AP BIOLOGY · UNIT 7 · TOPIC 7.7

Common Ancestry

Learning objective 7.7.A Describe structural and functional evidence on cellular and molecular levels that provides evidence for the common ancestry of all eukaryotes.

Name: Date: Period:

Use the tool **What Every Eukaryote Kept**. Parts 1, 2 and 5 use **Who has what**, Part 3 uses **One code, every organism**, and Part 4 uses **A bacterium inside you**. This topic asks a narrower question than it first appears: not what shows that all life shares an ancestor, but what shows that all eukaryotes do. Those are different questions with different answers. Keep the two lists separate.

Part 1 · Sorting the evidence

For each of the ten features, record which domains of life have it. Then, in the last column, record which claim the feature supports: the common ancestry of all life, or the common ancestry of all eukaryotes.

Feature	Bacteria	Archaea	Eukarya	Claim it supports
DNA as the genetic material				
The same genetic code				
Ribosomes				
ATP as the energy currency				
A phospholipid plasma membrane				
Glycolysis				
Membrane-bound organelles				
Linear chromosomes				
Genes containing introns				
A cytoskeleton of actin and tubulin				

1. Describe the structural and molecular evidence for the common ancestry of all eukaryotes.

2. (a) Using the Part 1 table, identify the features that provide evidence for the common ancestry of all life.

(b) Explain why the evidence for the common ancestry of all life differs from the evidence for the common ancestry of all eukaryotes.

Part 2 · What each eukaryotic feature is for

Open the panel headed **What each eukaryotic feature is actually for**. The exam asks students to name these features and also to describe what they do. Those are two different questions.

Eukaryote-only feature	What it is	What it does for the cell
Membrane-bound organelles		
Linear chromosomes		
Genes containing introns		
A cytoskeleton of actin and tubulin		

3. Describe the function of membrane-bound organelles in a eukaryotic cell.

4. (a) Describe what an intron is.

(b) Explain why the presence of introns in all eukaryotes is evidence of their common ancestry.

Part 3 · One code, every organism

Go to **One code, every organism**. Step through the first **19** codons of the human beta-globin gene, reading each with the standard genetic code. Fill in the first six rows as you go.

Codon number	Codon	Amino acid	Peptide so far
1			
2			
3			
4			
5			
6			

5. Humans and bacteria use the same genetic code. Explain why this shared code is evidence of common ancestry rather than coincidence.

6. Human insulin for people with diabetes is made in E. coli. Scientists insert a DNA copy of the human insulin coding sequence, with its introns removed, into a bacterial plasmid, and the bacteria produce the human protein. Explain why E. coli can make human insulin from the inserted DNA.

Part 4 · A bacterium inside you

Go to **A bacterium inside you**. For each trait, decide whether the mitochondrion resembles a free-living bacterium or the eukaryotic cell it sits inside.

Trait	In a bacterium	In a mitochondrion	Matches which?
Genome shape			
Ribosome type			
Divides by			
Number of membranes			
Introns in its own genes			
Sensitive to antibiotics that block bacterial ribosomes			

7. Based on the Part 4 table, describe the traits of mitochondria that indicate they descended from free-living bacteria.

8. A student claims that the double membrane of the mitochondrion is evidence against the endosymbiotic theory. Explain why the double membrane instead supports the endosymbiotic theory.

Part 5 · Answering the question that was asked

Go to Who has what and read the table headed **The two answers, kept apart**. For each piece of evidence, record the conclusion it supports and the conclusion it does not support.

Evidence	Supports	Does not support
The same genetic code in bacteria, archaea and eukaryotes		
Membrane-bound organelles		
Linear chromosomes with telomeres		
Genes containing introns		
Mitochondrial 70S ribosomes and circular DNA		

9. Asked for evidence of the common ancestry of eukaryotes, a student answers, "All eukaryotes use ATP."
(a) Explain why the student's answer does not provide evidence for the common ancestry of eukaryotes.

(b) Identify one feature that does provide that evidence.

10. The evidence in the Part 4 table shows where mitochondria came from. Explain why this evidence does not, by itself, show where the rest of the eukaryotic cell, including its nucleus, came from.

What the model simplifies

The grid treats each feature as simply present or absent across a whole domain. Biology has exceptions to nearly all of them: some bacteria have linear chromosomes, some archaea have introns of a different kind, and a few eukaryotes have lost their mitochondria. The pattern is strong and the exceptions are real, so a claim of the form “no prokaryote has X” is safer stated as “X is a general feature of eukaryotes and not of prokaryotes.”

Archaea appear as a single column. They are as different from bacteria as from eukaryotes in several respects: their membrane lipids use ether linkages rather than ester linkages, and their transcription machinery is closer to the eukaryotic kind. That is itself evidence about the shape of the tree, and it belongs to Topic 7.9.

The genetic code is described as “the same” everywhere. There are small documented variants, notably in mitochondria and in a few ciliates, where a handful of codons read differently. Those variants are themselves informative: they are rare, minor, and nested inside particular lineages, which is what descent with modification from a shared code looks like.

The mitochondrion's traits are given as a clean yes or no. In reality most of the original bacterial genome has moved into the nucleus over two billion years, so a mitochondrion today cannot live independently. That is expected after an obligate partnership of that length and is not evidence against the origin.