Biology I	Lecture Outline 7	Viruses

References (Textbook - pages 355-362, Lab Manual - pages 273-274)

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References (Textbook - pages 355-362, Lab Manual - pages 273-274)

Textbook definition of ***virus*** = a ***non-cellular*** parasitic ***agent*** consisting of an ***outer capsid*** and an ***inner*** core of ***nucleic acid***

An Enigma

1. Our ***textbook*** calls ***viruses*** a ***biological enigma***. WHY?

   (dictionary definition of enigma = puzzle, riddle, problem)

2. A ***virus*** is ***not*** an ***independent***-living ***organism*** and ***does not*** adhere to the ***strict definitions*** of ***life***.

3. They ***cannot reproduce*** unless they are able to ***infect*** a ***living cell*** and ***use*** the ***metabolic pathways*** of the ***living cell*** to ***reproduce***

4. They are ***non-cellular***. Remember we called ***cells*** the ***building blocks of life***

5. A ***virus*** is ***not strictly dead***, nor are they ***strictly alive***

6. They do ***not fit*** into any ***organizational scheme*** to ***classify living organisms*** like the ***5 Domain System*** (Monera, Protista, Fungi, Plantae, Animalia) we use in ***General Biology*** at ***DSCC***. ***(see pages 86-88 of Lab Manual)***

7. ***Therefore*** – we will study ***viruses*** as a ***separate topic*** before we ***begin*** our study of the ***Monera, Protista***, and ***Fungi***

Major Characteristics

1. ***Viruses*** are ***tiny*** geometric ***structures***

   A. Our textbook says they ***range*** from ***10-400nm (nanometers)***

   B. One ***web site*** (www.drgreene.com) states that if a ***virus*** was the ***size*** of a ***man***, a ***bacterium*** would be like a ***dinosaur*** over ***10 stories tall***

C. As we will see later, ***bacteria*** are much ***smaller*** than a ***typical human cell***, like a ***lymphocyte*** (a type of blood cell)

2. ***Viruses*** are ***obligate intracellular parasites*** – means they ***cannot*** reproduce ***outside*** a ***living cell***

3. They possess a ***RNA*** or ***DNA core*** covered by a ***protein coat*** called a ***capsid***.

4. Being ***non-cellular***, viruses ***usually***

   A. ***lack or possess few enzymes***

   B. ***cannot*** generate ***ATP***

   C. ***cannot*** be ***cultivated*** on an ***artificial media*** – like ***bacteria***

   D. ***cannot reproduce*** themselves ***independently***

   E. can be ***crystallized*** and stored like chemicals.

   Crystallization is the process of transformation of viral components into organized solid particles.

   Crystallization of biological macromolecules, including viral components, is used to study structural characteristics, for example, through X-rays, laser beams, etc.

5. ***Viral crystals*** will become ***infectious*** if allowed to ***enter*** a ***host cell***

6. Viruses infect a ***variety*** of ***cells***, but are ***host specific***

   A. ***bacteriophages*** infect only ***bacteria***

   B. ***tobacco mosaic virus*** infects only certain ***species of plants***

   C. ***rabies*** virus infects only ***mammals***

7. Some ***human viruses*** specialize in a ***particular tissue***

   A. ***HIV*** enters only ***certain blood cells***

   B. ***Polio virus*** reproduces in ***spinal nerve cells***

   C. ***Hepatitis virus*** infects only ***liver cells***

8. ***Antibiotics*** that normally ***kill bacteria*** will ***not harm viruses***.

9. ***Viruses*** can ***mutate*** and therefore ***quickly evolve (CHANGE)***, sometimes making a ***vaccine*** that ***worked today - ineffective tomorrow***

Viral Structure

(See Handout of Figure 20.1, page 356 of Textbook, Mader, 10th ED)

1. ***Viruses*** are ***categorized*** by
   A. ***size*** and ***shape***
   B. ***type*** of ***nucleic acid*** – whether ***single stranded*** or ***double stranded***
   C. ***presence*** or ***absence*** of an ***outer envelope***

2. ***All have***
   A. ***Outer*** protein ***coat*** called a ***capsid***
   B. ***Inner core*** of ***nucleic acids***, either ***DNA*** or ***RNA***, but ***NOT both***
      1) In Figure 20.1, note that
         a) ***A*** (adenovirus) and ***B*** (T-even bacteriophage) possess ***DNA***
         b) ***C*** (tobacco mosaic virus) and ***D*** (influenza virus) possess ***RNA***
      2) A ***viral genome*** may contain ***3*** to ***100 genes***
      3) The ***human cell*** may contain ***tens of thousands*** of ***genes***

3. Some ***viruses*** possess a ***outer*** membranous ***envelope*** around the ***capsid***
   A. In Figure 20.1, see D – the influenza virus
   B. The ***envelope*** is actually ***part*** of the ***host*** cell's ***plasma membrane***
   C. If the ***membranous envelope*** is ***absent*** the virus is said to be ***naked*** – like ***A, B,*** and ***C*** in Figure 20.1

Viral Reproduction

1. **Overview**

   A. According to our ***textbook*** "***viruses*** are ***microscopic pirates*** - they ***commandeer*** the ***metabolic machinery*** of a ***host cell***

   B. They ***gain entry*** into a ***host cell*** by attaching in a "***lock-and-key***" manner with a host cells' ***outer surface***

   C. This is the reason that ***viruses*** are very ***specific*** as far as their ***potential hosts***. ***(similar to the specificity of enzymes and their substrates)***

   D. The virus ***"key"*** must ***fit*** or they ***cannot attach***. A ***virus*** that ***cannot attach*** – ***cannot infect*** a host cell

   E. For example, a ***tobacco mosaic virus*** cannot attach to ***receptors*** on the ***surface*** of ***human cells*** and ***cannot infect human cells***

   F. Once ***inside*** a host cell, the ***viral nucleic acid*** (RNA or DNA) ***enter*** the ***host*** cell

   G. Here it ***takes over*** the host cells' ***ribosomes, tRNA, ATP*** and other ***normal cellular processes*** for its ***own reproduction***

   H. This is obviously ***harmful*** to the ***host's cells*** and the ***host***

2. **Reproduction of Bacteriophages**

   (See Handout of Figure 20.3, page 359 from Textbook, Mader 10th Ed)

   A. ***Bacteriophages*** are ***viruses*** that ***parasitize bacteria***

   B. There are 2 types of bacteriophage life cycles

      1) **Lytic**

         a) ***Lysis*** means to ***dissolve***, ***dissolution***, ***destruction***

         b) Virus ***penetrates host cell*** and ***reproduction occurs***

         c) ***Host cell*** breaks open ***(lysis)*** and ***releases viral particles***

2) **Lysogenic**

a) Virus ***penetrates*** host cell but ***reproduction*** does ***not immediately occur***

b) However, ***reproduction can*** occur ***sometime*** in the ***future***

C. **5 stages of Lytic Cycle**

1) ***ATTACHMENT*** – portions of viral ***capsid combine*** with ***receptor*** on ***bacterial*** cell ***wal***l in a ***"lock-and-key"*** manner

2) ***PENETRATIO***N – a viral ***enzyme digests*** away part of the ***cell wall*** and ***viral DNA*** is ***injected*** into ***host bacterial cell***

3) ***BIOSYNTHESIS***

a) ***Viral DNA*** shuts ***down*** host cell's ***genes*** that are ***not needed*** for ***viral reproduction***

b) ***Viral DNA*** takes over ***machinery*** of ***cell*** to make ***multiple copies*** of ***itself***

4) **MATURATION**

a) ***Viral DNA*** and ***capsid*** (outer coat) are ***assembled*** to make ***hundreds*** of new ***viral particles***

b) An ***enzyme*** is ***produced*** that ***breaks open*** the bacterial ***host cell wall***

5) ***RELEASE – new viruses leave*** the host cell and ***host cell dies***

D. **Lysogenic Cycle**

1) The virus ***attaches*** and ***penetrates*** the ***host cell***, but does ***not reproduce*** itself ***immediately***

2) ***Virus*** and ***infected bacterial cell*** can be called ***latent*** because ***virus*** is not ***actively reproducing***

3) ***INTEGRATION*** - occurs when ***viral DNA*** is ***incorporated*** into ***bacterial*** cell's ***DNA*** and is then ***passed on*** when ***bacteria reproduce***

4) The ***infected*** bacterial cells are ***not immediately destroyed***, but now ***carry*** the ***viral DNA***

5) While ***latent***, the ***viral DNA portion*** of an ***infected bacterial cell*** is called a ***prophage***

6) ***New bacterial cells*** that ***carry*** a ***copy*** of the ***prophage*** are called ***lysogenic cells***

7) The ***presence*** of a ***prophage*** may cause a ***bacteria*** to ***produce toxins*** and ***related diseases***

   a) ***Scarlet fever*** is caused by a ***bacterium*** carrying a ***viral prophage***

   b) ***Diphtheria*** is caused by a ***bacterium*** carrying a ***viral prophage***

8) Environmental ***factors*** can cause a ***prophage*** to become ***active*** and enter the ***lyctic cycle*** at the ***stage*** of ***BIOSYNTHESIS*** followed by

   a) ***MATURATION*** and

   b) ***RELEASE***

3. **Reproduction of Animal Viruses**

A. ***Animal viruses*** reproduce in a ***similar*** way to ***bacteriophages***

B. ***Animal viruses*** have a ***greater variety*** of ways of ***entering animal cells***

   1) Some ***attach*** and ***fuse*** to the ***outside*** of an ***animal cell*** similar to a ***bacteriophage***

   2) ***Others*** are simply ***taken into*** the ***animal cell*** by ***endocytosis*** of the ***plasma membrane***

C. ***Once inside*** a host animal cell, ***BIOSYNTHESIS*** and other steps like ***MATURATION*** AND ***RELEASE*** occur

D. ***Some animal viruses*** can also establish ***latent infections***

E. ***Latent infections*** may cause some ***human cells*** to become ***cancerous.*** ***Examples*** include ***lymphoma*** and ***cervical cancers***

Retroviruses

1. ***Retroviruses*** are ***animal RNA viruses*** that have a ***DNA stage***
2. ***HIV –Human Immunodeficiency Virus*** - is a ***retrovirus*** that causes ***AIDS***
3. On page ***361*** of your ***textbook*** (Mader, 10th Ed.) is ***Figure 20.4*** that ***summarizes reproduction*** of the ***HIV***

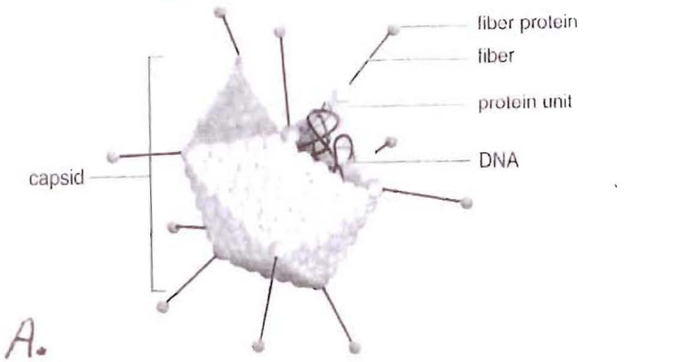
Examples of Viruses that Cause Disease

(See Handout of Table 20.1, page 356 of Textbook, Mader, 10th ED)

1. ***Discuss*** and ***review*** these ***quickly*** in class

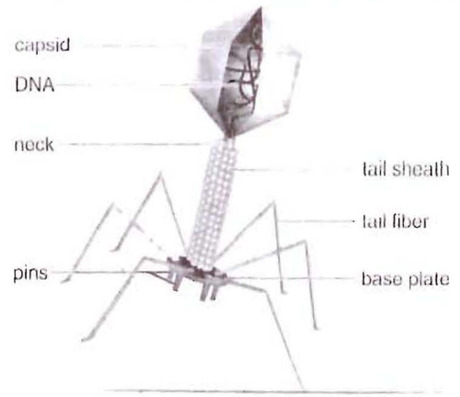
Figure 20.1 Viruses.
Page 356, Mader 10th Ed.

Adenovirus: DNA virus with a polyhedral capsid and a fiber at each corner.



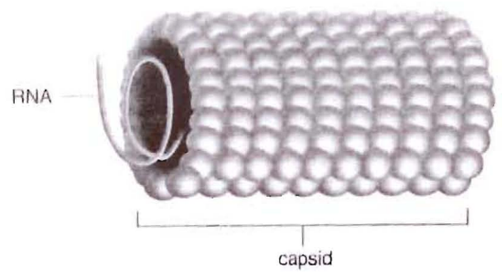
A.

T-even bacteriophage: DNA virus with a polyhedral head and a helical tail



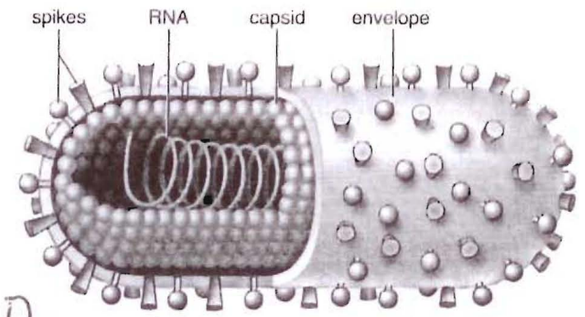
B.

Tobacco mosaic virus: RNA virus with a helical capsid.



C.

Influenza virus: RNA virus with a helical capsid surrounded by an envelope with spikes.



D.

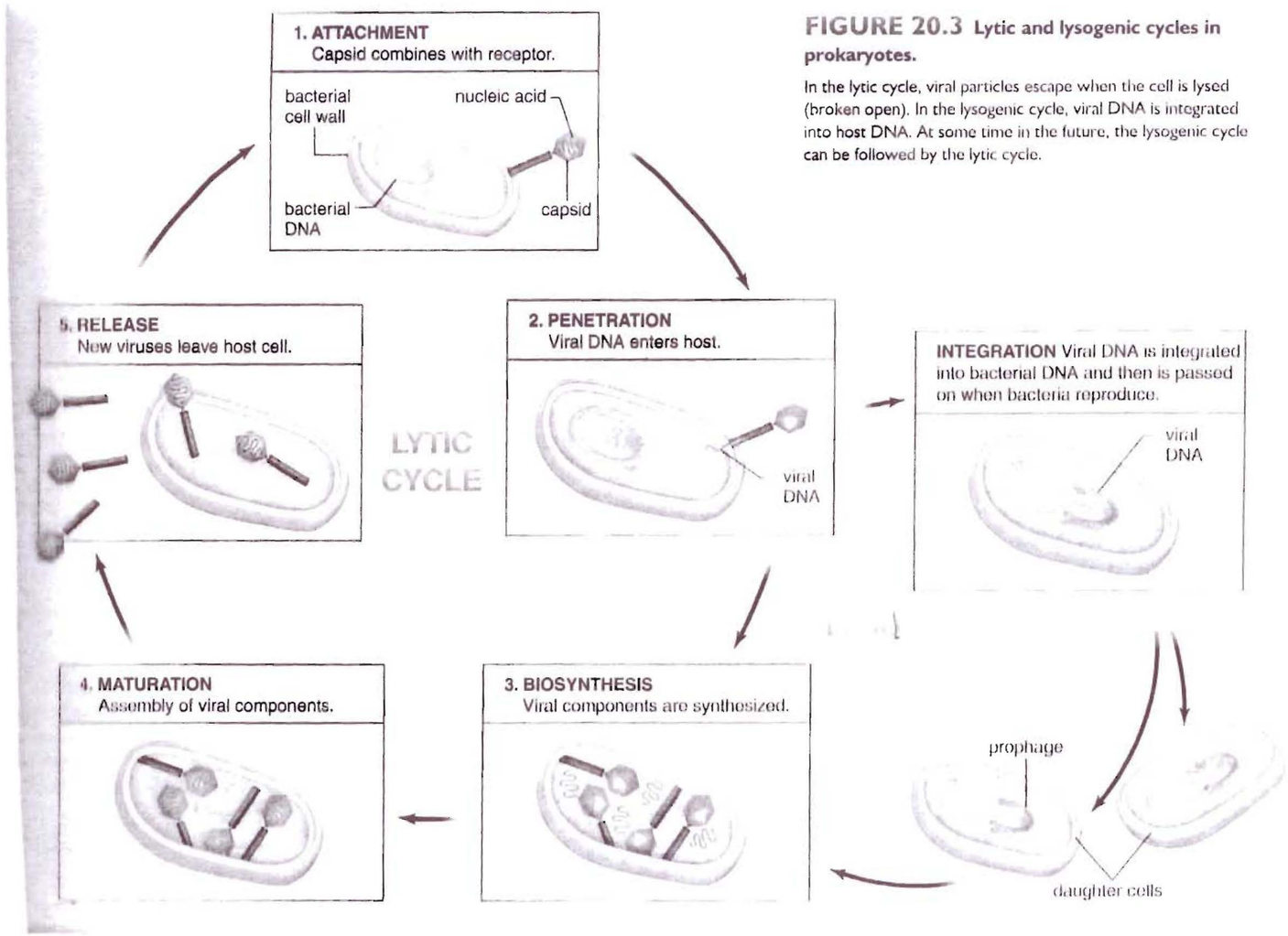


FIGURE 20.3 Lytic and lysogenic cycles in prokaryotes.

In the lytic cycle, viral particles escape when the cell is lysed (broken open). In the lysogenic cycle, viral DNA is integrated into host DNA. At some time in the future, the lysogenic cycle can be followed by the lytic cycle.

TABLE 20.1

Viral Diseases in Humans

Category	*Disease*
Sexually transmitted diseases	AIDS (HIV), genital warts, genital herpes
Childhood diseases	Mumps, measles, chickenpox, German measles
Respiratory diseases	Common cold, influenza, severe acute respiratory infection (SARS)
Skin diseases	Warts, fever blisters, shingles
Digestive tract diseases	Gastroenteritis, diarrhea
Nervous system diseases	Poliomyelitis, rabies, encephalitis
Other diseases	Smallpox, hemorrhagic fevers, cancer, hepatitis, mononucleosis, yellow fever, dengue fever, conjunctivitis, hepatitis C