actionbioscience.org lesson

To accompany the peer-reviewed article by Max Ingman:
"Mitochondrial DNA Clarifies Human Evolution" (May 2001)
http://www.actionbioscience.org/evolution/ingman.html

mtDNA: So What Did You Inherit from Mom? (June 2002)

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Grades & Levels:

- **Handout 1:** high school (general-advanced)
- **Handout 2:** high school (AP) – undergraduate (year 1)

Time Recommendations:

- 1 class period for article review and discussion
- up to 1 week for short projects in Handout 1
- up to 2-4 weeks for extended project in Handout 1 and all Handout 2 projects

NSES (USA) Content Standards, 9-12:

- NSES 1.4. Unifying Concepts & Processes: evolution & equilibrium
- NSES 4.1. Life Science: the cell
- NSES 4.3. Life Science: biological evolution
- NSES 6.2. Science & Technology: understanding about science & technology
- NSES 8.3. History & Nature of Science: historical perspective

Note: View the NSES content standards on this site to choose other curricular applications for additional activities at:
http://www.actionbioscience.org/educators/correlationcharts.html

Learning Objectives: Students will…

- identify structure and function of mitochondria
- understand mitochondria's role in evolution
- familiarize themselves with a mitochondrion map of genes

Key Words Include:
anthropology, D-loop, genomics, genotype, loci, maternal inheritance, mtDNA, nucleotide, organelle, polymorphisms, rRNA, tRNA

Preparation

Article Discussion:

- Students begin their activities by reading the article "Mitochondrial DNA Clarifies Human Evolution" by Max Ingman at http://www.actionbioscience.org/evolution/ingman.html.
- Discuss the article in class. Content and extension questions are provided on page 2.

Student Handout 1 or 2:

- Follow discussion with project assignments. Note that Student Handout 1 contains several "short projects" and one "extended project." The latter can be assigned as a class activity. Short projects, which require much less time to complete, can be assigned to teams.
- Tell students that their Internet searches will begin with the links that follow the article they have just read and discussed. These links are found in the "learn more," "get involved," and "educator resources" sections at the end of the article. They can follow the trail from these links to more links.

For Educators: Article Discussion

About the article by Max Ingman: "Mitochondrial DNA Clarifies Human Evolution"
http://www.actionbioscience.org/evolution/ingman.html

KEY WORDS REVIEW

anthropology, D-loop, genomics, genotype, loci, maternal inheritance, mtDNA, nucleotide, organelle, polymorphisms, rRNA, tRNA

ARTICLE DISCUSSION

Have students read the online article on their own in class or as a homework assignment before asking the following questions about the article:

Article Content Questions:

1. How would you describe the field of population genomics?
2. If you were a physical anthropologist, what would you be doing on a given workday?
3. How does one go about constructing an evolutionary tree?
4. You and a friend have 12 differences in your nucleotide sequence of the control region of your DNA. What might that tell you about your country origins?
5. How are the two opposing views of human origin alike and how are they different?
6. From which germ cell line did you receive your mitochondria?
7. What makes mtDNA so useful in evolutionary studies?
8. Considering a mitochondrion map, what is a D-Loop?
9. Why has the D-loop been so valued by persons studying population genomics?
10. What recent developments have decreased D-loop value in evolutionary relationships?
11. According to the study of human evolution mentioned in the article, when did modern humans appear?
12. How many genes are found on a mitochondrion?

Extension Questions:

1. What part do mitochondria play in the aging process?
2. What is a possible reason that mitochondria are only inherited from one parent?
3. How does mitochondrial architecture determine function?
4. What are some basic differences between physical and molecular anthropology?
5. In addition to phylogeny, how might mtDNA be used in other fields of study?

mtDNA: So What Did You Inherit from Mom?

Student Handout 1

Short Projects

1. There are basically three steps that must occur in order for a mitochondrion to do its job. Failure in any of these indicates mitochondrial disease. Describe the three steps in a visual or oral presentation.

2. Thinking historically, construct a concept map to include the milestones and scientists involved in the study of human evolution.

3. Write an essay about Mitochondrial Eve (ME) and include answers to the following questions:
   - Why is ME a confusing name to give a historical entity?
   - Why is ME not our common ancestor?

Extended Project

Leber's Disease

You have been asked by a group of physicians to prepare a tri-fold informational brochure that they will give to their patients who exhibit early onset of Leber's Disease. Below you will find the informational requirements that govern the contracted work. Each item listed below is worth 10 points, except item #7, which is worth 20 points (total points for project: 100).

- ✓ 1. The brochure must be ready to go to print by [date _____].
- ✓ 2. The brochure must be created on the computer.
- ✓ 3. Draw a diagram of the cross section of a mitochondrion. Of course the diagram will include accurate labeling. Use of color is recommended but not mandatory.
- ✓ 4. A brief description of the function of the organelle's parts should follow the graphic.
- ✓ 5. An accurate narrative of mitochondrial replication will be included.
- ✓ 6. A panel of the tri-fold will explain the variety of jobs completed by the organelle.
- ✓ 7. A minimum of two panels will be devoted to the history, signs/symptoms, and genetics of *Leber's Hereditary Optic Neuropathy*.
- ✓ 8. You may choose to include other pertinent information on mitochondria; some examples include current theory of mitochondrial origin, uniqueness of the genetic system of the mitochondrion, support for maternal inheritance, and what is coded in mtDNA.
- ✓ 9. It is expected that the brochure will be neat, error free, and easily understood by lay people.

Note: In addition to the key words you discussed in class, additional vocabulary might include: stroma, matrix, ATP, glycolysis, Kreb Cycle, electron transport, chain, neuropathy

Eve Theory

You will be interviewed by your local radio station about the Eve Theory. Surf the net to find an answer to the question you will be asked by the interviewer: "Does mitochondrial DNA support the Eve Theory?" You need to know several facts to be able to support your answer, including:

- What is a mitochondrion and mitochondrial DNA?
- How is mtDNA different from other forms of DNA?
- Is mtDNA inherited differently from other forms of DNA?
- What is the Eve Theory and why has it generated misconceptions?

Prepare your radio script and present it in class. After the interview, have classmates ask you questions as if they were callers to the radio show.

Cells – R – Us!

The well-known company, Cells-R-Us, has hired you. Recently the CEO (Chief Executive Officer) informed you that the Spring Organelle Catalog must be released by [due date_____]**.** The company wants you to create a page for the catalog and an attractive bonus will be awarded to the team with the most compelling page. The edition will be an 8 1/2" by 11" format. Your immediate supervisor has given you a list of considerations for your inclusion. Your organelle page will represent the mitochondrion and must be:

(Bous Points)	**(Mock-Up Format Directions)**
10 points	priced competitively (compare to other cellular organelles)
20 points	potential customers must want to purchase products
30 points	accurately describe the mitochondrion's structure and function in a cell's life
20 points	show an analogy or comparison to something customers are familiar with in their life
10 points	visually and colorfully appeal to the eye
10 points	contain neat and easy-to-read text

All participants in the catalog will receive from 0 to 100 points, from which your company bonus will be calculated. You will need to brainstorm, mock-up, review and collaborate with your colleagues. Consider the Who, What, When, Where, Why and How components as you make your decisions.