

BIOL 240: General Microbiology

Spring 2020

MW, 5/4-5/6

<http://accounts.smccd.edu/staplesn/biol240/>

1. **ONLINE Experiment 16/Bacterial transformation due THIS WEEK!** -- Complete the questions by **Monday, 5/4!**
2. **LATER This WEEK:** Labster Experiment ("17") on Identification of Bacterial Unknown. Due **Fri., 5/8.**
3. **QUIZ #7: Final quiz** – Experiments 16, new "17"; Chapters 12, 13, 15, 16, 17.
– Will open later this week. **DUE, Monday, 5/11.**
4. **KEEP working** on the New Chapters: 16-17; 22-25; 27, and their objectives/Study Questions **EVERY day!!**
5. **REVIEW SESSIONS** for the **Final Exam:** next M/W, 11am-1pm.

Ch. 17: Specific/Acquired Immunity!

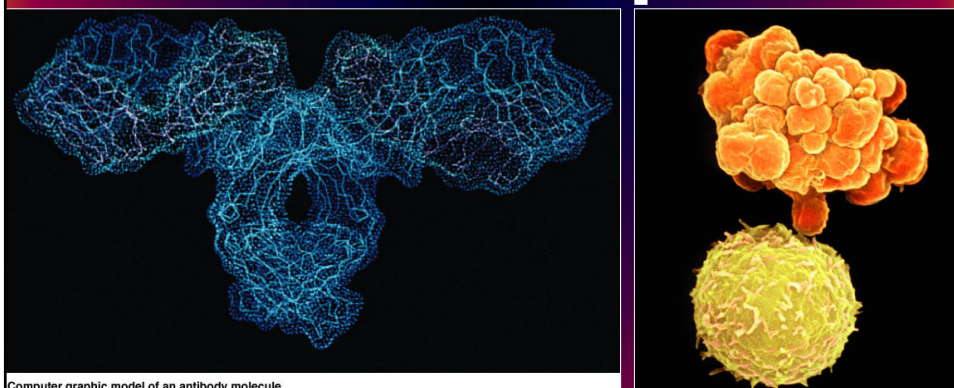
OBJECTIVES: Students should be able to:

1. **Ch. 17:** Compare the **cells & molecules** that produce **Humoral Immunity** with those that produce **Cell-Mediated Immunity**. (Th, B, Tc, NK, MΦ)
2. Describe how **immune MEMORY** is produced. How is this related to use of vaccines?
3. Diagram and describe **5 outcomes of antibody binding.**
4. Compare **Innate Defenses & Acquired Immunity** in the human immune system.
5. **Ch. 22:** Compare organisms, infection routes, virulence factors, symptoms & treatments of **4 Nervous system diseases.**
6. **Ch. 23:** Compare infection routes, virulence factors, symptoms and treatments of **4 Cardiovascular** and **Lymphatic** system diseases.
PLAGUES: <http://uhavax.hartford.edu/bugl/histepi.htm>
7. **Ch. 24:** Compare infection routes, virulence factors, symptoms and treatments for **4 Respiratory** system diseases.

❖ **Objectives are your HOMEWORK between classes!!! **Read, Review, Draw!!**

Chapter 17

Specific Defenses of the Host: The Immune Response



Specific Defenses of the Host: The Immune Response

- **Innate** (nonspecific) = Defenses against any pathogen
- **Immunity** = Specific antibody and lymphocyte response to an antigen; *Humoral, Cell-Mediated*.
- **Antigen** (Ag) = A substance that causes the body to produce specific antibodies or sensitized T cells
- **Antibody** (Ab) / **Immunoglobulin** (Ig) = Proteins made in response to an antigen

The Immune Response

- **Acquired immunity** =
 - Developed during an individual's lifetime.

- **Humoral immunity** =
 - Involves Ab produced by B cells.
 - (*EXTRACELLULAR invaders*)

- **Cell-mediated immunity** =
 - Involves T cells, especially T_C.
 - (*INTRACELLULAR invaders*)

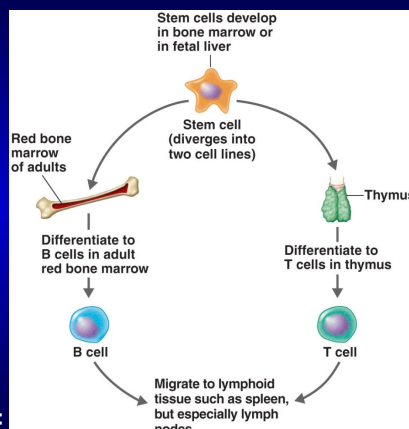


Figure 17.8

Acquired Immunity

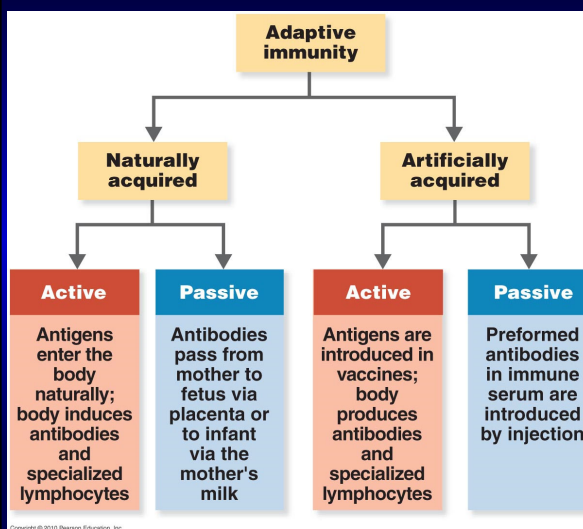


Figure 17.17

1. **Naturally acquired Active immunity**
 - Resulting from infection
2. **Naturally acquired Passive immunity**
 - Transplacental or via colostrum
3. **Artificially acquired Active immunity**
 - Injection of Ag (vaccination)
4. **Artificially acquired Passive immunity**
 - Injection of Ab

17.1) Humoral (antibody) Immunity: Antigenic Determinants

- Antibodies recognize and react with antigenic determinants or **epitopes** on an antigen.

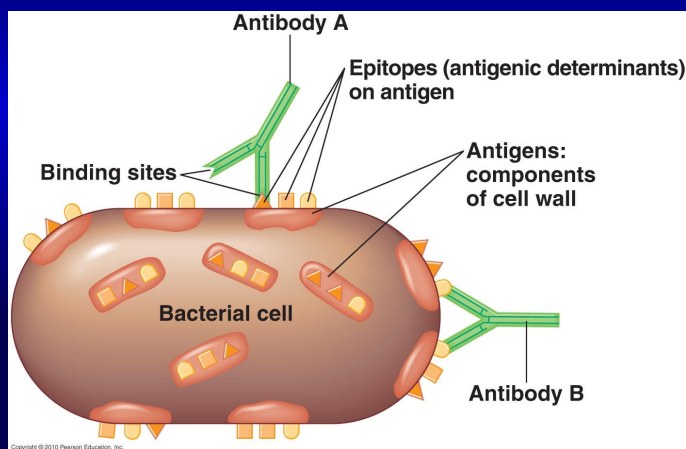
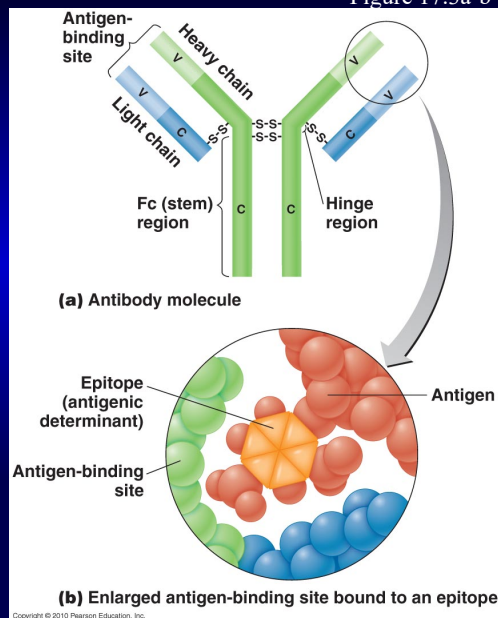


Figure 17.1

A. Antibody Structure

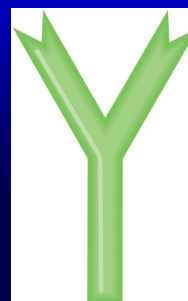
- V** = Variable polypeptide chains; Ag-recognition regions!
- C** = Constant regions;
 - recognized by phagocytic cells (**opsonins**)
 - also recognized by Complement

Figure 17.3a-b



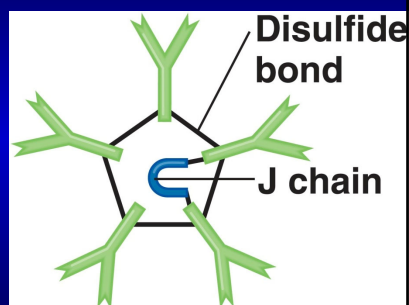
1. IgG antibodies

- Monomer
- 80% of serum antibodies
- In blood, lymph, intestine
 - 1) **Fix complement**
 - 2) **Cross placenta**
 - 3) **Enhance phagocytosis;**
 - 4) **Neutralize toxins & viruses;**
 - 5) **Protects fetus & newborn.**
- Half-life = 23 days



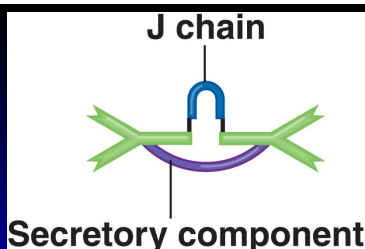
2. IgM antibodies

- **Pentamer.**
- 5-10% of serum antibodies.
- In blood, lymph, on B cells.
 - Fix complement.
 - **Agglutinates microbes;**
 - **first Ab produced in response to infection.**
- Half-life = 5 days.



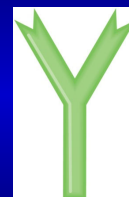
3. IgA antibodies

- Dimer
- 10-15% of serum antibodies
- **In secretions; breast milk!**
- **Mucosal protection**
- Half-life = 6 days



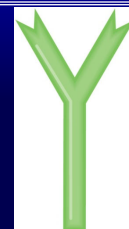
4. IgD antibodies

- Monomer; 0.2% of serum antibodies
- In blood, lymph, **on B cell PM's (50-100K/cell!!)**
- **On B cells (BCR) → initiate immune response!!**
- Half-life = 3 days

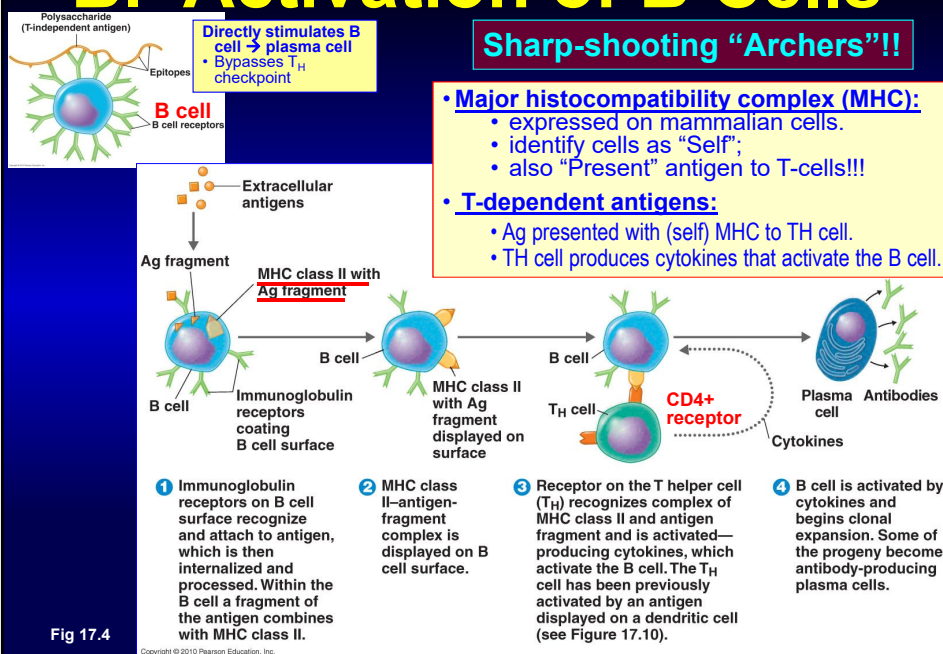


5. IgE antibodies

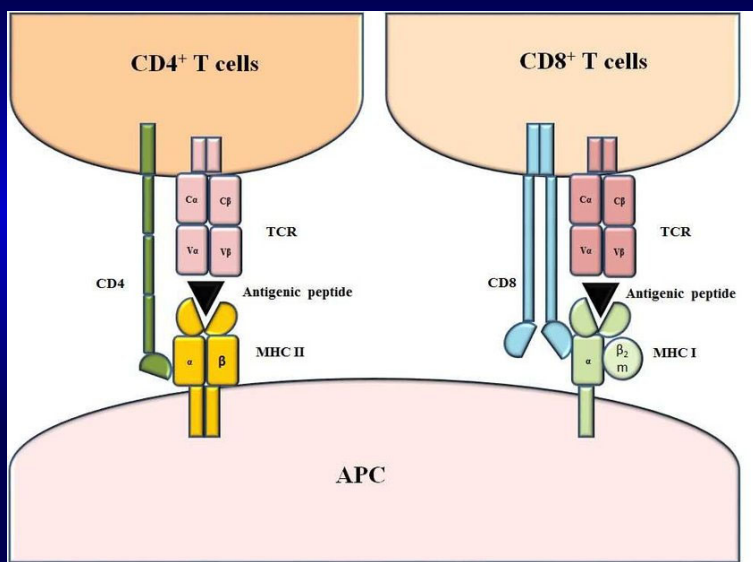
- Monomer; 0.002% of serum antibodies
- In blood
- **Receptors on mast cells and basophils,**
- **Allergic reactions; lysis of parasitic worms**
- Half-life = 2 days



B. Activation of B Cells



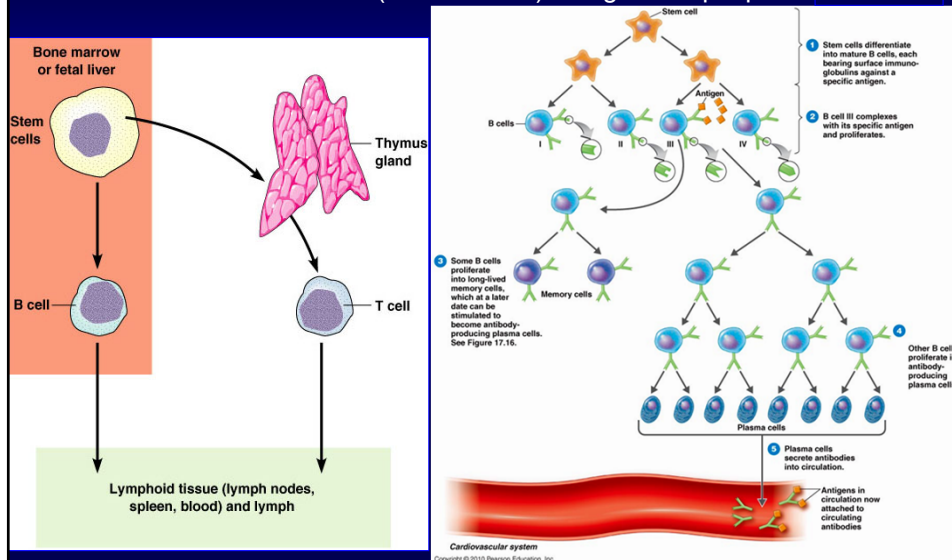
B/T-Cell Activation: MHC-II, Antigen, CD4 (T_H), and TCR



C. Clonal Selection

- Bone marrow gives rise to B cells.
- Mature B cells migrate to lymphoid organs.
- A mature B cell (**Plasma Cell**) recognizes epitopes.

Figure 17.5



D. Self-tolerance

- Body doesn't make Ab against self
 - *Self-reacting lymphocytes must be destroyed!*
 - *Prevents tissue destruction by “Friendly Fire”*
- **Clonal deletion:**
 - The process of destroying B and T cells that react to self antigens
 - ***Destroyed during fetal development***

http://highered.mheducation.com/sites/0072495855/student_view0/chapter24/animation_the immune_response.html

E. The Results of Ag-Ab Binding

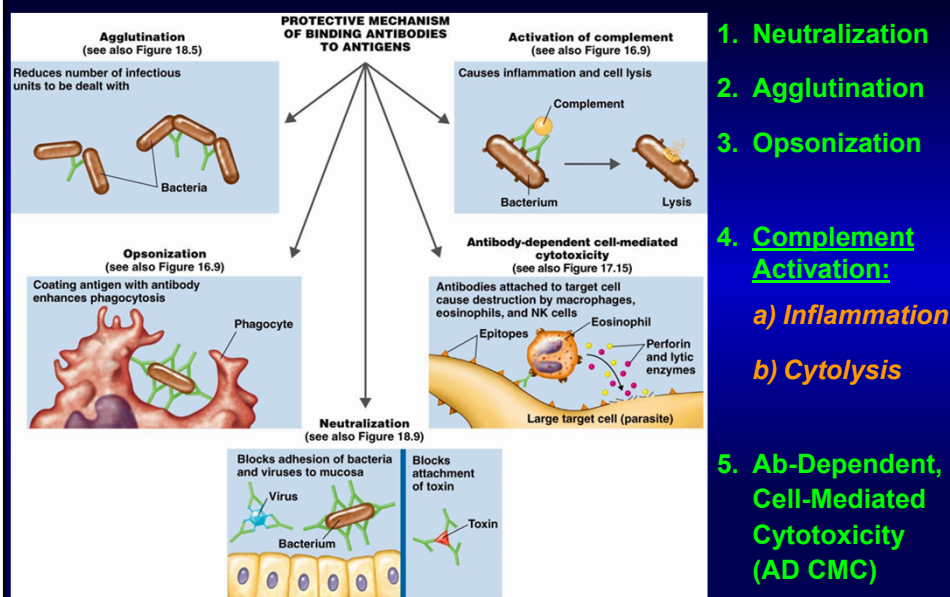


Figure 17.7

F. Antibody titer:

- = the amount of Ab in serum

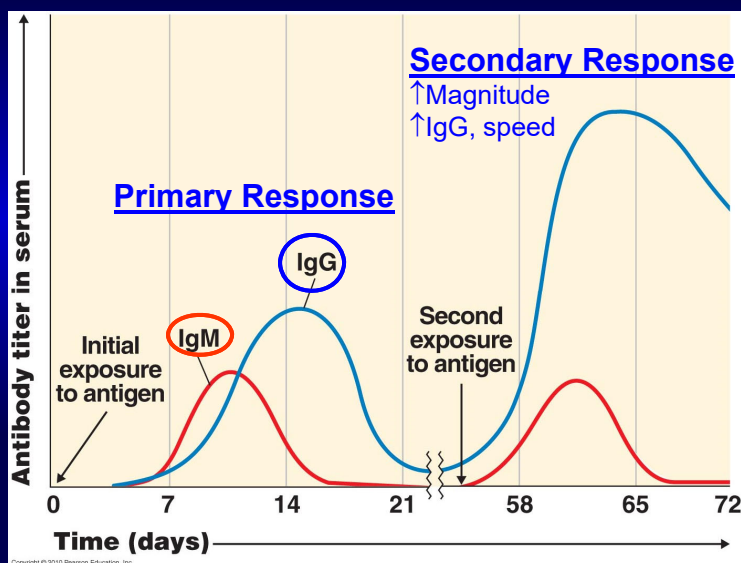


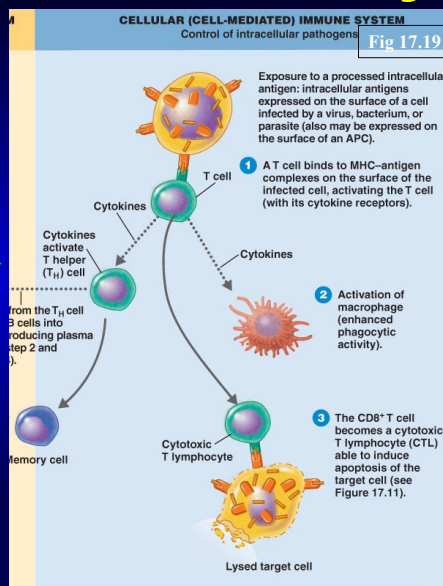
Fig 17.16

G. Immune system cells communicate via Cytokines

1. Interleukin-1 = Stimulates T_H cells. Fever!
2. Interleukin-2 = Activates T_H , B, T_C , and NK cells
3. Interleukin-8 = Attracts phagocytes (chemoattractant).
4. Interleukin-10 = Interferes with T_H1 cell activation.
5. Interleukin-12 = Differentiation of $CD4^+$ cells
6. γ -Interferon = Increase activity of macrophages
7. Chemokines = Cause leukocytes to move to an infection (chemoattractants).

17.2) Cell-Mediated Immunity

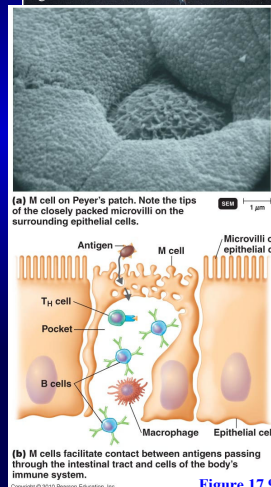
1. Specialized lymphocytes, mostly T cells, respond to intracellular Ag's.
2. After differentiating in the **thymus**, T cells migrate to **lymphoid** tissue.
 - Thymic selection eliminates many immature T cells
3. T cells differentiate into **effector T cells** when stimulated by an Ag.
4. Some effector T cells become **memory cells**.
5. T cells respond to Ag by **T-cell receptors (TCRs)**
6. T cells require **antigen-presenting cells (APCs)**
7. Pathogens entering the gastrointestinal or respiratory tracts pass through
 - **M (microfold) cells** over
 - **Peyer's patches**, which contain APCs



http://highered.mheducation.com/sites/0072556781/student_view0/chapter32/animation_quiz_1.html

Pathogens entering the Gastrointestinal or Respiratory tracts pass through:

1. **M (microfold) cells** in
 2. **Peyer's patches**, which contain
 3. **Dendritic cells**, which are antigen-presenting cells (**APC's**), and
 4. **T cells**
- ❖ **** GALT is part of the MALT!!**



T Cells

1. Helper T Cells ($CD4^+$, T_H)

The warning "Buglers"!!

- T_H1 = Activate cells related to *cell-mediated immunity*
- T_H2 = Activate B cells to produce *eosinophils, IgM, and IgE*

2. Cytotoxic T Cells ($CD8^+$, T_C)

The skilled "Swordsmen"!!

- Destroy target cells with *Perforin*, & induce *Apoptosis*.

3. Delayed Hypersensitivity T Cells (T_D)

- Associated with *allergic* reaction, *transplant* rejection, and *tuberculin* skin test

• Suppressor T cells (T_S)

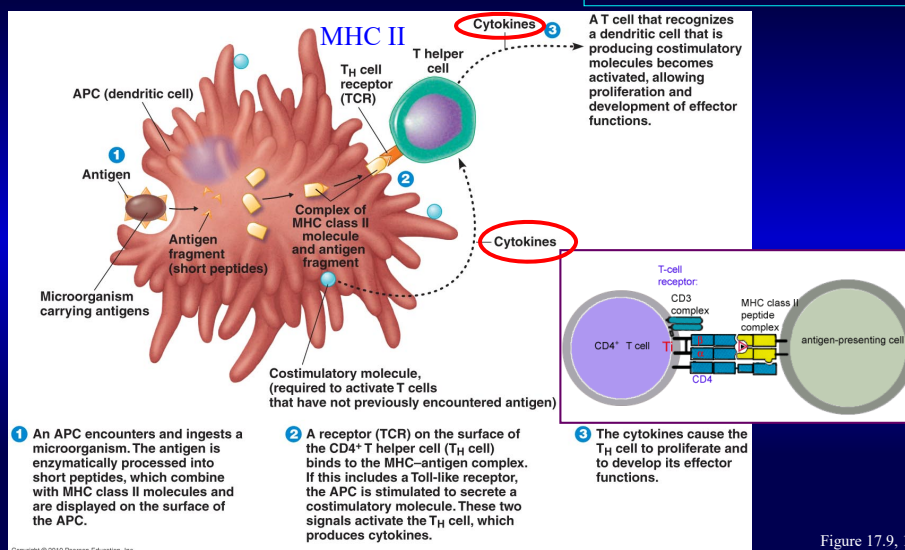
- Turn off immune response when Ag no longer present

http://web.biosci.utexas.edu/psaxena/MicrobiologyAnimations/Animations/Cell-MediatedImmunity/micro_cell-mediated.swf

A. Helper T Cells

The warning "Buglers"!!

- Permissive commanders!

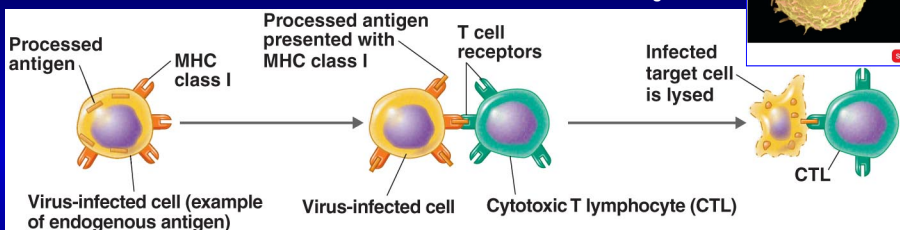


<http://www.bio.davidson.edu/courses/immunology/Flash/MHCII.html>

B. Cell-mediated Cytotoxicity: Cytotoxic T Cells

The skilled
"Swordsmen"/
Assassins!!

Figure 17.11



1 A normal cell will not trigger a response by a cytotoxic T lymphocyte (CTL), but a virus-infected cell (shown here) or a cancer cell produces abnormal endogenous antigens.

2 The abnormal antigen is presented on the cell surface in association with MHC class I molecules. CD8⁺ T cells with receptors for the antigen are transformed into CTLs.

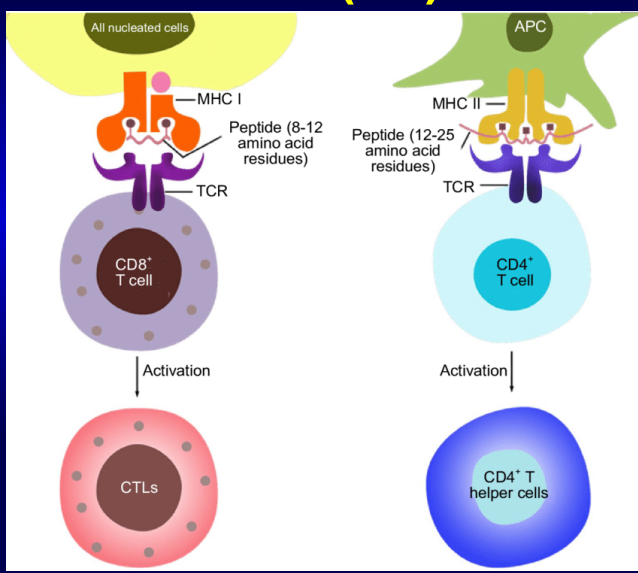
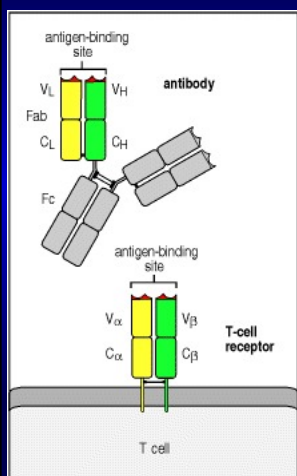
3 The CTL induces destruction of the virus-infected cell by apoptosis.

Apoptosis & Perforins, Granzymes

http://highered.mcgraw-hill.com/sites/0072556781/student_view0/chapter32/animation_quiz_1.html

Super-Ag: http://highered.mcgraw-hill.com/sites/0072556781/student_view0/chapter32/animation_quiz_4.htm

T-Cell Receptors, Antigen, and MHC-I/CD8 (Tc)



C. Nonspecific Cells ("Mercenaries")

- **Activated macrophages:**

Macrophages stimulated

- by ingesting Ag or
- by cytokines
- ["Pit Bulls"!]

- **Natural killer cells:**

Lymphocytes that destroy:

- virus-infected cells
- tumors
- ["Berserkers"!!]

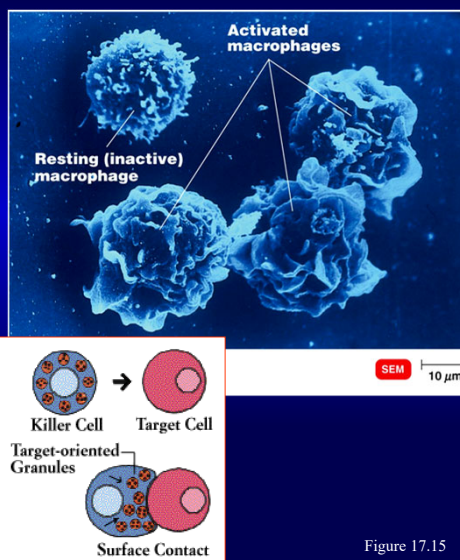
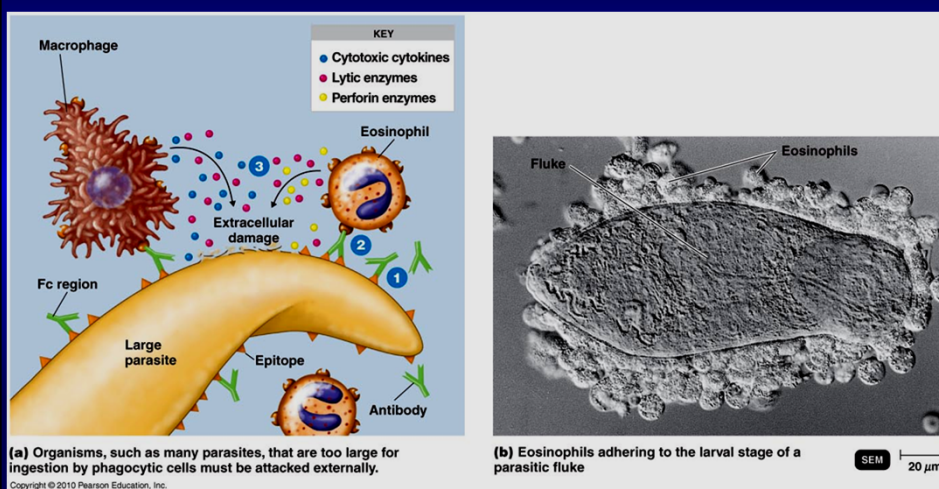


Figure 17.15

D. Antibody-Dependent, Cell-Mediated Cytotoxicity



(a) Organisms, such as many parasites, that are too large for ingestion by phagocytic cells must be attacked externally.

(b) Eosinophils adhering to the larval stage of a parasitic fluke

Figure 17.15

Immunity: Humoral & Cell-Mediated

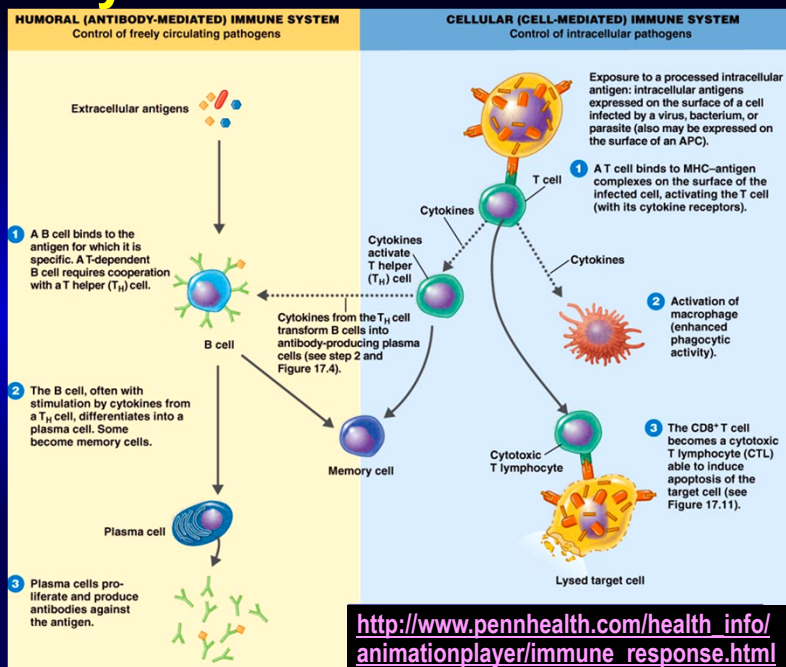


Figure 17.19