Lecture 1: CS 548 Introduction

Spring 2020

January 21, 2020

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

- Instructor: **Hamidreza Chistaz**

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  (office) CSB 342

  Office hours: Tuesday and Thursday 11 to noon

Logistics About the Course

- Course website: www.cs.colostate.edu/~cs548
  - Contains schedule, slides, added notes, assignments
  - 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

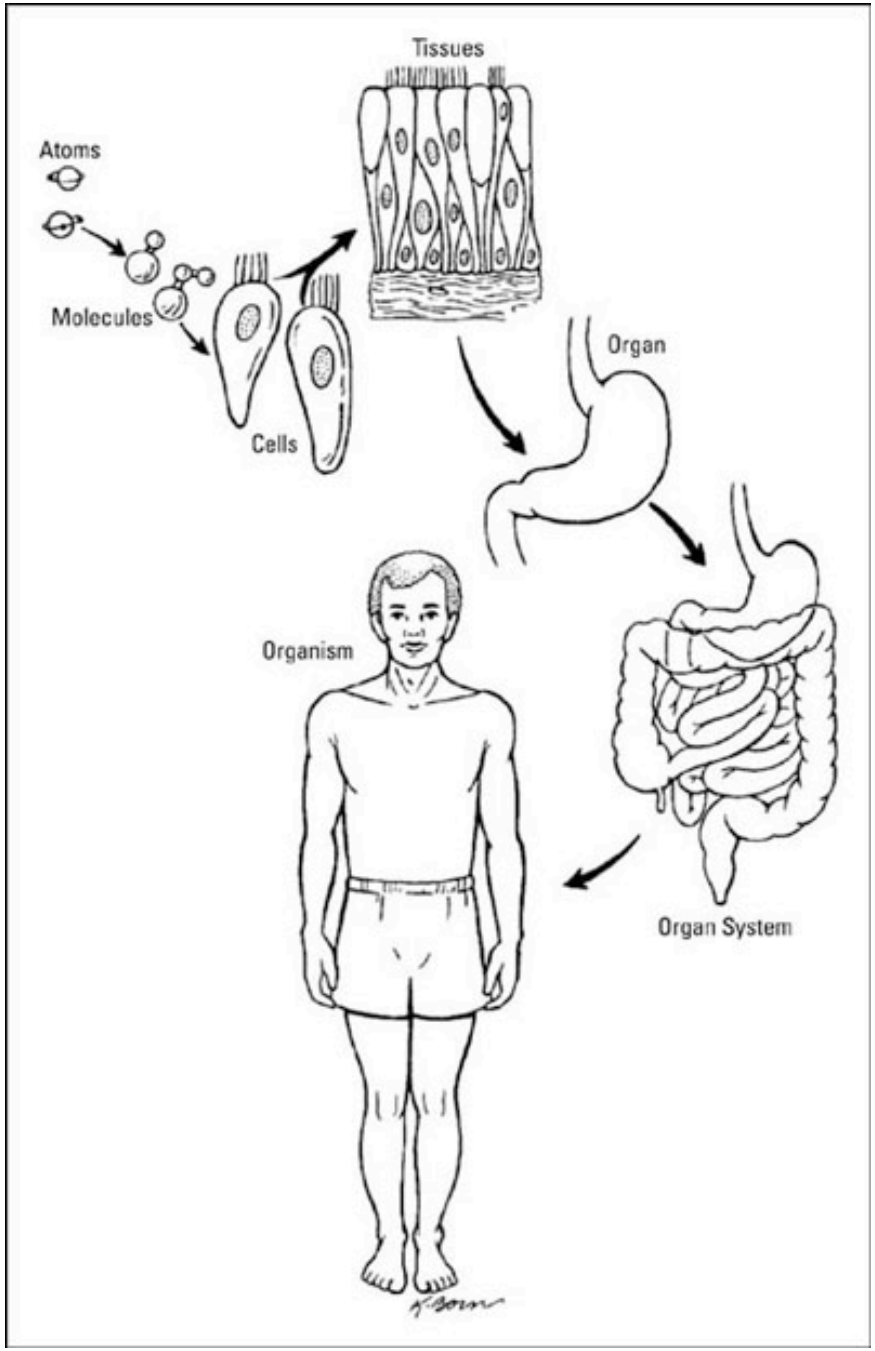
Syllabus

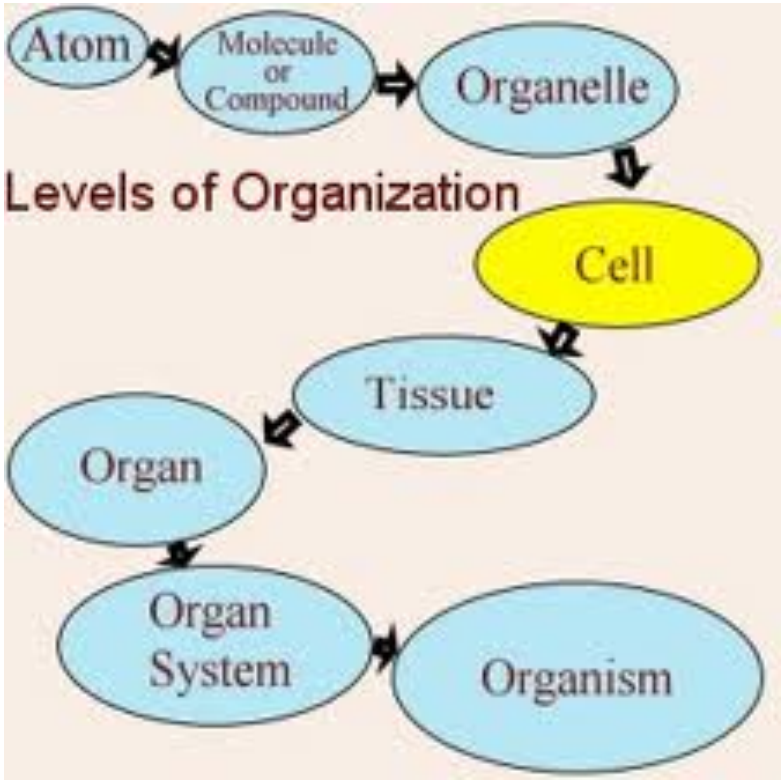
- Assignments (25%)
- Midterm exam (25%)
- Quizzes (10%)
- Project (40%)
  - Team work, two teams
  - Two topics: (i) Cancer and (ii) RNA-RNA and RNA structure
  - Multiple presentations in class (e.g. literature review, problem definition, results, discussion, etc.)
  - Final paper, must be at the level of a scientific paper

Biology Basics

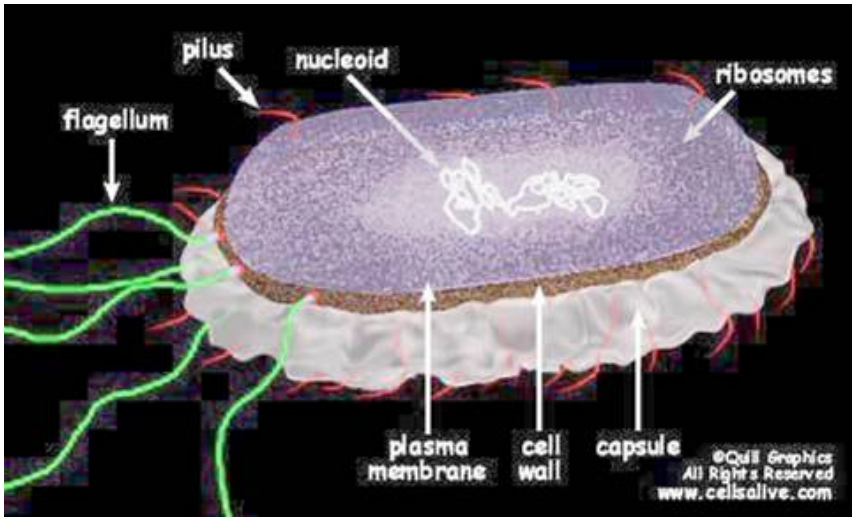
Objectives for this Lecture

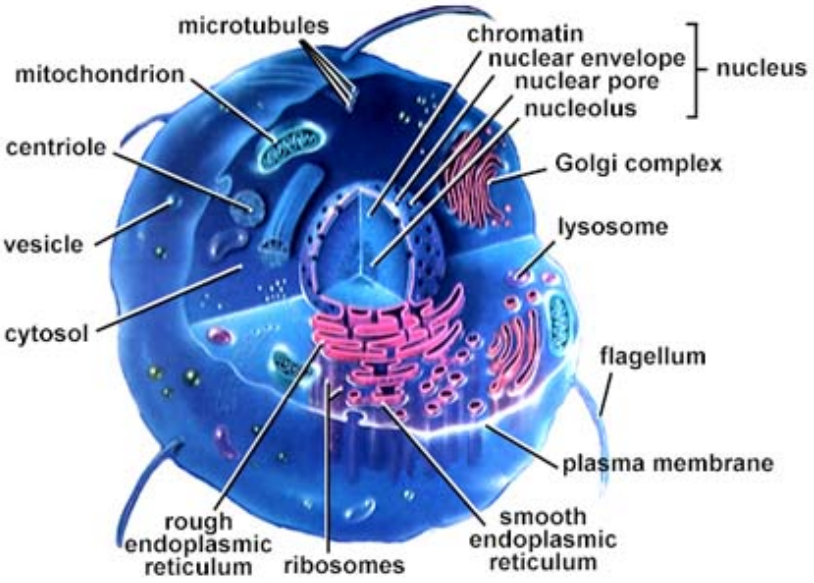
- Be able to list the six kingdoms of life
- Be able to name the five basic properties shared by all living things
- Be able to describe the properties of a cell.
- Understand the difference between prokaryotes and eukaryotic cells.
- Be able to give some examples of prokaryote organisms and eukaryotic organisms


Tissues
Atoms
Molecules
Cells
Organ
Organism
Organ System

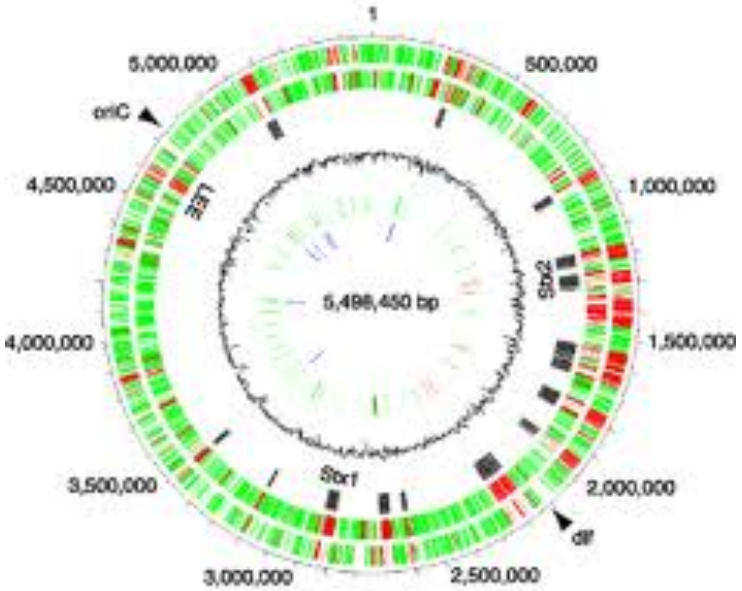

Atom
Molecule or Compound
Organelle
Levels of Organization
Cell
Tissue
Organ
Organ System
Organism

Two Types of Cells: Prokaryotes & Eukaryotes

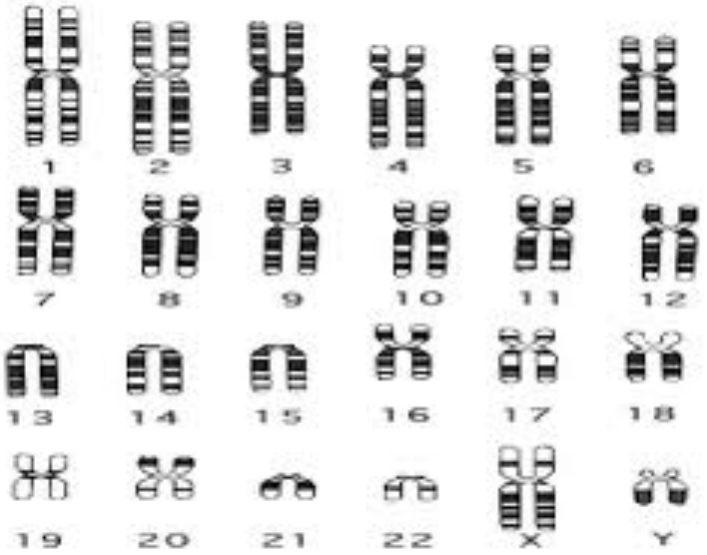




Chromosome for *E. coli* (Prokaryote)



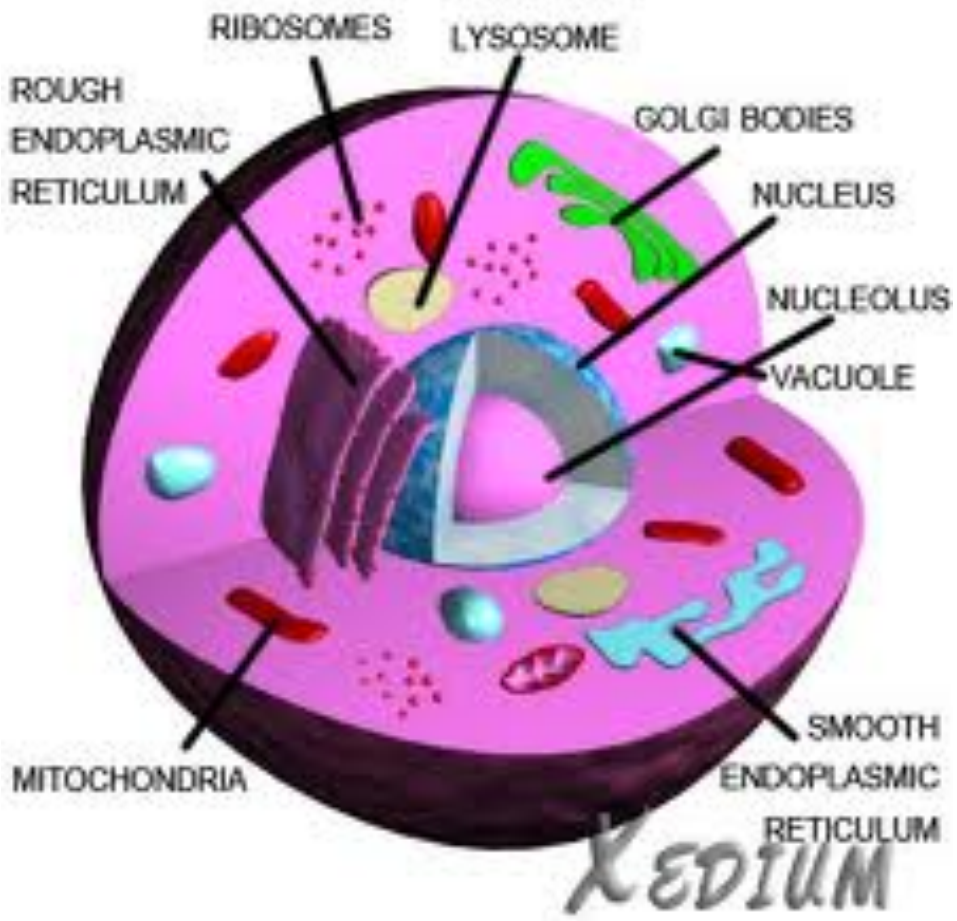
Chromosomes for Human (Eukaryote)



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

Eukaryote (Animal) Cell



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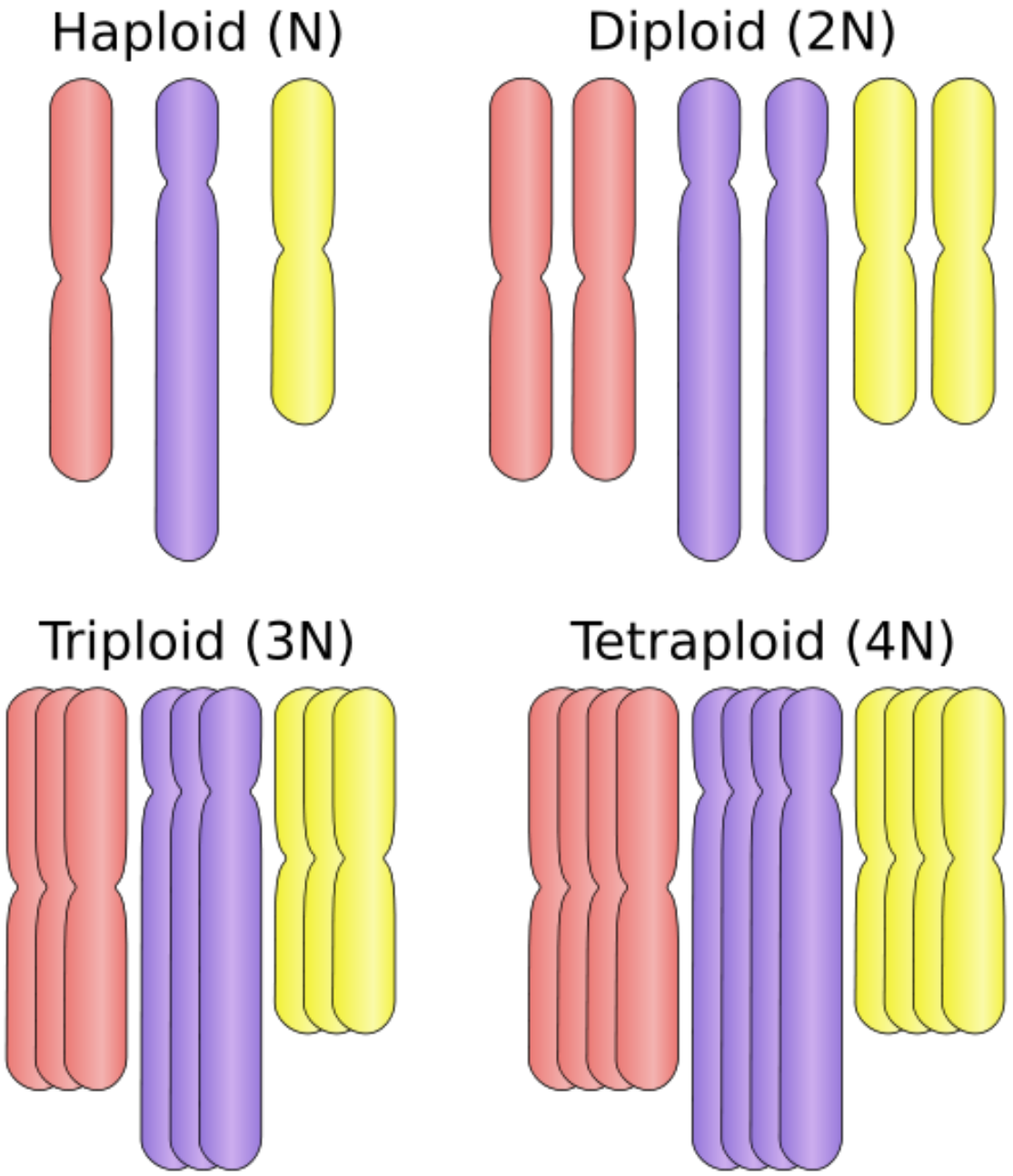
Prokaryotes vs. Eukaryotes

Prokaryotes	**Eukaryotes**
Single cell	Single or multi cell
No nucleus	Nucleus
No organelles	Organelles
One piece of circular DNA	Chromosomes
No mRNA post transcriptional modification	Exons/Introns splicing

Ploidy

Most eukaryotic species are **diploid**, meaning they have two sets of chromosomes (one from each parent). In some special conditions, such as in *gametes*, eukaryotic cells are **haploid**, meaning they have one set of unpaired chromosomes. **Polyploid cells** and organisms are those containing more than two paired (homologous) sets of chromosomes.


Haploid (N)
Diploid (2N)
Triploid (3N)
Tetraploid (4N)

Some Polyploidy Types

- **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 plants and amphibians

What does **Karyotype** mean**?**

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Karyotype refers to the number and appearance of chromosomes in the nucleus of a eukaryotic cell.

The Six Kingdoms

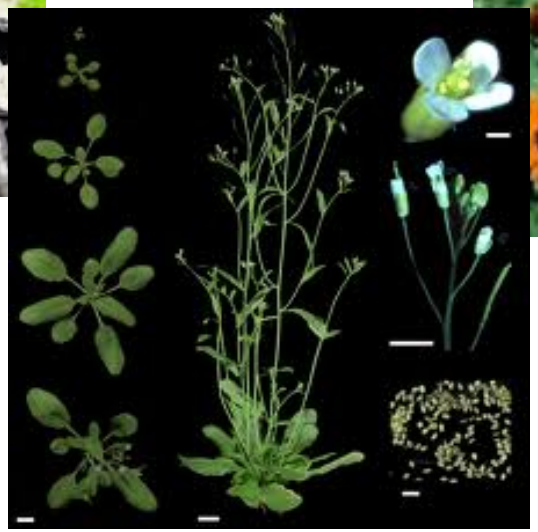
- How are organisms placed into their kingdoms?

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 are 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.

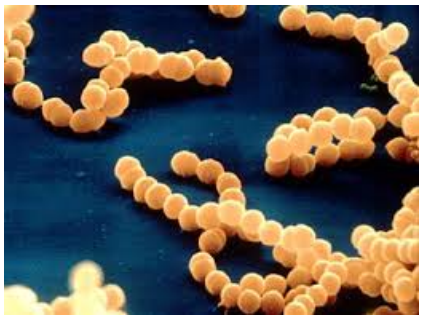


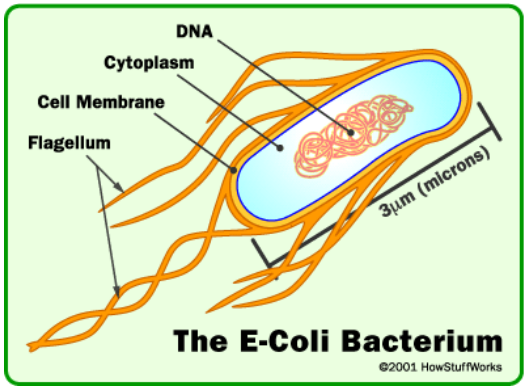
Animals

- *Also*, organisms that you're probably familiar with already.
- Also, are all multi-cellular and consist of complex cells.
- Animals are *hetrotrophs*, 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, archaea 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. Their power reactions are different, i.e. 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.

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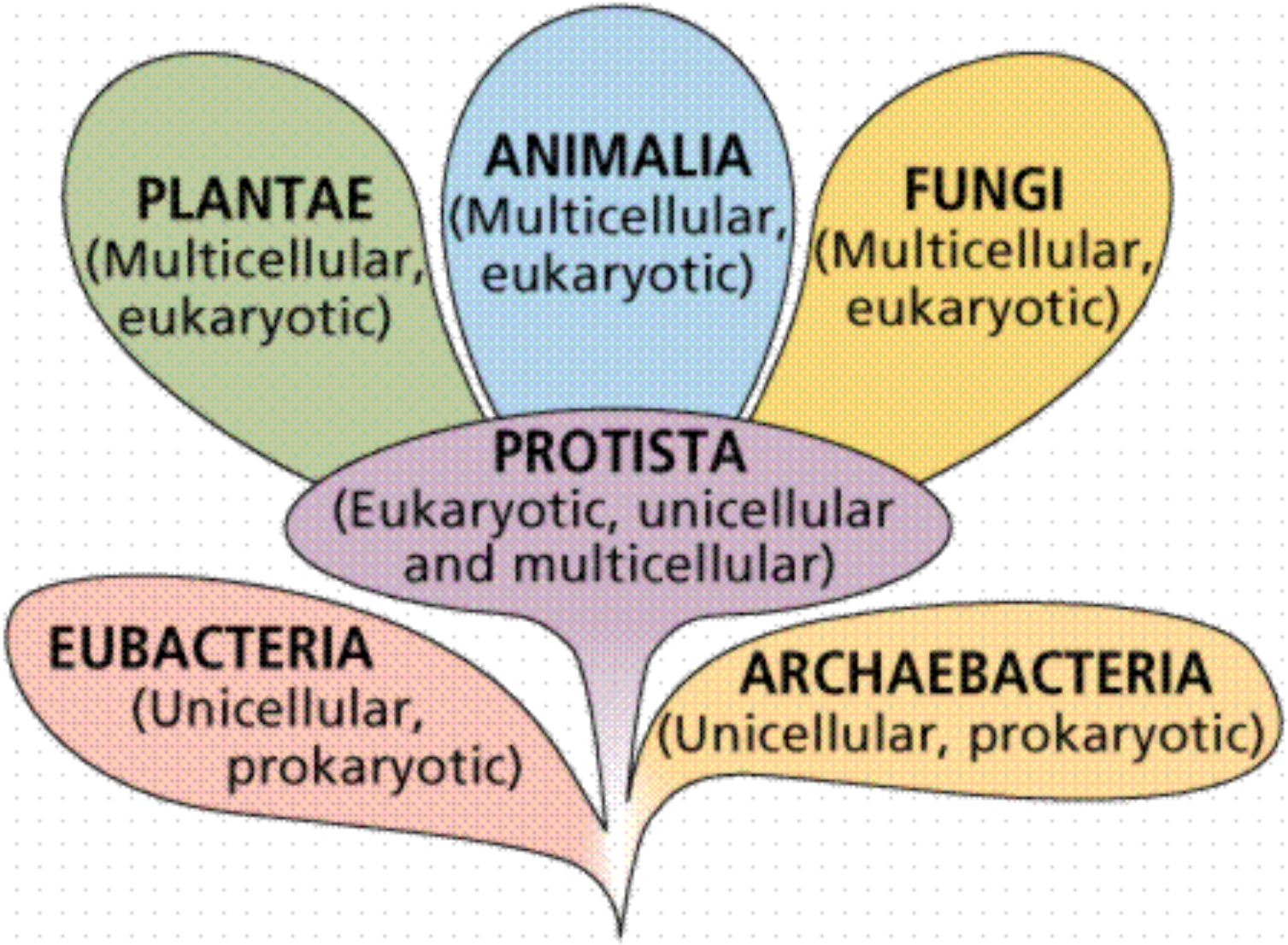
In structure, Archaea are like prokaryotes, but the genetic transcription and translation underlying their creation is similar to that of the more complex eukaryotes.

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

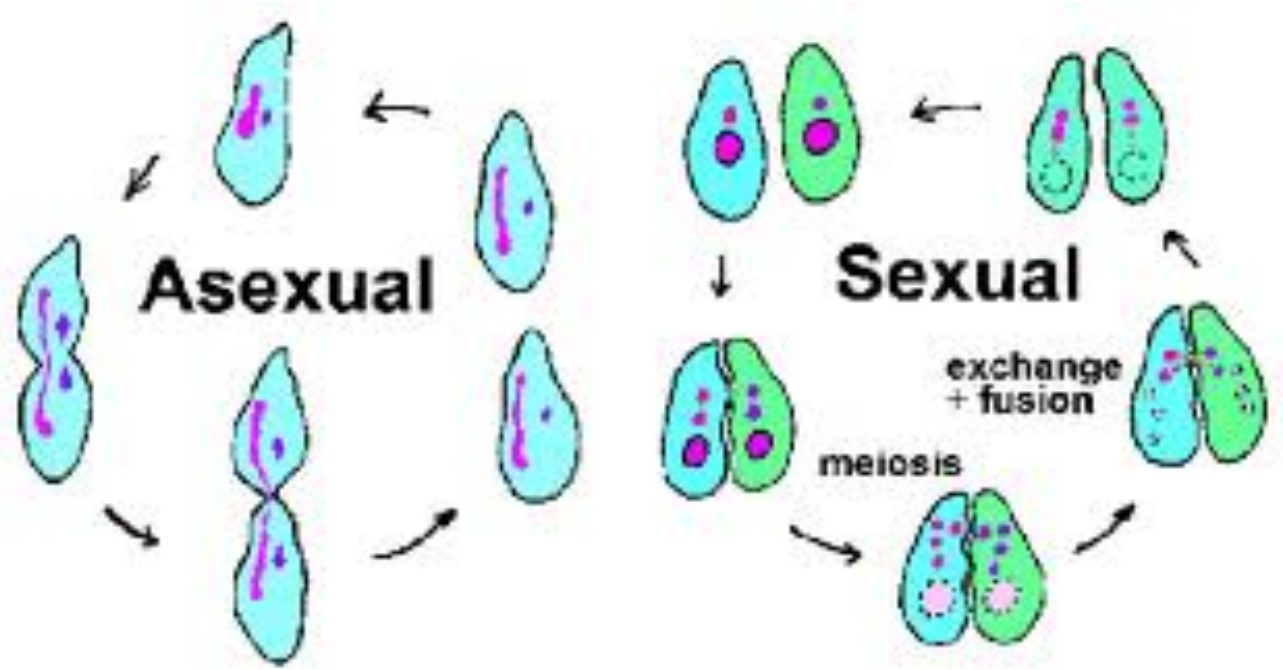
- All organisms need and use energy to live.
- Energy is the ability to do work.
- Sunlight is the source of energy for most living things.
  - Plants use the energy in sunlight to make food, and animals get energy by eating plants or other animals that have eaten plants.

3. Grow and Develop

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

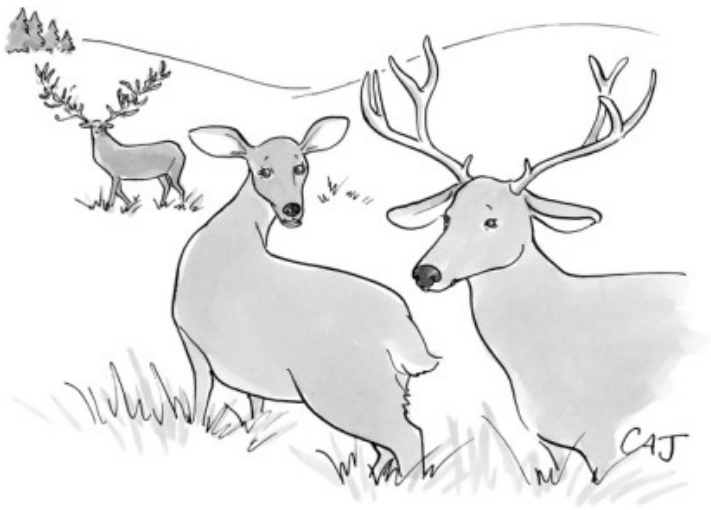
4. Reproduce

- 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."