ECOL/MCB 320 and 320H Genetics

Instructors

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Dept. of Ecology and Evolutionary Biology
Lecturing on
- Molecular genetics
- Transmission genetics
- Population and evolutionary genetics

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Lecturing on
- Developmental genetics
- Cancer genetics

Teaching Assistants

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Course Procedures and Policies

READ THE COURSE WEB SITE (yes, the WHOLE thing, except for the schedule of lectures, which isn’t finished) before Friday.
http://eebweb.arizona.edu/courses/ecol320/index.html

The Honors course web site deals only with things unique to 320H.

You are responsible for reading and knowing all the of the course procedures and policies, times of exams, policies on missed exams and assignments, grading, etc., etc.

If you have questions, read the web site before asking us.

Read the announcements every week; most will be left on for only one week.

Web site will have grade tracker where you can see your grades. Must have password; write it on the student questionnaire.
Diversity and Uniformity of Life

Take-home lessons:

• Diversity of life is under-appreciated, especially for microorganisms.

• There is both great diversity and great uniformity in genetics.

• Diversity is seen especially in life cycles; uniformity is seen especially in mitosis, meiosis, and molecular genetics.
Diversity and Uniformity of Life

Two points:
1. Diversity of life is under-appreciated.
2. Some aspects of genetics are highly diverse, while others are nearly uniform among all organisms.

1. Diversity of life
Three major groups: Eukarya (cells have nuclei), Bacteria, and Archaea.

- Two different ways of showing same evolutionary relationships.
- Root of the tree = common ancestor of all organisms.
- Each of these three groups contains many species.
Diversity and Uniformity of Life

Diversity of planktonic bacteria in 2.2-litre water sample from an estuary in northeastern Massachusetts. Anonymous PCR and sequencing of SSUrDNA of bacteria. Results gave estimate of 443-1113 species of bacteria.

Note the application of genetics to study the diversity of life and questions of ecology and evolution.

Morphological diversity limited:
Diversity of eukaryotes and their life cycles.

S = Sexual only
A = Asexual only
S/A = Sexual and asexual

Possible locations of root •
Komodo Dragon
**Figure 1.** A tree of eukaryotes. The tree is constructed from various sources, as well as morphological and molecular evidence. Five ‘superkingdoms’ have been identified (i.e. where several ‘kingdoms’ have merged). Other branches are shown dotted when they are preliminary indications of relationships. Relationships within the three ‘kingdoms’ are not resolved. There are few data from these organisms and they are not yet associated with any of these groups.
Beetle Diversity

Homo sapiens?
Diversity of Organisms

Most of the named groups of organisms actually include hundreds, thousands, or millions of different species.

Macroorganisms vs. microorganisms:

• Macroorganisms are some Animals, some Fungi, most Land Plants, a few algae.
• All the rest are microscopic microorganisms.
• There are probably more described species of macroscopic organisms than of microscopic organisms.
• Surveys of molecular diversity suggests that the majority of biological diversity is in the microorganisms.
• There is evidence that many microscopic species haven't been discovered, or are known only from DNA sequences.
• Many microscopic species that have been described haven't been studied at the molecule level and put on the tree.
Organisms Used to Study Genetics

- Most of what we know about genetics is based on a small number of “model organisms”.
- Most of these are macroorganisms.
- All are animals, plants, fungi, or bacteria.
- Genomics (sequencing complete genomes, i.e. all the genes and other DNA in an organism) is done mainly on organisms that are important for human health or food, or are model systems.

Partial list of model organisms:

- *Homo sapiens* us
- *Mus musculus* house mouse
- *Drosophila melanogaster* fruit fly
- *Caenorhabditis elegans* a nematode
- *Zea mays* maize
- *Arabidopsis thaliana* a cruciform plant
- *Saccharomyces cerevisiae* baker’s yeast
- *Schizosaccharomyces pombe* fission yeast
- *Neurospora crassa* bread mold
- *E. coli* an enteric bacterium
- *Bacillus subtilis* a spore-forming bacterium
Uniformity in Genetics

Uniformity in genetics is seen in the following examples:

- Genes = base sequences in DNA molecules
- One chromosome = one DNA molecule with many genes on it
- Genetic code similar in all
- Basic processes of DNA replication, transcription, translation
- Some genes are found in all organisms
- All eukaryotes have mitosis and mechanism is nearly identical
- Meiosis is nearly identical in all eukaryotes that have it
- All organisms have recombination due to crossing-over and gene conversion, although the mechanisms may differ in eukaryotes and prokaryotes
Diversity in Genetics

• Diversity in genetics is seen in the following examples:

• Diversity in sequences of genes. The diversity shown in the trees is diversity of gene sequences. All of this diversity can be seen in a single large gene, e.g. SSU rDNA.

• Genome size varies ca. $10^6 – 10^{11}$ bp

• Number of genes varies ca. 500 – 30,000

• Number of chromosomes varies 1– several hundred

• Arrangement of genes on chromosomes

• Number and kind of transposable elements and introns

• Weird variations: e.g. RNA editing, the ciliate macronucleus, imprinting
Diversity in Genetics

Diversity in genetics is also seen in life cycles:

Bacteria and Archaea
• no mitosis, but when cell divides, partitions chromosome 1 copy to each daughter
• no meiosis or fertilization, but has several other ways of exchanging genes (sex)
Diversity in Genetics

Diversity in eukaryotic life cycles:

- asexual reproduction by mitosis
- sexual reproduction by meiosis and fertilization
- diverse life cycles with different combinations of these

- most common life cycle includes haploid and diploid cells, both of which reproduce asexually by mitosis, with occasional sexual reproduction by fusion of haploids to start diploid phase, followed by meiosis to produce haploids

- some eukaryotes reproduce only sexually (but how do our cells reproduce?)

- some eukaryotes reproduce only asexually; some in every major group except mammals and birds

- sexual reproduction varies from extreme inbreeding (mating with close relatives, even with one's self) to outcrossing
Eukaryotic Life Cycles

Asexual life cycle = mitosis
Sexual life cycle = meiosis + syngamy

EUKARYOTIC LIFE CYCLES

General, most common? e.g. Saccharomyces
Predominantly haploid, e.g. Chlamydomonas

Predominantly diploid, e.g. animals
Asexual, common? e.g. some fungi (N, 2N)
Diversity and Uniformity of Life

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