

Final Exam

Honor pledge: "I have neither given nor received unauthorized aid on this test."

Signed : Key Date : _____

Name : _____

1. What are the 3 primary evolutionary branches of life? (5pts)

Bacteria

Archaea

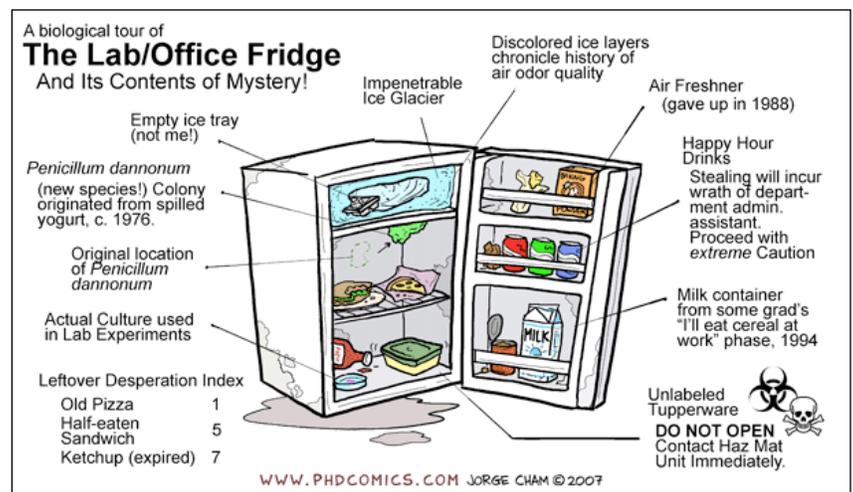
Eukarya

2. What is *horizontal transfer*? (2 pts)

The transfer of genes from one organism to another that is not its offspring

3. List the possible scenarios for the origin of viruses. (3 pts)

- genetic offshoots ('satellites') of their hosts*
- remnants of precellular life*
- degenerate parasites*



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4. ___**E**___ Thermophiles have to deal with what issue(s) compared to mesophiles? (2pts)
- A. membrane fluidity
 - B. DNA/RNA/protein denaturation
 - C. small molecule stability
 - D. balancing enzymatic function
 - E. all of the above
5. ___**A**___ The genomes of obligate parasites are what compared to free-living relatives? (2pts)
- A. simplified
 - B. more complex
 - C. divided into multiple chromosomes
 - D. more condensed
 - E. none of the above
6. ___**C**___ Large-scale genomic sequencing of environmental DNA is known as ... (2pts)
- A. Maxim & Gilbert sequencing
 - B. pyrosequencing
 - C. metagenomics
 - D. shotgun sequencing
 - E. all of the above
7. ___**B**___ All endospore-forming Bacteria are members of the ... (2pts)
- A. Actinobacteria
 - B. Firmicutes
 - C. Crenarchaea
 - D. cyanobacteria
 - E. none of the above
8. ___**E**___ The planctomycetes ... (2pts)
- A. lack peptidoglycan
 - B. have external fibrous stalks
 - C. divide by budding
 - D. contain an internal cell membrane
 - E. all of the above
9. ___**B**___ Secondary metabolites are produced during ... (2pts)
- A. log phase
 - B. stationary phase
 - C. thermal stress
 - D. nitrogen limitation
 - E. all of the above
10. ___**C**___ Which of the following is not a sulfur metabolism found in Archaea? (2pts)
- A. sulfur oxidation
 - B. sulfur reduction
 - C. sulfur fermentation
 - D. sulfur respiration
 - E. All of the above are used by Archaea
11. ___**B**___ Which of the following is not a common phenotype of Archaea? (2pts)
- A. sulfur-metabolizing thermophiles
 - B. pathogens
 - C. methanogens
 - D. halophiles
 - E. none of the above
12. ___**A**___ Which of the following groups of eukaryotes lack mitochondria? (2pts)
- A. archaeozoans
 - B. alveolates
 - C. ciliates
 - D. heterokonts
 - E. all of the above have mitochondria
13. ___**D**___ Insect gut *Arthromitis* is ... (2pts)
- A. *Bacillus anthracis*
 - B. *Bacillus thuringensis*
 - C. *Bacillus antibioticus*
 - D. *Bacillus cereus*
 - E. *Arthrobacter mitis*
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14. For each genus, give the major phylogenetic group to which it belongs. **Answer 20 out of the 24**; if you answer more, only the first 20 will be graded. (1pt each) A list of these major phylogenetic groups is given on the last page of the exam.

Genus	Major phylogenetic group it belongs to
<i>Bacillus</i>	<i>Firmicutes</i>
<i>Dermocarpa</i>	<i>Cyanobacteria</i>
<i>Caulobacter</i>	<i>alpha-proteobacteria</i>
<i>Streptomyces</i>	<i>Actinobacteria</i>
<i>Chlamydia</i>	<i>Chlamydia & relatives</i>
<i>Pyrococcus</i>	<i>Euryarchaea</i>
<i>Thermotoga</i>	<i>Thermotoga & relatives</i>
<i>Thermoplasma</i>	<i>Euryarchaea</i>
<i>Clostridium</i>	<i>Firmicutes</i>
<i>Oscillatoria</i>	<i>Cyanobacteria</i>
<i>Giardia</i>	<i>Eukaryotes</i>
<i>Pfeisteria</i>	<i>Eukaryotes</i>
<i>Ignicoccus</i>	<i>Crenarchaea</i>
<i>Anabaena</i>	<i>Cyanobacteria</i>
<i>Sulfolobus</i>	<i>Crenarchaea</i>
<i>Rhodomicrobium</i>	<i>alpha-proteobacteria</i>
<i>Kuenenia</i>	<i>Planctomycetes</i>
<i>Gemmata</i>	<i>Planctomycetes</i>
<i>Arthrobacter</i>	<i>Actinobacteria</i>
<i>Halobacterium</i>	<i>Euryarchaea</i>
<i>Planctomyces</i>	<i>Planctomycetes</i>
<i>Thermoproteus</i>	<i>Crenarchaea</i>
<i>Methanothermobacter</i>	<i>Euryarchaea</i>
<i>Prochlorococcus</i>	<i>Cyanobacteria</i>

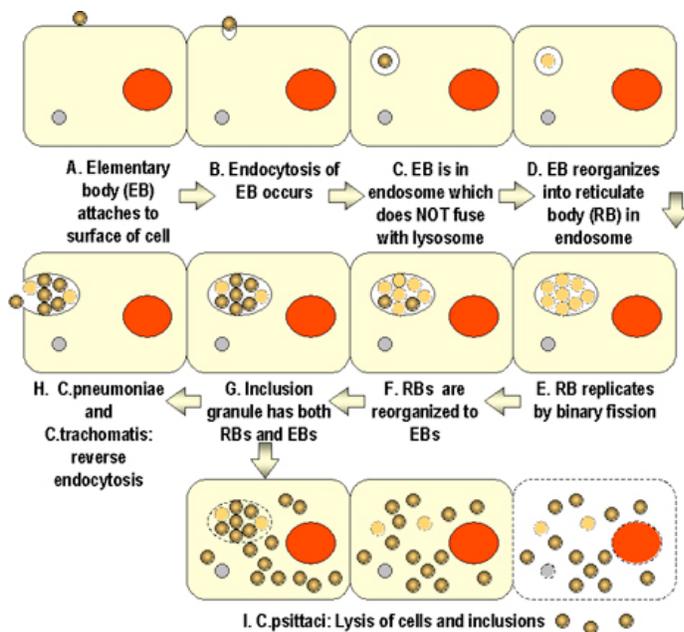
15. Describe an organism (species or genus) we've talked about in class since the second midterm exam. (5 pts)

Example answer: Oscillatoria

Oscillatoria is a cyanobacterium, ubiquitous in freshwater environments. As a cyanobacterium, it is a photoautotroph, carrying out oxygenic photosynthesis. They are often large enough to be mistaken for filamentous eukaryotic green algae. Filaments typically have a light sheath, if any, and the individual cells are cylindrical disks. Filaments are rigid, and rotate during gliding; this can make them appear to writhe as they rotate around slight curves and bends in the filament.

16. Describe the life cycle of a *different* organism, from a *different* major phylogenetic group than the organism used to answer question 15 above. (5 pts)

Example answer : Chlamydia



17. Describe *in detail* the question/problem, approach, results and conclusion of any one of the papers discussed in class since the second midterm exam. (10 pts) A list of these papers can be found on the last page of the exam.

Example answer: Wayne Litaker, et al., 2002 J. Phycol. 38:442-463 Life cycle of the heterotrophic dinoflagellate Pfeisteria piscicida (Dinophyceae).

Purpose - to describe the life cycle of Pfeisteria piscicida

In this paper, the authors (from UNC-Chapel Hill) use video microscopy to watch the life cycle of this organism. They do not observe anything but the traditional life cycle stages of a generic dinoflagellate. Amoeba matching the descriptions of the strange life cycle stages of Pfeisteria failed to hybridize to their Pfeisteria-specific probe (but did to eukaryotic "universal" probes). The life cycle is nicely documented. However, they're making a tough argument - it's hard to prove a negative, and the Burkholder camp could argue that they weren't using the right conditions, strains, &c. On the other hand, the onus is on the Burkholder group to document the life cycle they claim for Pfeisteria, and they have not done so.

In a later paper (by other authors), amoeba were isolated that match in every detail the descriptions of Pfeisteria amoeboid stages from environments harboring Pfeisteria and Pfeisteria-laden aquaria, and rRNA sequence analysis was performed on these cultures. They were all found to be standard amoeba of various types - not dinoflagellates.

18. List, in one sentence each, the purpose, approach, and results of another paper discussed in class since the second midterm exam. (5 pts)

Example answer: Thermotoga genome paper

Purpose: To report the complete genome sequence of Thermotoga maritima

Approach: standard genome sequencing and annotation

Results; The genome sequence, and the hypothesis that there are large amounts of genome that don't follow the ancestry of the rRNA - i.e. that a lot of the genome came via horizontal transfer

19. List, in one sentence each, the purpose, approach, and results of still another paper discussed in class since the second midterm exam. (5 pts)

Example answer : Arthromitis paper

Hypothesis/purpose : Arthromitis is the natural insect gut form of Bacillus cereus

Approach : Fresh isolation & cultivation in media mimicking insect guts.

Results : The hypothesis is confirmed - Arthromitis and Bacillus cereus are indistinguishable

20. Compare cyclic and oxygenic photosynthesis, including the various ways these are used to get reducing power for carbon fixation. (10pts)

In cyclic photophosphorylation, a single photosystem (PS) is used. Upon light absorbance, electrons are transferred from the PS to the electron transport chain, and at the end of the chain, the electrons go back to re-reduce the PS. In the process, everything is regenerated and protons are pumped, generating a proton gradient for ATP synthesis. NADH for CO₂ fixation has to come from reverse electron flow, using something like sulfide as the electron donor (purple Bacteria), or electrons can be siphoned off before they enter electron transport, and the PS gets re-reduced using sulfide (green sulfur Bacteria).

In oxygenic photosynthesis, electrons for CO₂ fixation are siphoned off before electron transport, as in green non-sulfur Bacteria, but instead of using sulfide to re-reduce the PS, a second PS with a lower oxidation potential is used; this PS (PSII) can strip electrons from water, feeding them to the electron transport chain for re-reduction of PS I and generating O₂ as a by-product.

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21. The rod-shaped α -proteobacterium *Agrobacterium tumefaciens* has two chromosomes: a 2.8Mbp circular chromosome and a 2.1Mbp linear chromosome (with the origin of replication in the center). How do you think these two chromosomes might be arranged physically in the cell? What might the process of chromosome replication and cell division look like in this organism? (8 pts)

Example answer:

These two chromosomes might both have their ori at one end of the cell and their ter's (the ends of the linear chromosome) at the other. Both would be replicated at the same time, and the new ori's would migrate to the other end of the cell. The ter's are now in the middle, and division could occur. Basically, this is the same as normal replication & division, except in this case there are two chromosomes side-by-side.

22. Oh, No! I just remembered! *Agrobacterium tumefaciens* **also** has two plasmids, *At* and *Ti*, that each occur in many copies per cell. How do you suppose these plasmids might be arranged in the cell? (2 pts)

Example answer:

Maybe all the copies of each plasmid are joined together like polytein chromosomes, with their ori's at one end and ter's at the other. These might lay side-by-side along the length of the nucleoid just like the two chromosomes.

E X A M I N F O R M A T I O N

Major phylogenetic groups of microbes we've talked about since the second mid-term exam:

- *Thermotoga* & relatives
- *Chlamydiae* & relatives
- Cyanobacteria 2.5
- Firmicutes
- Planctomycetes
- α -proteobacteria
- Actinobacteria
- Crenarchaea
- Euryarchaea
- Eukaryotes

List of Papers:

- Evidence for lateral gene transfer between Archaea and Bacteria from genome sequence of *Thermotoga maritima*.
- Illuminating the evolutionary history of Chlamydiae. (UWE25)
- Environmental genome shotgun sequencing of the Sargasso sea.
- The *Arthromitis* stage of *Bacillus cereus*: Intestinal symbionts of animals.
- The hidden lifestyles of *Bacillus cereus* and relatives
- Deciphering the evolution and metabolism of an anammox bacterium from a community genome.
- Rapid and sequential movement of individual chromosomal loci to specific subcellular locations.
- Mycelium development in *Streptomyces antibioticus* ATCC 11891 occurs in an orderly pattern which determines multiphase growth curves.
- The genome of *Nanoarchaeum equitans*: insights into early evolution and derived parasitism.
- Transcription by an archaeal RNA polymerase is slowed but not blocked by an archaeal nucleosome.
- Life cycle of the heterotrophic dinoflagellate *Pfiesteria piscicida* (Dinophyceae).
- The controversial protein-only hypothesis of prion propagation.
- TSE agent strains and PrP: reconciling structure and function