Announcements

• Problem Set 5 KEY posted on website.
• Problem Set 6 posted next week.
• Graded essays available next week for pickup.
• Next three lectures based on material not in the book. Come to class!
• Stay tuned for special announcement at end of class.

Chapter 13: Evolution and Diversity
Among the Microbes

Bacteria, archaea, protists, and viruses: the unseen world

Microbes are the simplest but most successful organisms on earth.
Out of Siberian Ice, a Virus Revived

Pithovirus, isolated (and grown!!!) from 30,000 year old Siberian permafrost. Infects Amoeba and is HUGE. 1.5 microns in length.

Microbes Are Genetically Diverse

- >500,000 kinds
- Millions more expected to be distinguished!

Microbes Can Live Almost Anywhere and Eat Almost Anything

- Escherichia coli (inset), a bacterium, lives in the human intestine.
- Thermus aquaticus (inset), a bacterium, lives in geothermal pools that can reach temperatures greater than 160°F.
- Halobacteria (inset) are archaeons that live in extremely salty environments, such as the Great Salt Lake.

Microbes live in nearly every kind of environment, including water at temperatures of up to 750°F and as low as 5°F.

Fossilized bacteria that are 3.4 BY old! Found in Australia, must have been based on Sulfur due to their age. Similar critters on Mars.....?
Microbes are abundant!

Not all microbes are evolutionarily related.

Bacteria may be the most diverse of all organisms.
Bacterial growth and reproduction is fast and efficient.
Metabolic diversity among the bacteria is extreme.

**METHODS OF GENETIC EXCHANGE IN BACTERIA WITHIN THE SAME GENERATION**

**CONJUGATION**
A bacterium transfers a copy of some or all of its DNA (from the main chromosome or a plasmid) to another bacterium, giving the second bacterium genetic information it did not have before.

**TRANSFORMATION**
After a bacterial cell bursts open, short lengths of DNA can be taken up by a living bacterial cell and inserted into its own chromosome, potentially adding genes that it did not have before.

**TRANSUDCTION**
A virus containing pieces of bacterial DNA that it inadvertently picked up from its previous host infects a bacterial cell, and passes along new bacterial genes to the bacterium.
Some bacteria eat organic molecules, some eat minerals, and still other bacteria carry out photosynthesis.

About 2.6 billion years ago, the photosynthesizing bacteria were responsible for the first appearance of free oxygen in the Earth's atmosphere.

In humans, bacteria can have harmful or beneficial health effects.

Many bacteria are beneficial.

Bacteria cause many human diseases.
Bacteria’s resistance to drugs can evolve quickly.
Where do antibiotics come from, and why do they so quickly lose their effectiveness?

*Chemicals that kill!*

Bacteria and other microbes resist antibiotics in a variety of ways:

- Pumping antibiotics out of their cell
- Proteins that bind to the antibiotic molecule and block its lethal effect
- Enzymes that break down the antibiotic molecules that are then used as fuel to help the bacteria grow faster

Viruses are not exactly living organisms.

Viruses are at the border between living and non-living.

![BASIC STRUCTURE OF A VIRUS](image)
Viral Infection and Replication

http://www.youtube.com/watch?v=nh1FvzFnQ&feature=related

Viruses are responsible for many health problems.

Why do flu viruses change quickly?

DNA vs. RNA viruses
Viruses infect a wide range of organisms.

The influenza pandemic of 1918–1919 killed millions.

In 2002–2003, the virus that causes severe acute respiratory syndrome (SARS) infected several thousand people around the world.

INFLUENZA A STRUCTURE

SURFACE GLYCOPROTEINS

- Bind to receptors on the surface of the host cell and allow the virus to enter
- Allow the virus to break free from the host cell

Surface glycoproteins are the “keys” that allow a virus into and out of a host cell.
What role does a pig play in the transmission of virus from a bird to a human?

Bird Flu
- So far requires close contact with infected flocks of birds or by eating birds that had died of the virus.
- WHO and national health agencies are preparing for a worldwide pandemic.

Mixing RNA
- Pig + bird flu virus + human virus = might produce a new form of the virus that carries the genes that make the bird flu lethal to humans AND the gene that codes for the host-entry glycoprotein.
Vaccines

Vaccination ‘Debate’

- Our generation has not seen the diseases that used to arise frequently, like measles, mumps, whooping cough, and smallpox.
- Many parents thus feel little pressure to vaccinate.
- Study published in the Lancet claimed a causal connection between vaccines and autism.
- Paper now retracted. Lead scientist guilty of fraud, due to conflict of interest. Paid by company developing alternate vaccines. Can no longer practice medicine.
- There is currently no data indicating a causal link between immunization and any serious health risk.

Measles

Between the years 1987 and 2000, the case fatality rate across the United States was three measles-attributable deaths per 1000 cases, or 0.3%. In underdeveloped nations with high rates of malnutrition and poor healthcare, fatality rates have been as high as 28%. In immunocompromised patients (e.g. people with AIDS) the fatality rate is approximately 30%.

Measles Vaccine

Measles cases in the United States, 1944-2007

- Vaccine licensed
- Second dose recommended
**Measles Vaccine**

Common adverse reactions after vaccination (< 5% of vaccinated patients).

- Fever or rash between 7 and 12 days following the vaccination.
- Pain at the site of injection.

These side effects are generally mild and are dealt with symptomatically.

**Serious but rare adverse reactions after vaccination**

- Encephalitis (1 in 2 million)
- Febrile seizures (1 in 3,000)
- Thrombocytopenia (1 in 30,000)
- Anaphylaxis (1 in 1 million).

The risks of serious complications following measles infection are significantly greater than vaccine-related serious adverse reactions.

**Recent Measles Outbreak in San Diego**

http://www.thisamericanlife.org/radio-archives/episode/370/ruining-it-for-the-rest-of-us

**Good perspectives on the issues:**

Frontline: The Vaccine War

Vaccinations have prevented at least 103 million cases of contagious disease since 1924:

http://www.theverge.com/2013/11/30/5160490/vaccines-prevent-at-least-103-million-cases-disease-since-1924
**Penn and Teller on Vaccines:**

http://www.youtube.com/watch?v=RfdZTZQvuCo

**Pathogen Humor**

http://www.youtube.com/watch?v=e7DkeQ0roAM