Viruses and Bacteria Notes
AP Biology Mrs. Laux

I. Viruses
1. parasites-live off cells
2. nucleic acid-DNA or RNA is enclosed in a protein coat (capsid)
a. ss DNA, ds DNA
ss RNA, ds RNA (retroviruses)
b. may have 4→several hundred genes

A. Types of capsids: (shapes)
1. rod (helical shape) drawing below:

ex: tobacco mosaic virus
2. polyhedral capsid drawing below

ex: Adenovirus (upper respiratory infection)
3. capsid with outer envelope drawing below

ex: influenza
4. Complex-bacteriophages, T-even (T2, T4) drawing below

-most complex

B. Facts
1. obligate parasites
→can only reproduce within a host cell
2. viruses are species-specific
→viruses can only infect certain species, sometimes others that are closely related
a. ex: T4→*E.coli*
b. some viruses are even specific to certain cell types of one species
ex: cold virus→specific to cells of upper respiratory tract
ex: AIDS virus→ only to T_H (WBCs) cells

C. Reproductive Life Cycles
-most discovery comes from bacteriophage study
-phage→DNA
-lambda phage of *E.coli*→2 distinct mechanisms of reproduction
-lytic cycle
-lysogenic cycle
1. Lytic cycle→kills the cell
→considered virulent (lethal)
a. Attachment
i. virus attaches to cell receptors

b. Penetration
i. Phage injects DNA into cytoplasm
ii. DNA stored in head:
a. pierce E.coli cell wall and membrane
b. inject viral DNA thru tail
iii. capsid is left outside
c. Hydrolytic enzymes destroy host DNA
i. made using host material
d. Replication and Assembly
i. virus uses host material to synthesize new viral parts-proteins and DNA
ii. spontaneously assemble
e. Release
i. cell lyses and releases phages
ii. lysozymes specified by viral genome digest bacterial cell wall
iii. releases 100s of phages
iv. released phages infect nearby cells
v. 20-30 minutes at 37 degrees C (body temp.)

Bacterial Defenses
1. change receptor sites used by phages for cell recognition
2. restriction enzymes→recognize and cut up foreign DNA
→methylation of bacterial DNA protects bacterial DNA
3. problems→bacteria evolves→virus evolves
→coevolution
→bacteria and phages are constantly coevolving

D. Lysogenic cycle
→some viruses have 2 options to cycle-lytic-kills cell; lysogenic-coexists with cell (usually will undergo lytic later at some point)
→these viruses (both) are called temperate viruses
cycle: (lambda phage of *E.coli*)
1. phage binds to surface of E.coli
2. injects DNA into bacterial host cell
3. either can begin lytic or lysogenic cycle
4. phage inserts via genetic recombination into a specific site on the bacterial chromosome
a. becomes a prophage
b. most are inactive (dormant site)
c. some may alter bacterial cells
-ex: virus that causes Diphtheria; encodes for toxin-is made and produces symptoms
d. when inactivated→prophage encodes for repressor protein
→switches off other prophage genes
e. as bacterial cell reproduces, DNA reproduces; prophage genes also reproduce
→genes copied

→both bacterial DNA and prophage are passed down to daughter cells

f. at any time, environment influences can cause phage to leave chromosome
→will begin lytic cycle
→new viruses may enter lytic or lysogenic cycle

Animal Viruses
1. very diverse modes of infection and mechanisms of replication
2. nucleic acids→DNA or RNA
-ex:
a. Herpes virus
i. temperate virus
ii. lysogenic→becomes a provirus
iii. lays dormant in genome until environmental influences (physical, emotional stress) cause an outbreak
b. shingles and Epstein Barr
c. HIV virus (Human Immunodeficiency Virus)
i. RNA virus (class IV)
-single stranded
-retrovirus
-infects T_H cells of WBCs
→because can use enzyme, reverse transcriptase, to transcribe DNA from RNA (of virus)
→copy made→provirus
a. transcribe mRNA immediately (lytic)
b. remain incorporated→lysogenic

Mode of Infection: (Retrovirus)
Attaches to and enters cells→
RNA injected into cytoplasm→
Reverse transcription→
Viral DNA enters nucleus→
Inserts into chromosomal DNA and becomes provirus→
During life of provirus-not completely dormant-still synthesizes viral HIV and each virus "buds" out of cell by leaving via exocytosis→
Environmental influences→
Enters lytic phase→
Viral RNA→new viruses and protein synthesis→expression of oncogenes

Tumor viruses
1. viruses that activate oncogenes that cause cells to become cancerous
2. oncogenes→code for cellular growth factors or proteins involved in functioning of growth factors
-virus "switches on" oncogenes

Viruses linked to human cancers:

Viral group	Diseases	Cancer
Retroviruses	Adult leukemia, HIV	Leukemia, Karposi's sarcoma
Herpes viruses	Epstein Barr, infectious mononucleosis	Burkitt's lymphoma
Papovirus	Papilloma, human warts	Cervical cancer
Hepatitis B virus	Chronic hepatitis	Liver cancer

Effects of Animal Viruses:
(Disease Symptoms)

1. Damage or kill cells
2. Become toxic or cause infected cells to produce toxins
3. causes varying degrees of cell damage depending on regenerative ability of cell
   - -ex: cold→upper respiratory tract cells undergo cell division and replace (regenerate) lysed cells
   - -ex: poliovirus→ attacks nerve cells
     - →cannot be regenerated
4. can be indirectly responsible for disease symptoms
   - →fevers, aches, inflammation result from activities of immune system

Viroids

- -tiny, naked molecules of RNA~250-400 nucleotides
- -plant pathogens, some may infect animals
- -important because until discovery-it was thought that the protein coat was necessary, in some way, for viral replication
- -believe that viroids affect gene regulation

Prions→

- -proteins that cause infectious diseases
- -degenerative diseases of the nervous system
- -cannot replicate itself, but still highly infectious
  - →defective versions of normal cellular proteins
- -infect cells→catalyze conversion of normal proteins to prion version
- -chain reaction→degenerates cell
- -causes: Mad cow disease in cows
  - scrapie in sheep
  - humans→degenerative disease of nervous system
    - -100% mortality rate
    - -book "Deadly Feasts"
      - →Richard Rhodes (New Guinea)
  - animal virus:
    - -Ebola

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II. Bacteria
A. Common shapes:
1. Cocci-round
a. monococcus
b. diplococcus
c. streptococcus
d. staphylococcus
2. Bacilli-rod shaped
-ex: *E.coli, Salmonella*
3. Spirilla-helical
B. Cell walls-
→peptidoglycans
-different compositions-Christian Gram
1. Gram-positive
a. absorb and retain crystal violet stain-purple
b. structure

2. Gram-negative
a. do not absorb crystal violet
→pink
b. structure

3. important to distinguish between 2 types
-ex: penicillin→gram-positive
C. Motility
1. move via flagella
2. not microtubules
3. structure
a. basal body→anchors in membrane
b. hook→basal body with filament
c. filament→rotary motion generated by ATP in tail
D. Other modes of reproduction
1. Budding→new individual develops as bud from parent
2. Fragmentation→walls develop within the cell, separating one cell into many
3. No sexual reproduction→but genetic material can be exchanged between organisms via cytoplasmic bridges
-called conjugation
-only between different mating types (+) and (-)
E. Plasmids
→episomes
1. can exist/replicate independently or can become integrated into bacterial chromosome
2. viruses can also become integrated

→provirus, prophage
3. differences:
a. no extracellular stage in plasmids
b. plasmids→usually beneficial
-viruses→not beneficial, parasites

F Plasmids
1. F→fertility
2. ~25 genes→most involved in production of sex pili
3. F^+→bacteria that contain F plasmid male
-F^-→bacteria without F plasmid
4. F plasmid replicates in synchrony with chromosomal DNA; therefore, F^+ is inheritable
-1 F^+ cell→2 F^+ daughter cells
5. F^- bacteria can become F^+ if F factor (plasmid) is transferred from one bacterium to another

Process:
1. F factor replicates via rolling circle replication
2. New copy→5' end peels off and is transferred in linear form-through cytoplasmic bridge formed by F^+ and connecting F^+ and F-
3. F^+ transfers copy of f factor to F^- partner→ F^- cell becomes F^+→now can form sex pili
4. F factor is episome→occasionally becomes integrated into bacterial chromosome
a. bacteria→Hfr cell (High frequency recombination)
→crossing over-variation

R plasmids
→resistance to antibiotics
1. up to 10 genes
2. during conjugation, some mobilize own transfer to nonresistant strains
3. increased antibiotic use selects for resistant strains
4. R plasmids can transfer resistance genes to different species of bacteria
→increasing pathogenic strains
5. result→resistant strains of pathogens→more and more common

Metabolic Diversity in Bacteria
A. Types→based on nutrition
1. heterotrophs→must obtain nutrition from environment
a. majority→saprobes
i. nourishment from dead organic matter
ii. major part of life cycle
b. other→obtain nourishment from living organisms
i. negative→can cause disease
ii. positive→providing beneficial service
a. humans→ex: bacteria in large intestine→vitamin K
2. autotrophs→manufacture organic nutrients from inorganic ones

a. photoautotrophs→use light as source of energy
b. chemoautotrophs→use chemicals as source of energy

B. Types→based on respiration
1. aerobes→require O_2 for cellular respiration
2. obligate anaerobes→only respire anaerobically (without O_2)
3. facultative anaerobes→use O_2 when available, but also carry on respiration anaerobically when necessary
-ex: muscle cells also do this

Medical Weapons that fight viruses:
1. Vaccines
a. harmless variants or derivatives of pathogenic microbes
b. inject antigen (protein part common to individuals of species) into person; person is able to make own antibodies to pathogen-builds up immunity
c. when infected by virus or bacteria, already immune
d. Jenner, 1796→1st smallpox vaccine-today, almost completely eliminated
e. today-polio, rubella, measles, mumps, many others
f. vaccines can prevent onset of some viruses-but little can be done once it occurs
2. Antibiotics→kill bacteria by inhibiting enzymes or process carried out by bacteria
-ex: penicillin→cause weakening of peptidoglycan cell wall
-viruses→no enzymes of their own; therefore, antibiotics do nothing
3. Antiviral Drugs
a. purine nucleosides that interfere with viral nucleic acid synthesis
b. ex: acyclovir→inhibits herpes virus upon entrance into lytic cycle

Types of bacteria→based on molecular biology
→looking at molecular biology, appears to scientists that there was a major split in bacteria very early on in life
1. 2 types of bacteria→Archaebacteria and Eubacteria are very different in terms of molecular biology
2. Systems of classification:
a. 5-Kingdom→most familiar
Monera (both types) Protista, Fungi, Plantae, Animalia
b. 6-Kingdom→separates 2 bacteria types Eubacteria, Archaebacteria, Protista, Fungi, Plantae, Animalia
c. System of Domains:
i. during evolution of life, divergence between Eubacteria and Archaebacteria
Archaebacteria later evolved into Domain Eukarya (eukaryotes)

ii. prominent school of thought:

a. Eubacteria→common bacteria, peptidoglycan cell wall, no nucleus, no organelles, simple ribosomes

b. Archaebacteria→less common
bacteria that typically live in extreme conditions
no peptidoglycans
no nucleus
no organelles
mode of transcription is more similar to Eukaryotes than Eubacteria; therefore, more closely related to Eukarya than other Eubacteria

c. Eukarya→Eukaryotes

1. no peptidoglycan cell wall
have nucleus
have organelles (membrane-bound structures)

3. Types of Archaebacteria

→types survive in environments that are similar to conditions on early Earth

a. Methanogens→

- O_2 free environments: sewage, swamps, digestive tracts of humans

-obligate anaerobes
-produce methane gas from simple C compounds
-important in recycling components of organic compounds in sewage

b. Extreme halophiles
-heterotrophs
-live in areas with high alt concentrations

c. Extreme thermophiles
-grow in hot, acidic environments
-45 to 110 degrees C=100-300 degrees F
-ex: hot spring of Yellowstone National Park
-temps:~60 degrees C
pH~1 to 2
-others→volcanoes