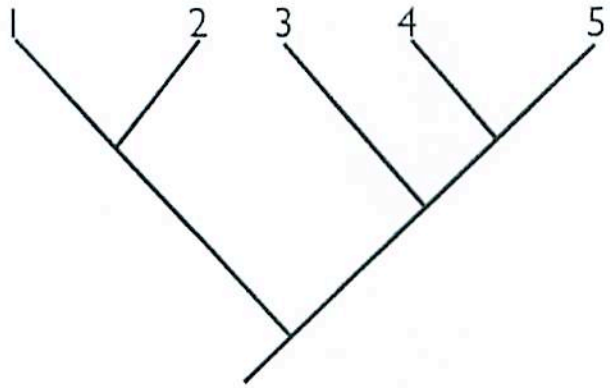
Initials: Naomi

**1.** On the tree below, please circle and label the following: (2.5 points)

**(a)** one example of a node
**(b)** the root
**(c)** one example of a taxon
**(d)** one example of sister taxa
**(e)** one example of a monophyletic group



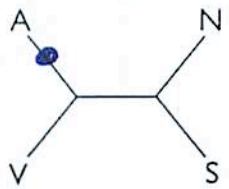

There are multiple possible answers here. Please see p. 2 of "Phylogeny + Evolutionary History" notes.

**2.** (a) Define the term *outgroup*. (1 point)

An outgroup is a taxon related ~~related~~ to the groups of interest, but OR that branched off earlier in evolutionary time

// An outgroup is a taxon more distantly related to the ingroup than they are to each other.

**(b)** You would like to understand the relationships among three taxa: Spraguea (S), Nosema (N) and Vavraia (V). You infer an unrooted phylogenetic tree, adding Allomyces (A) as an outgroup. The resulting tree looks like this:




Given that Allomyces (A) is the outgroup, re-draw this tree as a <u>rooted, bent-branch tree</u>. (3 points)

**(c)** In the tree you drew in (b) above, which two taxa are most closely related? (0.5 points)

N + S

**3. (a)** Define *lateral (or horizontal) gene transfer.* In one sentence, describe how the "standard" process of inheritance differs from lateral gene transfer. (2 points)

LGT/HGT is the acquisition of foreign DNA. Compared to vertical transmission/inheritance, where DNA is transmitted w/in a species from 1 gen$^{n}$ to the next, in LGT DNA moves between species w/in the same gen$^{n}$

**(b)** *Lateral gene transfer events are predicted to be much more prevalent among bacteria than among eukaryotes.*

Describe one feature of **bacterial** biology that supports the statement above. (1.5 points)

- possess mechanisms to move DNA around (transform$^{n}$, transduc$^{n}$, conjug$^{n}$)

Describe one biological feature possessed by **eukaryotes** that supports the statement above. (1.5 points)

- separation of germ + soma makes LGT less likely in many euks.

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4. **(a)** Which molecule (DNA, RNA or protein) features in the discussion of life's origins based on its self-replicating nature? (1 point)

RNA

**(b)** Name the early life hypothesis that includes the molecule above, and give one other piece of evidence (besides self-replication) that supports this hypothesis. (2 points)

- RNA World

Any one of:
- prebiotic enviro. likely contained RNA building blocks
- ribozymes (or RNA enzymes) exist
- invitro evidence for key processes like RNA extension (template based)

5. **(a)** Define LUCA. (1 point)

Last Universal Common Ancestor

**(b)** Currently there is no fossil evidence for LUCA. Given what you know about the limitations and biases in fossil formation, predict some of the general features of LUCA and explain why fossils of LUCA may never be found. (3 points)

LUCA likely single-celled w/ no hard outer covering. Fossil form^n biased towards hard parts + mueticellular organisms. Even if formed, fossils from taxa as old as LUCA less likely to survive to present b/c old rocks are rarer than new rocks (ie. recycling Earth's crust/tectonic subduction etc.). Geography / Environment could also play role if LUCA didn't live in a lowland/aquatic habitat.

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**6.** "The Big 5" refers to five mass extinction events that have occurred in the Phanerozoic Eon. Although the causes of these mass extinctions vary, their effects can be more general. Describe three generalizations about the effects of mass extinction on species, using only the given space below. (4.5 points)

Any 3 of:

- 60-80% of all species become extinct
- broad geographic range acts as buffer (ie. tend to survive.
- species losses not even across taxa
- groups experiencing general period of decline more susceptible to becoming extinct

(- generally no correlation b/w body size + survival)

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Please do not write below this line.

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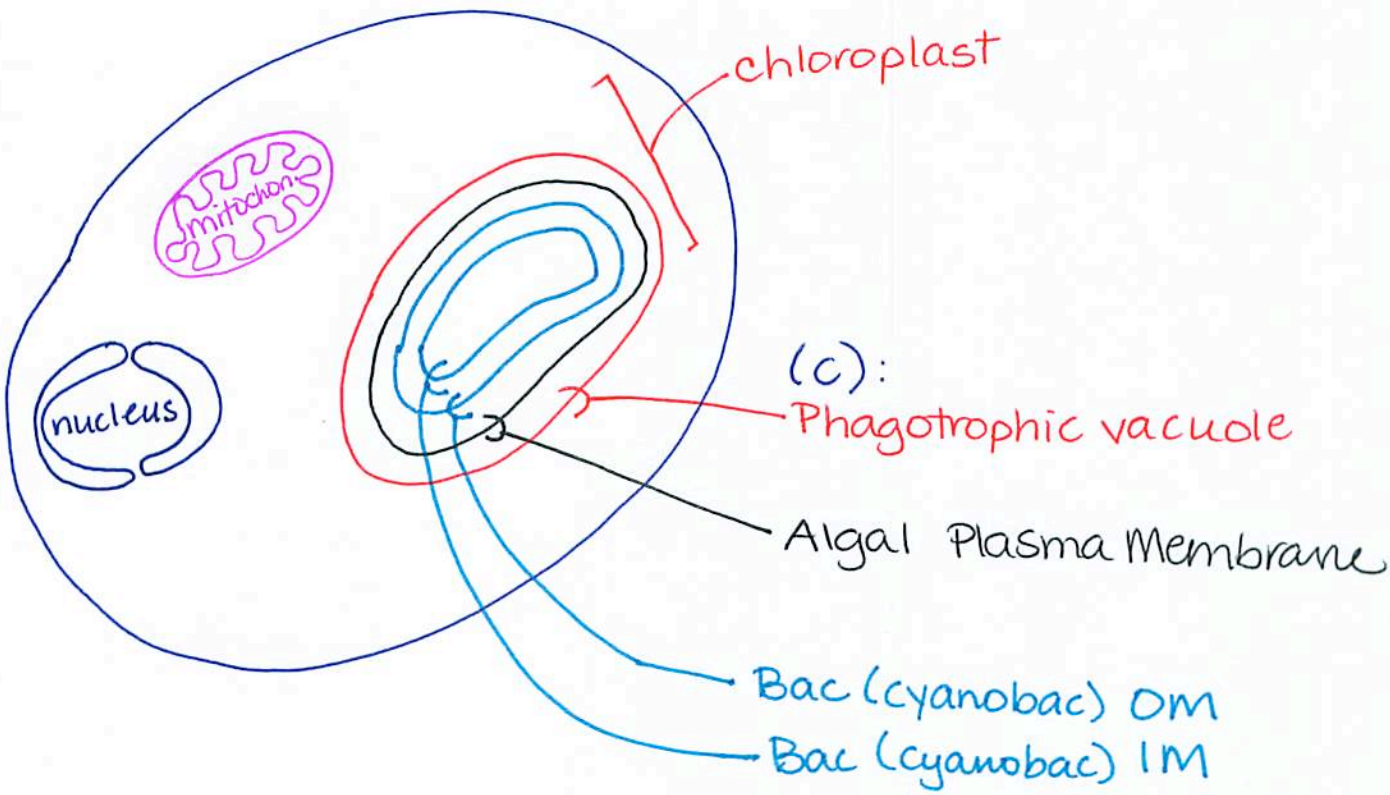
**7.** Dr. Smart finds a new species of eukaryote in a local tidepool. Upon microscopic examination, it is clear that the eukaryote is unicellular and possesses a chloroplast with 4 membranes.

(a) Is the chloroplast derived from primary or secondary endosymbiosis? Give a one sentence explanation for your choice. (1.5 points)

- 2°

- > 2 membranes

(b) Diagram the new eukaryote. Include and label the following structures: nucleus, mitochondrion and chloroplast. (4 points)




(c) On your diagram above, please indicate the origin for each membrane of the chloroplast. (3 points)

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**8. (a)** What is the Burgess Shale and what features make it significant? (3 points)

- fossil deposit from Cambrian
- enormous # of diverse fossils
- remarkable preserv^ of soft body forms

**(b)** The Burgess Shale has been designated a UNESCO World Heritage Site. World Heritage Sites include the Pyramids of Egypt and the Galapagos Islands, and are defined as "features of exceptional cultural and natural significance, and are considered to be of outstanding universal value to humanity."

**Thesis Statement:** The Burgess Shale is of outstanding universal value to humanity based on what it teaches us about the evolution of life.

In the space below, support this thesis statement with evidence. (5 points)