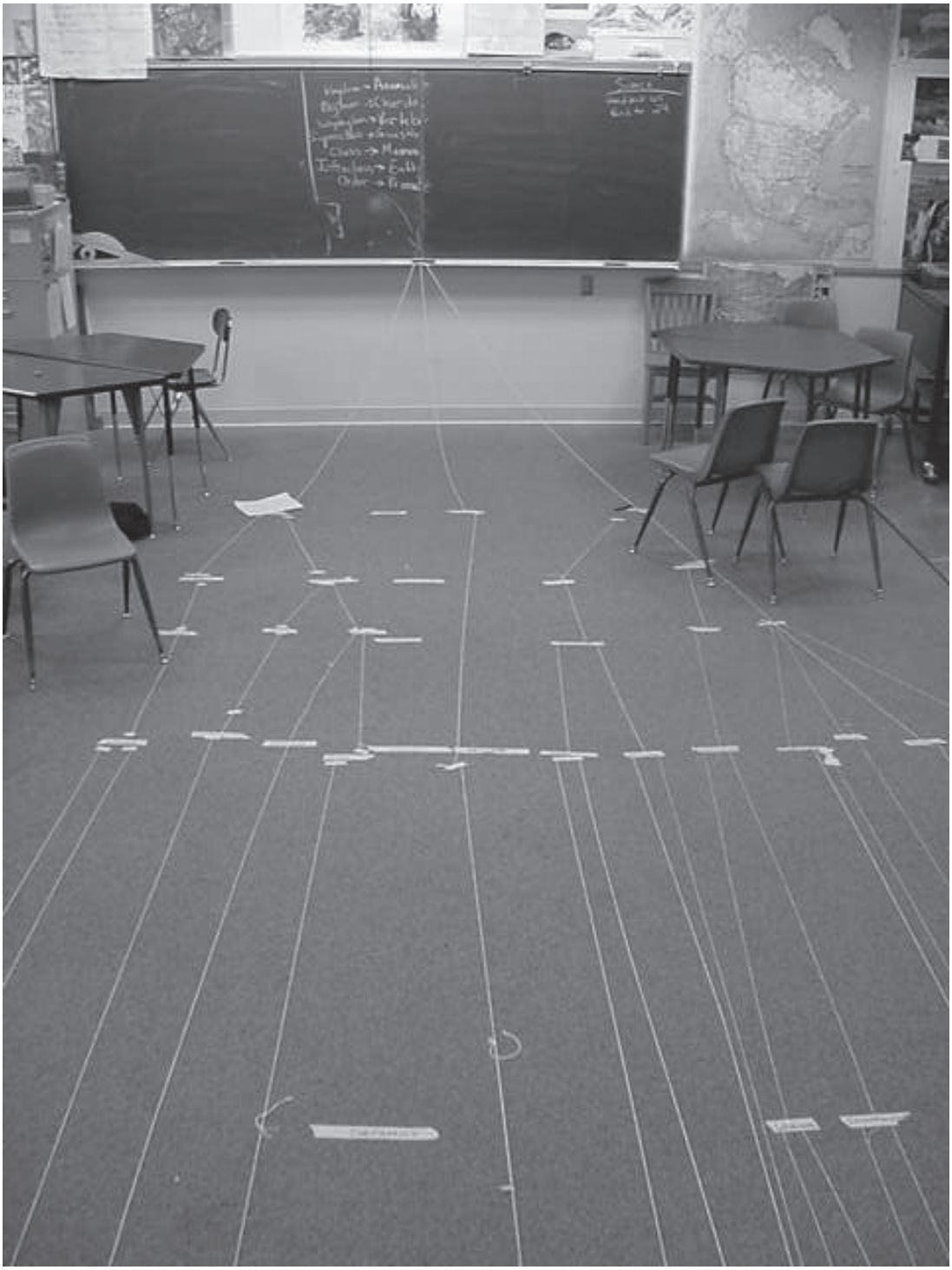
Assessment Criteria: The student accurately classifies his or her species, collaborates with classmates to expand and revise the model, and demonstrates a comprehension of the classification hierarchy.

Extensions

- Can the students identify any trends in the classification system with respect to where the different primates live in the world?
- Ask students to add humans to the model. What do they notice about the range of human habitat? What are some implications of this?
- Start a discussion about your students' ideas of what it means to be human. How do they feel about placing humans in this taxonomic group? Why do they feel this way?

Skills used in this activity

- Collaborative inquiry
- Creating scientific models
- Classifying organisms using taxonomy



Kristina Peterson

Complete taxonomic model of primates

1.4: How can we test the usefulness of opposable thumbs to primates? (C, M, S)

Materials: Per student group: stopwatch, one copy of "Opposable Thumbs worksheet" (2 pages), pen/pencil, one roll of masking tape. Three stations using the following: chopsticks and small bowl with cereal; shoes with shoelaces; oranges, bananas, or other fruit with a peel

Objective: The student will be able to hypothesize about the importance of opposable thumbs to primates and test that hypothesis by experimenting with thumb use.

Procedure:

- Break students into groups of three to four individuals. Give each group masking tape, stopwatch and one copy of the "Opposable Thumbs Worksheet." Students should complete worksheet parts one and two before beginning the tasks. Part two of the worksheet involves formulating a hypothesis. If your students are not yet experienced in hypothesis formulation, you may need to spend additional preparation time helping them to develop this important science skill. A hypothesis should make a prediction about what will happen in an experiment; a hypothesis should be measurable and should be worded such that it can be tested in an experiment.
- Stagger student groups at the three stations for worksheet part three. You may have a note card at each station that explains the task (see below), or you may verbally explain each task.
- There should always be one student in each group on stopwatch and note-taking duty, but all students in the group must be allowed to test their hypothesis by attempting to complete the tasks. Allow students to collaborate within their groups on how to make such arrangements.
- At each station, the testers will attempt each task twice—once with the aid of thumbs and once with their thumbs taped to their hands using masking tape. The timekeeper must use the stopwatch to record the time it takes each individual to complete each task, with and without thumbs. This procedure should be repeated at each station, until all students have had a chance to be testers.
- **Note to Teacher:** This activity assumes certain physical abilities of your students. Please be sensitive to the diversity of physical abilities in your class, and be prepared to address questions and issues raised regarding people with different abilities.

Station One: Use the chopsticks to pick up and remove a total of five pieces of cereal.
Station Two: Tie a bow in the shoelaces of each shoe at the station.
Station Three: Peel the rind (or other covering) from the provided fruit.

- Now students should return to their worksheet as a group for questions four and five.
- Conclude with a class wrap-up discussion based on students' answers to question five.

Assessment Criteria: The student is able to collaborate within the group to assure that all members have participated as testers. The student is able to articulate a hypothesis regarding the usefulness of opposable thumbs to primates, and articulate whether the hypothesis is supported by the results of the testing.

Extensions

- Discuss with students their hypothesis, results, and conclusions. What were their impressions of the tasks? Which was hardest for them? Easiest?
- Ask students to graph their group's task results. Have them develop an appropriate scale, and represent the individual timed results both with and without thumbs for the members of their group.
- How would human life differ if we had opposable big toes?

Skills used in this activity

- Collaborative inquiry
- Conducting inquiry-based science, including formulating and testing hypothesis
- Synthesizing evidence and knowledge to make predictions
- Presenting research conclusions
- Creating graphs
- Calculating statistical measures

Name _____ **Date** _____

Worksheet: Opposable thumbs

RESEARCH QUESTION: How does the opposable thumb affect primate abilities?

As a group, you will test the usefulness of opposable thumbs to primates by attempting a series of tasks with and without the aid of your thumbs.

1. Discuss your ideas about the usefulness of opposable thumbs. Think about your morning—as you were getting ready for school, how useful were your thumbs? What do you think non-human primates use them for?

2. A **HYPOTHESIS** is a trial answer to your research question that can be tested through experiment. As a group, formulate a hypothesis for the above research question.

_____

_____

_____

_____

3. Following your teacher's instructions, you will now test your hypothesis. At each station is a task. Each group member is to attempt to complete the task twice—once with the aid of his or her thumbs, and once without. Masking tape has been provided to you. Use the tape to secure your thumbs to your hands so that it is restricted during your "Without thumbs" trials.

   While attempting the tasks, one student in each group should time and record the trials of the testers. Make sure that every student in the group has a chance to test, including the student who has been timing and recording.

   Use the chart on page two to record your trial outcomes. Enter group members' names under "Testers" column. You may use the "notes" column to record any interesting experiences.

AFTER YOU COMPLETE YOUR TRIALS

4. Looking at your results, is your hypothesis supported? Explain why or why not.

_____

_____

_____

_____

5. Synthesis: What if primates did not have opposable thumbs? How might that affect what they eat, where they live, how they move, what activities they can complete, or how they interact with each other? Discuss with your group. You may write down some of your ideas here.

_____

_____

_____

_____

_____

Name _____ **Date** _____

Worksheet: Opposable thumbs, contd.

Station One _____

Tester	Time with thumbs	Time without thumbs	Notes
1.			
2.			
3.			
4.			

Station One _____

Tester	Time with thumbs	Time without thumbs	Notes
1.			
2.			
3.			
4.			

Station One _____

Tester	Time with thumbs	Time without thumbs	Notes
1.			
2.			
3.			
4.			