Student Name: Margaret A. Lambert
Subject: Biology
Topic: Taxonomy
Grade Level: 9-10th

Duration: 7 90-minute periods

Essential Questions: What is taxonomy and how has it evolved throughout time?

Virginia Standards of Learning (SOLs):
BIO.4 The student will investigate and understand life functions of Archaea, Bacteria and Eukarya. Key concepts include c) how the structures and functions vary among and within the Eukarya kingdoms of protists, fungi, plants, and animals, including humans;

BIO.7 The student will investigate and understand how populations change through time. Key concepts include a) evidence found in fossil records; b) how genetic variation, reproductive strategies, and environmental pressures impact the survival of populations; c) how natural selection leads to adaptations; d) emergence of new species; and e) scientific evidence and explanations for biological evolution.

Objectives:
Students will know:

- Taxonomy is the foundation for sorting all of life.
- On the taxonomic tree, animals that are more similar to each other are closer together and occupy the same branch.
- The names of the scientists who were responsible for the multiple theories of taxonomic thinking: Aristotle, John Ray, Carolus Linnaeus, Georges Culvier, Ernst Haeckel, Edouard Chatton, and Robert Whittaker.

Students will be able to understand:

- Taxonomy began as a simple naming system between plants and animals and has grown into a web of mapped connections (phylogenetic trees), which is still being updated with new genetic information.
- Various scientists have proposed systems and their knowledge has built upon prior knowledge to create the current 3- Domain system, 5-Kingdom system we have today.

Students will be able to do:

- Students will sort and order cards to create their own system of taxonomic classification.
- Students will read and pull information from a taxonomic family tree.
- Students will research one theory in detail.
- Students will create and present a poster demonstrating one scientist/theory.

Background Information:

This unit on taxonomy would be taught following a unit on cell biology and the hierarchy/classification of life and could lead nicely into a unit on Evolution and the Theory of Natural Selection.

Taxonomy, the field of biological classification, attempts to group types of organisms in meaningful ways. Modern taxonomy is based on similarities among organisms that reflect descent from recent shared ancestors, rather than similar solutions to environmental challenges. For example, a bird's wing

and a human's arm reflect common descent from a vertebrate ancestor, whereas a bird's wing and an insect's wing are derived from different structures and therefore not characteristics on which modern classification might be based.

Taxonomic designations increasingly rely on deoxyribonucleic acid (DNA) sequence similarities. Because DNA mutates at a known rate, the more alike the DNA sequences are for two types of organisms, the more recently they diverged from a shared ancestor. By considering such data on pairs of species, biologists can construct evolutionary tree diagrams that depict how existing organisms are related to one another. In this way, taxonomy in the modern sense reflects evolution.
Read more: http://www.biologyreference.com/Ta-Va/Taxonomy-History-of.html#ixzz4cHiOYiG6

Procedures: Unit Plan Outline

The Evolution of Taxonomy			
Classes	**Year(s)**	**Historical Description**	**Class Problem**
1 & 2 Week 1	384–322 B.C. & 1627-1705	Early taxonomist and Greek philosopher, **Aristotle (384–322 B.C.),** organized five hundred types of animals according to habitat and body form. **John Ray (1627–1705),** naturalist who classified more than twenty thousand types of plants and animals. His highly descriptive method distinguished animals by their hoofs, nails, claws, teeth, and toes.	1-**Animal/Plant Card Sort** Have students **sort animal picture cards** in groups of 2-3 by creating their own categories (example: wings, tail vs. no tail, webbed feet, etc.) Examples of animal card format: Example of Animal Cards for Activity 1, which would be created or bought. (Actual cards would not include exclusively extinct animals) https://www.vice.com/en_uk/article/trading-v12n7 http://kellylewis.edublogs.org/2016/04/12/gr-2-science-animal-trading-cards-project/ Add in **plant cards** and see have students **sort** them according to a system they come up with. (Underline this tidbit. John Ray's inability "to see microscopic distinctions and reliance on **superficial** similarities led him to group together algae, lichens, fungi, and corals. A lichen is a compound organism that consists of an alga and a fungus, but a coral is an animal.") 2- **Historia Animalium (History of Animals)** Expose students to Aristotle's thinking by having them read a portion of his writing (in English, translated from original Latin). A reading guide or a KWL would be a good resource for this reading. **(Formative Reading Assessment)** http://classics.mit.edu/Aristotle/history_anim.html
3 & 4 Week 2	1707-1778 & 1769-1832	**Carolus Linnaeus** (1707–1778) is the best-known taxonomist. Heavily influenced by John Ray, Linnaeus compared, contrasted, and meticulously listed types of organisms from his earliest childhood.	3- **"Dichotomous Key" Activity** Students work in small groups to make a dichotomous key with 6 everyday classroom objects. They do this by starting with two groups "blue" and "not blue" and getting more specific each time. By the end, students create a key with each of the objects listed with two defining adjectives. They should end with answers like (Pencil-blue, and pencil-red). This will act as an introduction to Bionomial Nomenclature.

		French anatomist, **Georges Cuvier**, (1769–1832) and others contributed broader levels of taxonomic classification: family, order, class, phylum or division, and kingdom.	**Systema Naturae or The System of Nature** Have students watch a video clip of "Taxonomy – Life's Filing System – a Crash Course." https://www.youtube.com/watch?v=F38BmgPcZ_I 4- **Phylogenetic Tree Activity** Have students do a discovery activity by looking at a phylogenetic tree and answering questions about the layout. Students will discover knowledge such as: 1) how to determine which animals are more closely related and 2) which animals share a common ancestor. **(Formative Problem Solving Assessment)** Worksheets: Clade Race- http://www.evolutioned.org/teaching-resources.html https://prezi.com/a1et3ca1iz8q/the-great-clade-race/ http://study.com/academy/practice/quiz-worksheet-cladograms-and-phylogenetic-trees.jpg http://study.com/academy/practice/quiz-worksheet-cladograms-and-phylogenetic-trees.html
5 & 6 Week 3	1834-1919 & 1937	German naturalist **Ernst Haeckel** (1834–1919) proposed a third kingdom, Protista, to include one-celled organisms. In 1937, French marine biologist **Edouard Chatton** made an enormous contribution to biology by introducing the terms prokaryote and eukaryote.	5- **Theory of Recapitulation – Read and Respond** Have students read and answer questions about Haeckel's Theory of Recapitulation. **(Formative Reading Assessment)** http://amazingdiscoveries.org/C-deception-Ernst-Haekel_theory_multicellular_organisms Also, have students look at his AMAZING drawings: http://www.graphicine.com/ernst-haeckel-protists/ And his "Pedigree of Man" (see previous link, mid-page) to see an historic document with a phylogenetic tree. 6- **Microscopes and Cells** Have students look at slides under microscopes of prokaryotes and eukaryotes and correctly identify each type.
7 & 8 Week 4	1959-1969 & 2000's	Cornell University ecologist **Robert Whittaker's** five-kingdom system. He introduced it in 1969 and it prevailed for many years. Whittaker's scheme recognized the	7- **Phylogenetic Pin-the-Tail** Have students play the game "pin the protest-monera-fungi-plantae-animalia" on the family tree in which they work in teams to correctly place each organism in the correct location, given a blurb about each one. **Genetics and Phylogenetic Trees** During the game, above, stop and introduce new information onto the organism cards showing genetic relationships between them. Also students to reshuffle

		Monera (prokaryotes), Protista (unicellular eukaryotes), Fungi, Plantae, and Animalia. **Modern Genetic Research** has shown that some animals are more closely related than previously thought due to genetic similarity. One famous example of this is the elephant and the rock hyraxe, a small rodent like furry animal that lives in South Africa.	up the cards on the tree, as needed. This will mimic what is currently happening in the scientific world in the field of Evolutionary Genetics. See article in *Nature:* http://www.nature.com/scitable/topicpage/origins-of-new-genes-and-pseudogenes-835 http://www.nature.com/scitable/topic/evolutionary-genetics-13 **8- Research Project** Students will choose one theory/scientist to research, which was covered in class and will create a poster demonstrating what the basic idea/life story is and how that theory/scientist fit into the large evolution of taxonomy. Posters will be hung in the room and will create a group "timeline of taxonomy" which will stay up all year for reference. **(Summative Assessment)**

Materials/Resources:

- Days 1 & 2: Animal/Plant sorting cards. (One bag per group).
- Days 3 & 4: Large pieces of paper for the "Dichotomous Key" creation activity and multiple sets of classroom objects. A follow-up worksheet for students to write out their naming system.
- Days 5 & 6: Article and worksheet about Haeckel, color copies or projection of Haeckel's drawings. Slides of various pro and eukaryotes.
- Days 7 & 8: A large poster of "Pin the Organism on the Family Tree" Game and various species cards with tape on the back. A follow-up worksheet for each group to fill out. Materials for a poster presentation (poster board, markers, glue, tape, etc.)

Safety

- Students will be responsible for hanging microscopes carefully and according to demonstration and lab safety rules.

Assessment:

- Students will demonstrate their understanding of the evolution of taxonomic thought by creating a poster presentation highlighting one scientist or one theory. These posters will be placed on a class timeline, on which every major scientist is represented. Students will also need to take a short quiz on the ordering of the scientists and their contributions.

Closure:

- Each day, I will recap the scientists we discussed and their major contributions to our understanding of Taxonomy. Students will fill out daily exit cards on their key take aways each day.

Accommodations for individual differences:
Students will have a choice at the end of this unit about what they'd like to create their poster projects about. They will get to choose the direction of their investigation.

Behavioral and organizational strategies:
Students will be sorted into some heterogeneous and some homogeneous groups in various days to allow for multiple aptitudes to come through. The teacher will always reserve the right to shift a group, as needed.

Resources/References:

http://www.biologyreference.com/Ta-Va/Taxonomy-History-of.html
http://amazingdiscoveries.org/C-deception-Ernst-Haekel_theory_multicellular_organisms
http://www.graphicine.com/ernst-haeckel-protists/
http://davesgarden.com/guides/articles/view/2051/#b
https://www.youtube.com/watch?v=jbVG2Cs-Tvo&feature=player_embedded
http://classics.mit.edu/Aristotle/history_anim.html