Lecture 1: CS 548 Introduction
In this lecture...

• Logistics of the course
• Introduction to basic biology... which will continue in the following lecture
Logistics of the Course
Logistics About the Course

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Logistics About the Course

• Course website: www.cs.colostate.edu/~cs548
  – Contains schedule, slides, papers
  – Try to check frequently to keep informed about all happenings concerning CS 548
Goals of the Course

• Working at the interface of computer science and biology:
  – New motivation
  – New data and new demands
  – Real impact

• Introduction to main issues in computational biology

• Opportunity to interact with algorithms, tools, data in current practice
Grading

1. Paper Summaries and Class Participation: 10%
2. Presentation(s): 30%
3. Project Proposal: 10%
4. Related Work: 10%
5. Final Project: 40%

• The grading breakdown is found on the website
Class Participation

• Paper discussions and summaries and group quizzes
• There will be a number of group quizzes.
  – The focus of the quizzes will be testing basic biological understanding
  – Your group will be specified and stay with you for the remainder of the semester
Paper Summaries

• Paper summaries will be due for the papers indicated on the website.

• A paper summary is one page and addresses the following points about the paper:
  1. What is the paper out about?
  2. What is one or more limitation(s) or criticism(s) of the work?
  3. What is one or more extension(s) to this work?
Paper Presentations

• Each student or course participant will give one or two paper presentations.

• A list of the papers will be given out in this lecture and you can sign up or suggest a related paper that you would like to present. All presented papers have to be approved.

• The length of the presentation and discussion period will be TBD.
Paper Presentations

• I don’t want just a conference presentation on the paper.

• Require some critical thinking about the material and problem that is in the paper.

• Address the following questions:
  1. What is the paper about?
  2. What are the weaknesses of the paper?
  3. What is an extension or follow-up study that could be done?
Class Project

• This is the most important aspect about the course and should involve either
  – Non-trivial use or analysis of bioinformatic tools.
  – Software development and application.

• Project will be done individually.

• The project will be developed and discussed throughout the course; with me and your colleagues in the course.
• **Final report and presentation:** will be discussed more later on in the semester.

• **Peer reviewing.** You will review everyone else’s presentation and 2 papers. It will be anonymous. Each reviewer must give 5 points that the individual needs to improve on.

**Specific points.** Example:

– “I didn’t get the problem” → Not acceptable

– “On page 10, the author failed to define X, Y and Z, which was then used in Definition 3.” → acceptable.
Biology Basics
Objectives for this Lecture

• Be able to list the six kingdoms of life
• Be able to name the five basic properties shared by all living things
• Be able to describe the properties of a cell.
• Understand the difference between prokaryotes and eukaryotic cells.
• Be able to give some examples of prokaryote organisms and eukaryotic organisms
Two Types of Cells: Prokaryotes & Eukaryotes
Prokaryotes vs. Eukaryotes

• Prokaryotes
  – No nucleus
  – Their genomes are circular
  – Prokaryotes **do not** have a nucleus, mitochondria, or any other membrane-bound organelles
  – The genome in a prokaryote is held within a DNA/protein complex in the cytosol called the nucleoid.

• Eukaryotes
  – have nucleus (animal, plants, fungi)
  – Linear genomes with multiple chromosomes in pairs
Chromosome for E. coli (Prokaryote)

Chromosomes for Human (Eukaryote)
Eukaryote (Animal) Cell
**Prokaryotes vs. Eukaryotes**

<table>
<thead>
<tr>
<th>Prokaryotes</th>
<th>Eukaryotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single cell</td>
<td>Single or multi cell</td>
</tr>
<tr>
<td>No nucleus</td>
<td>Nucleus</td>
</tr>
<tr>
<td>No organelles</td>
<td>Organelles</td>
</tr>
<tr>
<td>One piece of circular DNA</td>
<td>Chromosomes</td>
</tr>
<tr>
<td>No mRNA post transcriptional modification</td>
<td>Exons/Introns splicing</td>
</tr>
</tbody>
</table>
Polyploid

**Polyploid cells** and organisms are those containing more than two paired (homologous) sets of chromosomes. Most eukaryptic species are **diploid**, meaning they have two sets of chromosomes (one from each parent)
Types of Polypolids

- **triploid** (three sets; 3x), for example watermelons, bananas, apples, citrus
- **tetraploid** (four sets; 4x), for example salmon fish, potato, cotton
- **pentaploid** (five sets; 5x), for example Kenai Birch (plant)
- **hexaploid** (six sets; 6x), for example wheat, kiwifruit
- **octaploid** (eight sets; 8x), for example special types of fish (Acipenser), dahlias,
- **decaploid** (ten sets; 10x), for example strawberries
- **dodecaploid** (twelve sets; 12x), for example special types of the plants and amphibians
What does Karyotype mean?
What does **Karyotype** mean?

**Karyotype** refers to the number and appearance of chromosomes in the nucleus of a eukaryotic cell.
The Six Kingdoms

• How are organisms placed into their kingdoms?
The Six Kingdoms

• How are organisms placed into their kingdoms?
  – Cell type, simple or complex
  – Their ability to make food
  – Their ability to reproduce
  – The number of cells in their body.
Plants

• The organisms that you’re probably familiar with already.
• Plants are all multi-cellular and consist of complex cells.
• Plants are *autotrophs*, meaning they are organisms that make their own food.
Animals

• Also, organisms that you’re probably familiar with already.
• Also, are all multi-cellular and consist of complex cells.
• Plants are *heterotrophs*, meaning they are organisms that feed on other organisms.
Eubacteria

• Translates to “true bacteria”, which includes all bacteria except for archaebacteria. Hence, almost all bacteria are Eubacteria.

• Most eubacteria organisms are single-celled, and all are characterized by the lack of a membrane-enclosed nucleus. Prokaryote cells.

• Archaea and bacteria are quite similar and distinguishing between the two of them can be confusing and there frequently are contradictory definitions and reasoning.
Archae

• Consist of single-cell microorganisms, which have no cell nucleus or any other membrane-bound organelles within their cells. **Prokaryote cells.**

• Previously, they were grouped with bacteria and named “archaebacteria” but this is considered outdated.

• Initially, archaebacteria were viewed as **extremophiles** that lived in harsh environments (i.e. hot springs, salt lakes) but we now know that is not true. They are found in a broad range of habitats, including soils, oceans, marshlands and the human colon and navel (i.e. HMP project).
Differences Archaea and Eubacteria

1. The base "thymine" is not present in tRNA of archaea.
2. The first amino acid is methionine in archaea.
3. Sensitivity to many antibiotics, such as kanamycin, chloramphenicol, rifampicin, and anisomycin are different when comparing the two cell types. Also, archaea are sensitive to the diptheria toxin (bacteria are not).
4. Promoter structures are different.
5. Structure of their ATPases are different.
6. Methanogenesis is unique to archaea.
7. Some archaea are photosynthetic, and it is strictly non-chlorophyll based. Photosynthesis in bacteria (and eukaryotes) is strictly chlorophyll based.
Differences Archaea and Eubacteria

1. The base "thymine" is not present in tRNA of archaea.
2. The first amino acid is methionine in archaea.
3. **In structure, Archaea are like prokaryotes, but the genetic transcription and translation underlying their creation is similar to that of the more complex eukaryotes.**
4. 
5. 
6. 
7. Some archaea are photosynthetic, and it is strictly non-chlorophyll based. Photosynthesis in bacteria (and eukaryotes) is strictly chlorophyll based.
Fungi

• Most fungi are multi-cell and consist of many complex cells. Eukaryote cells.
• Fungi are organisms that biologists once confused with plants, however, unlike plants, fungi cannot make their own food. Most obtain their food from parts of plants that are decaying in the soil.
• Examples: Mushrooms, mold, mildew
Protists

- Multi-cell and single-cell organisms. Very large and diverse kingdom.
- Sometimes they are called the “odds and ends” kingdom because its members are so different from one another.
- Protists include all microscopic organisms that are not bacteria, not animals, not plants and not fungi.
- Why those protists are not classified in the Archaebacteria or Eubacteria kingdoms? Because they are Eukaryotic, i.e. they have an enclosed nucleus and membrane bound organelles.
- For example: algae
PLANTAE
(Multicellular, eukaryotic)

ANIMALIA
(Multicellular, eukaryotic)

FUNGI
(Multicellular, eukaryotic)

PROTISTA
(Eukaryotic, unicellular and multicellular)

EUBACTERIA
(Unicellular, prokaryotic)

ARCHAEBACTERIA
(Unicellular, prokaryotic)
5 Characteristics of all Living Things
5 Characteristics of all Living Things

1. Are made of cells.
2. Obtain and use energy.
3. Grow and develop.
4. Reproduce.
5. Adapt. Respond to their environment.
1. Made of Cells

- Organisms are made up of one or more cells.
- A cell is the basic unit of structure and function in living things.
- Cells = the “building blocks of life”.

2. Use and Need Energy

- All organisms need and use energy to live.
- Energy is the ability to do work.
- Sunlight is the source of energy for most living things.
  - Plants use the energy in sunlight to make food, and animals get energy by eating plants or other animals that have eaten plants.
3. Grow and Develop

• All organisms grow and develop.
• Living things change, or develop, during their lifetimes. One way organisms change is by growing.
4. Reproduce

- Organisms produce more organisms of their own kind.
- Reproduction allows organisms to continue living on the earth.
5. Adapt to Their Surroundings

- Organisms are adapted, or suited, to their surroundings.
- This frequently ties into the idea of evolutionary selection.
  - Species obtain adaptations through evolution over great periods of time.
- All organisms have features that help them survive in their surroundings.

“It’s not you— it’s natural selection.”