STEM core

STEM Careers through Outreach, Research, & Education

UNIVERSITY OF OREGON

"How similar am I to a zebra fish?" Genetic Similarity and Animal Models

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Synopsis of the Activity: Visitors interact with animals commonly used in research (if available) and use card matching to learn how much genetic material humans share with these animals. Another card-matching activity provides examples of specific animals models for different diseases/conditions (insomnia, cancer, diabetes, etc.). Visitors learn that genetic similarity allows us to use other animals to learn about ourselves.

Audience: The general public. However, written materials are geared towards 6th to 8th graders. Younger children may also be able to understand the main point of this activity: we're similar enough to other animals that we can research them to learn about ourselves.

Activity (Learning) Goals OR Learning Objectives:

-Give visitors the opportunity to interact with live animals commonly used in research (e.g. rat, zebra fish, nematodes).
-Promote an awareness of animal research and what we can/have learned from it.
-Visitors will understand that humans are animals, and that we share many genes with other animals.
-Visitors will be able to match animal models to the amount of genetic material humans share with them.
-Visitors will be able to explain why we can use other animals to learn about ourselves.

Concepts:

Big idea: We're similar enough to other animals that we can research them to learn about ourselves.

DNA/genes
Biological similarity
Last common ancestor

Materials:

Required:
Informational Tri-fold Poster and game cards - ~ $20

Optional:
"Reflections" Poster, Post-it notes, pens/pencils - ~ $7
DNA 3-D Model - $40 - $200
Portable Microscope (for nematodes) - $10-$300
Animals (rat, zebra fish, nematodes) and holding containers (cage, etc.) - prices vary

**The tri-fold poster, game cards, "reflections" poster, Post-it notes, and signs (for each card game, potential animal stations, etc.) have been donated to the STEM core office. One sign has all the information given on the tri-fold poster, so the tri-fold need not be used if it takes up too much space. DNA 3-D model can be rented through Holly Lynn, lab preparator for the UO Biology department.

Preparation and Set-up: Place the tri-fold poster, signs, and game cards on a table. Cards/signs should be grouped by mini-activity:

(i) Match animals to genetic percentages. Associated signs are on green construction paper. There's one sign for directions, another for the answer key, and another for "last common ancestor" hints. One set of percentage cards includes: 42%, 61%, 71%, 85%, 93%, 98%, 99.9%. One set of animal cards includes: nematode, fruit fly, zebra fish, mouse/rat, rhesus

macaque, chimpanzee, and human. A set of percentage cards and animal cards constitutes one game set. You can put out up to 3 game sets, so 3 visitors can play simultaneously.

(ii) Match animals to disease models. Associated signs are on blue construction paper. There's one sign for directions and another for the answer key. One set of disease cards includes: diabetes, insomnia, anemia, cancer, and polio, hepatitis C. One set of animal cards includes: nematode, fruit fly, zebra fish, mouse/rat, rhesus macaque, and chimpanzee. (Human has been removed.) A set of disease cards and animal cards constitutes one game set. You can put out up to 3 game sets, so 3 visitors can play simultaneously.

Live animals and/or DNA model, if available, should be placed on either side of the poster. Animals will draw in visitors. Even without animals, the poster is colorful and eye-catching (e.g. "How similar am I to a zebra fish?" More than you might think!). The "reflections" poster (What's something new you've learned from this activity? Draw, write, and share!) May be taped to a wall or placed on a table alongside the Post-it notes and writing utensils.

Guiding Questions:

ENGAGE:
Have you looked at this animal yet?
How much DNA do you think you share with a [insert organism]?

PRIOR KNOWLEDGE/ASSESSMENT:
What animals do you think of when you hear the word "research"?
Why can we use other animals to learn about ourselves?
What are examples of animals?
How do scientists classify humans?
What are genes?

DISCUSSION:
Why do you think we use these animals and not other ones?

Activity Description: As visitors approach, ask them some of the guiding questions discussed above. Monitor handling of animals. Invite visitors to complete the card activities, each of which will have written directions above the associated cards (E.g. "Try matching each animal to its percentage of genetic similarity with humans!"). As visitors drop in and out, direct them to an activity that's not currently occupied (cards, poster info, animal handling) or engage them in discussion questions until an activity frees up. *If visitors use cards differently than anticipated, encourage them to answer a guiding question by fulfilling the card activity's directions.

Teaching Strategies: This activity aims to make visitors aware of animal research, have them reflect on science (How do we know what we know?), and have them learn/use scientific language (see key terms below).
Engage: Ask visitors some of the guiding questions above (e.g. Have you looked at this animal yet? How much DNA do you think you share with a [insert organism]?).

Explore: Visitors complete each card game. They may rely on prior knowledge to make educated guesses, or read the posters/signs for hints/information to guide their choices.

Explain/Evaluate: As visitors complete the card activities, you can assess their reasoning by asking why they're making particular choices. When they're finished, they can compare answers with other visitors and the answer key. The answer key provides more detailed explanation of the answers and reinforces vocabulary/concepts discussed in the informational poster and card-game signs.

Express: Visitors can draw/write something new that they've learned and post it on the "reflections" poster.

Vocabulary:

Genome – the complete set of genetic material, or DNA, in a living thing
Genes – specific segments of DNA that determine what we look like and how our bodies function
Genetic Similarity – the amount of DNA two living things have in common; scientists may compare entire genomes, genes only, or a subset of genes (e.g. only those that cause disease)
Animal Models – non-human animals that we observe to learn about ourselves; some mimic aspects of a disease such as cancer or a condition such as insomnia; we can also use them to study how we perceive the world, learn/remember, and make decisions

Science Content Background and Additional Resources:

We're similar enough to other animals that we can research them to learn about ourselves.
What makes us similar? Our genomes! Every living thing has its own **genome**—a complete set of genetic material, which is made up of **DNA**. Specific segments of DNA, called **genes**, determine what we look like and how our bodies function. [A surprisingly small portion of the genome is made up of genes. Scientists are still trying to figure out what the rest of genome does!]

Scientists can figure out **genetic similarity**—the amount of DNA two living things have in common. Scientists may compare entire genomes (all the DNA), genes only (specific segments of the DNA), or a subset of genes (for example, only those that cause disease). For example, if we compare entire genomes, humans share 40% of their DNA with mice. However, if we compare genes only, that number jumps up to 85%. If we compare disease-causing genes, that number jumps up to 99%.

Because other animals are genetically similar to us, their bodies and brains may act similarly to ours. We often study them to learn about diseases that affect us, but we can also study them to understand how we see, hear, and smell…how we learn and remember…and even how we make decisions! We refer to animals in research as **animal models** if they "model" (essentially mimic) a disease, condition, or behavior that we're interested in studying.

Nematodes share 42%* of disease-causing genes with humans.[1]
Fruit flies share 61% of disease-causing genes with humans.[2]
Zebra fish share 71% of genes with humans.[3]
Mice/rats share 85% of genes with humans.[4, 5, 6]
Macaques share 93% of the genome with humans (i.e. 93% of DNA nucleotides are identical to ours).[7]
Chimps share 98% of the genome with humans (i.e. 98% of DNA nucleotides are identical to ours).[8]
One human shares 99.9% of its genome with another human's. That 0.1% difference (along with the environmental factors that shape gene expression) makes you the unique person you are.[9]

*Note: Percentages are approximations. In journal articles, a range is typically given. For example, if we include gene duplications, we share 98% of our DNA nucleotides with chimps, but if we exclude duplications, we share about 96%. Also, a percentage does not necessarily imply that that much of the DNA sequence is *identical*. For example, mice share 85% of genes with humans; more specifically, of the mouse genes that have a functional counterpart in humans, the mouse gene may be 60-99% identical to the corresponding human gene (nucleotide per nucleotide). "Similarity" has more to do with if the gene codes for a functionally equivalent protein product. If visitors ask why some cards say "genes" versus "disease-causing genes" versus "genome," explain that these analyses take a lot of time and computer power, so we only analyze the specific information we want. In the case of a fruit fly, we specifically want to know what diseases we can model, so we only look at disease-causing genes. For chimps, we want to know more about evolutionary differences, so we look at the entire genome.

References:

1. Culetto and Sattelle. (2000). A role for *Caenorhabditis elegans* in understanding the function and interactions of human disease genes. *Hum. Mol. Genet., 9*(6), 869-877.
2. Rubin et al. (2000). Comparative genomics of the eukaryotes. *Science, 287*, 2204-2215.
3. Howe et al. (2013). The zebrafish reference genome sequence and its relationship to the human genome. *Nature, 496*, 498-503.
4. http://www.genome.gov/10001345
5. Emes, Goodstadt, Winter, and Ponting. (2003). Comparison of the genomes of human and mouse lays the foundation of genome zoology, *Hum. Mol. Genet., 12*(7), 701-709.
6. Rat Genome Sequencing Project Consortium. (2004). Genome sequence of the Brown Norway rat yields insights into mammalian evolution. *Nature, 428*, 493-521.
7. Rhesus Macaque Genome Sequencing and Analysis Consortium. (2007). Evolutionary and biomedical insights from the rhesus macaque genome. *Science, 316*, 222-234.
8. Chimpanzee Sequencing and Analysis Consortium. (2005). Initial sequence of the chimpanzee genome and comparison with the human genome. *Nature, 437*, 69-87.
9. http://science.education.nih.gov/supplements/nih1/genetic/guide/genetic_variation1.htm

Additional Resources:

Simple explanation of genes and proteins: kidshealth.orgkid/talk/qa/what_is_gene.html

How to broadly classify organisms (why we're classified as animals): faculty.fmcc.suny.edu/mcdarbyAnimals&Plants Book/History/02-Explaining-Life-Classification.htm

Finding DNA similarities: www.genome.gov; in Google Scholar or a Library Database, type a phrase such as "comparative genomic analysis [organism] and human." Be sure you know what the percentage refers to (e.g. similarity between genomes versus similarity between disease-causing genes).