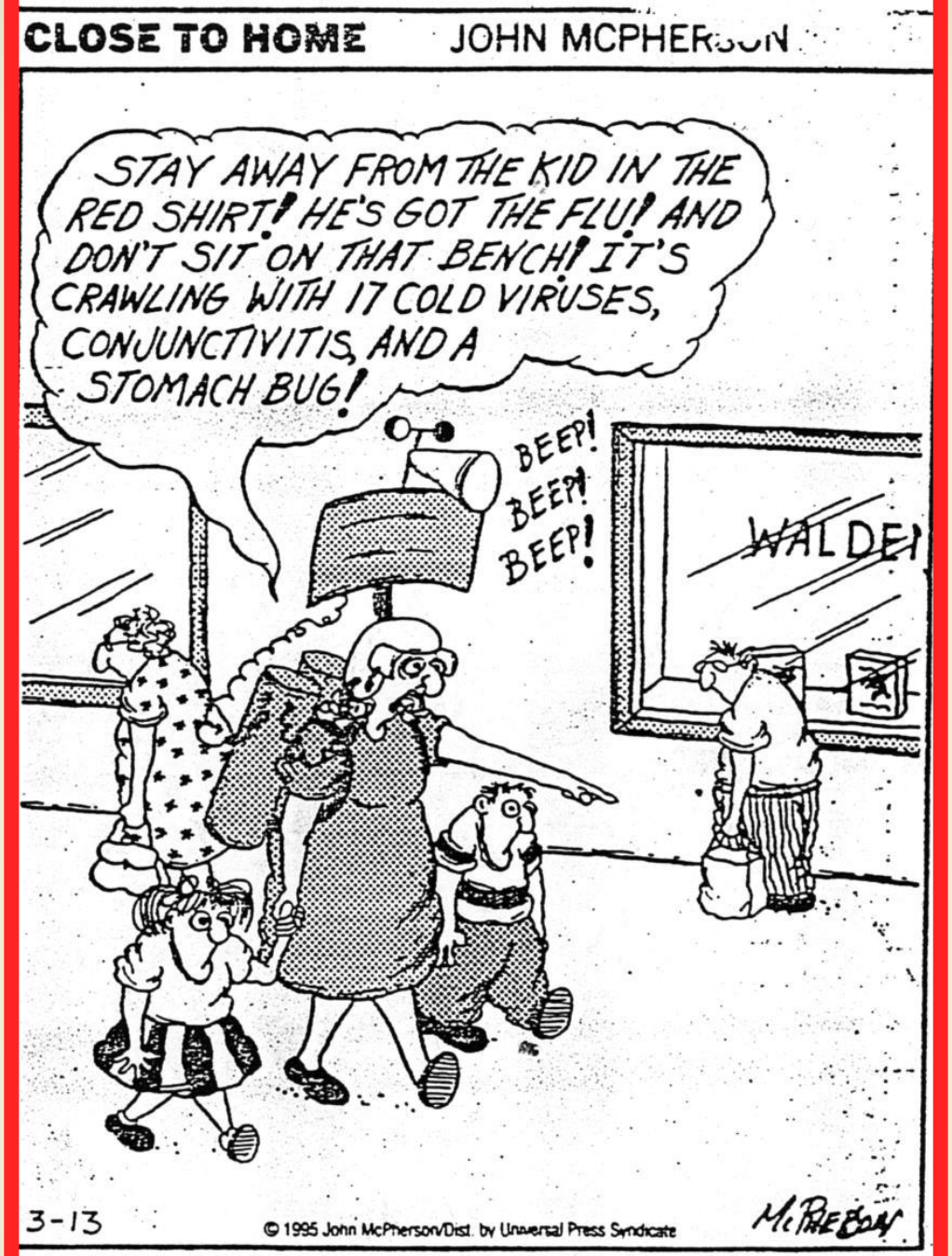
HOST-PARASITE INTERACTIONS



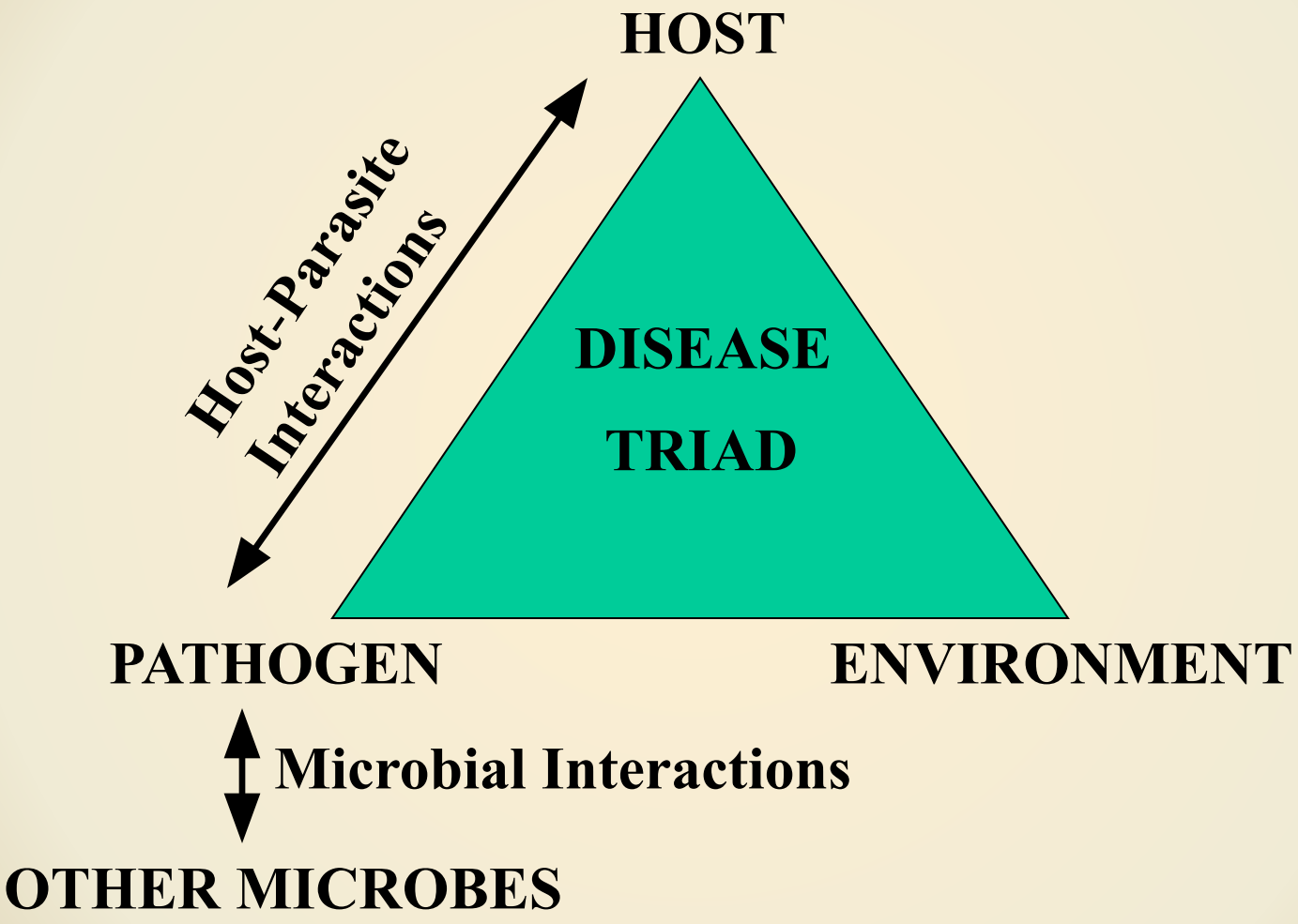
The latest in family health care: infection detectors.

ECOLOGICAL RELATIONSHIPS

Microbial Interactions

Host-Parasite Interactions

Environment


HOST
Host-Parasite Interactions
DISEASE TRIAD
PATHOGEN
ENVIRONMENT
Microbial Interactions
OTHER MICROBES

ECOLOGICAL RELATIONSHIPS

SYMBIOSIS: neutral, antagonistic or synergistic relationship between two dissimilar organisms (SYMBIOTES, SYMBIONTS) living in close association with each other;

MUTUALISM (+/+): mutually beneficial relationship between two species

COMMENSALISM (+/0): relationship between two species in which one is benefited and the other is not affected, neither negatively nor positively

PARASITISM (+/-): relationship between two species in which one benefits (**parasite**) from the other (**host**); usually involves detriment to the host

BASIC ECOLOGICAL DEFINITIONS

FLORA; **MICROBIOTA** (Microbiology Definition)**:** microorganisms present in or characteristic of a special location (**FLORA** generically refers to plants; **FAUNA** generically refers to animals)

INDIGENOUS (Resident) MICROBIOTA: microbial flora typically occupying a particular niche; given diversity of environmental conditions, organisms tend to segregate

TRANSIENT FLORA: microbial flora only temporarily occupying a given niche

NICHE (ecological niche): the place of an organism within its community (ecosystem); unique position occupied by a particular species, perceived in terms of actual physical space occupied & function performed within ecosystem

NATURAL MICROBIAL HABITATS

Soil

Water

Air

Animals and Animal Products

MICROBIAL FLORA OF THE NORMAL HUMAN BODY (a.k.a., **normal flora**)

SKIN

RESPIRATORY TRACT

Nose and Nasopharynx; Mouth and Oropharynx

EYE (Conjunctivae) and **OUTER EAR**

INTESTINAL TRACT

Stomach and Small Intestine; Large Intestine;
Intestinal Tract of Newborn
Antibiotic Alteration of Flora
Significance of Intestinal Flora

GENITOURINARY TRACT

External Genitalia & Anterior Urethra
Vagina

BLOOD and TISSUES

NORMALLY STERILE SITES IN THE HUMAN BODY

Colonization of one of these sites generally involves a defect or breach in the natural defenses that creates a portal of entry

- Brain; Central nervous system
- Blood; Tissues; Organ systems
- Sinuses; Inner and Middle Ear
- Lower Respiratory Tract: Larynx; Trachea; Bronchioles (bronchi); Lungs; Alveoli
- Kidneys; Ureters; Urinary Bladder; Posterior Urethra
- Uterus; Endometrium (Inner mucous membrane of uterus); Fallopian Tubes; Cervix and Endocervix

FACTORS CONTROLLING GROWTH OF MICROORGANISMS

1. **NUTRIENT AVAILABILITY:** the accessibility of a necessary resource, substance or compound providing nourishment to maintain life, i.e. capable of conversion to energy and structural building blocks

Fastidious: an organism that has complex nutritional or cultural requirements, making isolation and culture more difficult

MAJOR ESSENTIAL ELEMENTS:

C, O, H, N, S, P, K, Mg, Ca, Fe, Na, Cl

MINOR ESSENTIAL ELEMENTS:

Zn, Mn, Mo, Se, Co, Cu, Ni, W

2. PHYSICO/ENVIRONMENTAL PARAMETERS:

WATER ACTIVITY/OSMOTIC PRESSURE:

Water activity (a_w): represents the available water

Osmotic pressure (p): expressed in atmospheres; reflects the concentration of solute in an aqueous solution

OXYGEN: metabolic oxygen requirements; **OBLIGATE** or **FACULTATIVE**, **ANAEROBIC** or **AEROBIC**, or in between, (**MICROAEROPHILIC)**

pH: power of hydrogen; a measurement of the amount of hydrogen ion in solution; the logarithm of the reciprocal of the hydrogen ion concentration in an aqueous solution used to express its acidity or alkalinity (0-14)

TEMPERATURE:

Psycrophile (psychrophilic): liking cold temperatures;
Optimal growth at 15º to 20ºC

Mesophile (mesophilic): liking moderate temperatures;
Optimal growth at 20º to 45ºC

Thermophile (thermophilic): liking elevated temperatures;
Optimal growth at 50º to 70ºC

FACTORS CONTROLLING GROWTH OF ORGANISMS (cont.):

3. **COMPETITION:** the simultaneous demand by two or more organisms or species for a necessary, common resource or physical space that is in limited or potentially limited supply, resulting in a struggle for survival

4. **HOST IMMUNE SYSTEM:** the cells and tissues involved in recognizing and attacking foreign substances in the body

ACQUIRING INFECTIOUS AGENTS

PORTAL OF ENTRY/EXIT

- **INGESTION**
- **INHALATION**
- **DIRECT PENETRATION**
  - Trauma or Surgical Procedure
  - Needlestick
  - Arthropod Bite
  - Sexual Transmission
  - Transplacental

ACQUIRING INFECTIOUS AGENTS (cont.)

COLONIZATION: the successful occupation of a new habitat by a species not normally found in this niche

- **Adherence (attachment):** close association of bacterial cells and host cells generally characterized by **receptors** on **target** sites
  - **Adhesin:** structure or macromolecule located on the surface of a cell or extracellularly that **facilitates adherence** of a cell to a surface or to another cell; site of attachment is often a **specific receptor** and host cell receptors are often sugar moieties (**lectin**), but the adherence may also be **nonspecific**

ACQUIRING INFECTIOUS AGENTS (cont.)

INVASION: the entry and spread throughout the cells and/or tissues of the host; specific recognition of receptor sites on target cells enhances pathogenic advantage

- **Invasins (invasive factors):** structures or macromolecules that facilitate invasion by a pathogenic microorganism

MULTIPLICATION: the ability of a microorganism to reproduce during an infection; influenced by underlying disease, immunologic status, antibiotic treatment, nutrient availability

TRANSMISSION OF DISEASE

ENTRANCE, COLONIZATION, PENETRATION: Dependent upon Age, Sex, Nutrition, Immunologic State and General Health of Host, and Bacterial Virulence Factors

VECTOR: a carrier, especially the animal that transfers an infectious agent from one host to another, usually an **ARTHROPOD**

CARRIER (Carrier State): symptomless individual who is host to a pathogenic microorganim with the potential to pass the pathogen to others

NOSOCOMIAL INFECTIONS: an infection acquired in a hospital setting that was not present in the host prior to admission, generally occurring within 72 hours of admission

NOSOCOMIAL INFECTIONS in ACUTE CARE INSTITUTIONS

Infection Site	Percentage of All Nosocomial Infections	Most Common Agents
Urinary Tract	40%	*Escherichia coli, Enterococcus, Proteus, Klebsiella, Pseudomonas aeruginosa*
Surgical Wound	20%	*Staphylococcus aureus, Staphylococcus epidermidis, E. coli*
Pulmonary	10%	*Klebsiella, Pseudomonas, E. coli, S. aureus*
Primary Bacteremia	5% - 10%	*S. aureus, S. epidermidis,* Gram-negative rods
Others	20% - 25%	*S. aureus, E. coli*

EPIDEMIOLOGY

EPIDEMIC: disease occuring suddenly in numbers clearly in access of normal expectancy

ENDEMIC: disease present or usually prevalent in a population or geographic area at all times

PANDEMIC: a widespread epidemic distributed or occuring widely throughout a region, country, continent, or globally

Emerging Infectious Diseases

- New diseases and diseases with increasing incidences are called **emerging infectious diseases** (**EIDs**).
- EIDs can result from the use of **antibiotics** and **pesticides, climatic changes, travel,** the **lack of vaccination**, **and insufficient case reporting**.
- The **CDC, NIH, and WHO** are responsible for surveillance and responses to emerging infectious diseases.

Tuberculosis	**SARS***	**Venezuelan Equine Encephalitis**
Hepatitis C	**AIDS**	**Enterohemorrhagic *E. Coli***
Malaria	**Lassa Fever**	**S.American Hemorrhagic Fevers**
Influenza		***Hantavirus***

PATHOGENICITY vs. VIRULENCE

PATHOGENICITY: the quality of **producing disease** or the ability to produce pathologic changes or disease

VIRULENCE: a **measure of pathogenicity**; a measurement of the degree of disease-producing ability of a microorganism as indicated by the severity of the disease produced; commonly ascertained by measuring the **dosage** required to caused a specific degree of pathogenicity; one general standard is the **LD_{50}** (lethal dose 50%)

PATHOGENICITY vs. VIRULENCE (Definitons)

DOSAGE: the number of pathogenic microorganisms entering the host

LD_{50} = the number of microorganisms required to cause lethality (death) in 50% of the test host

TRUE PATHOGEN: any microorganism capable of causing disease; an infecting agent

OPPORTUNISTIC PATHOGEN: a usually harmless microorganism that becomes pathogenic under favorable conditions causing an **opportunistic infection**

INFECTION vs. DISEASE

INFECTION: the **colonization** and/or **invasion** and **multiplication** of pathogenic microrganisms in the host **with or without** the manifestation of **disease**

DISEASE: an **abnormal condition** of body function(s) or structure that is considered to be harmful to the affected individual (host); any deviation from or interruption of the normal structure or function of any part, organ, or system of the body

INFECTION vs. DISEASE
(Definitons)

BENIGN: a non-life or non-health threating condition

MALIGNANT: a disease tending to become progressively worse (**MORBIDITY** = illness) and potentially result in death (**MORTALITY** = death)

CONTAGIOUS: capable of being transmitted from one host to another; **communicable**; **infectious**

INFECTIOUS DOSE: number of pathogenic organisms required to cause disease in a given host

KOCH'S POSTULATES

Four criteria that were established by Robert Koch to identify the **causative agent of a particular disease**, these include:

1. the microorganism (pathogen) must be **present in all cases of the disease**
2. the pathogen can be **isolated** from the diseased host **and grown in pure culture**
3. the pathogen from the pure culture must cause the **same disease when inoculated** into a healthy, susceptible laboratory animal
4. the pathogen must be **reisolated** from the new host and **shown to be the same** as the originally inoculated pathogen

Bacterial Virulence Mechanisms

- Adherence (Colonization)
- Invasion
- Degradative enzymes
- Exotoxins
- Endotoxin
- Induction of excess inflammation
- Evasion of phagocytic & immune clearance
- Byproducts of growth (gas, acid)
- Superantigen
- Resistance to antibiotics

MICROBIAL PATHOGENICITY VIRULENCE FACTORS

COLONIZATION FACTORS: specific recognition of receptor sites on target cells enhances pathogenic advantage

1. CAPSULE: nonspecific attachment

2. SURFACE RECEPTORS/TARGET SITES:
Receptors on both bacteria (**adhesins**) and host (**target**)

Examples include:
i) **fimbriae** (formerly known as pili) of *Enterobacteriaceae*
ii) *Chlamydia* binds host N-acetyl-D-glucosamine which is a cell surface **lectin** (polysaccharide target receptor)
iii) Protein **adhesin** of *Mycoplasma* located in specialized tip structure; adheres to sialic acid-containing cell receptors

MICROBIAL PATHOGEN	ADHESIN	RECEPTOR
Staphylococcus aureus	**Lipoteichoic acid**	Unknown
Staphylococcus spp.	**Slime layer**	Unknown
Group A *Streptococcus*	**LTA-M protein complex**	**Fibronectin**
Streptococcus pneumoniae	Protein	N-acetylhexosamine-gal
Escherichia coli	Type 1 **fimbriae**	D-**Mannose**
	CFA 1 fimbriae	GM **ganglioside**
	P fimbriae	P blood grp glycolipid
Other Enterobacteriaceae	Type 1 fimbriae	D-Mannose
Neisseria gonorrhoeae	Fimbriae	GD_1 ganglioside
Treponema pallidum	P_1, P_2, P_3	Fibronectin
Chlamydia spp.	Cell surface lectin	N-acetylglucosamine
Mycoplasma pneumoniae	Protein P1	Sialic acid
Vibrio cholerae	Type 4 pili	Fucose and mannose

VIRULENCE FACTORS (cont.)

INVASIVE FACTORS (invasins): enable a pathogenic microorganism to enter and spread throughout the tissues of the host body; specific recognition of receptor sites on target cells enhances pathogenic advantage

DEGRADATIVE ENZYMES: a class of protein capable of catalytic reactions; bacterial and host enzymes both play roles in the disease process

VIRULENCE FACTORS (cont.)

TOXIGENICITY: the ability of a microorganism to cause disease as determined by the **toxin** it produces which partly determines its virulence

1. **ENDOTOXIN:** a complex bacterial toxin that is composed of protein, lipid, and polysaccharide (**LPS**) which is released only upon lysis of the cell

2. **EXOTOXINS:** a potent toxic substance formed and secreted by species of certain bacteria

BASIC EFFECTS of ENDOTOXIN

FEVER: any elevation of body temperature above normal

LEUKOPENIA/LEUKOCYTOSIS: abnormal reduction in number of leukocytes in blood, ($\leq$5000/mm^3) / abnormally large number of leukocytes in blood, as during hemorrhage, infection, inflammation, or fever ($\geq$12,000mm^3)

METABOLIC EFFECTS : pathogenic organisms can affect any of the body systems with disruptions in metabolic processes, e.g.,hypotension, hypoglycemia, etc.

RELEASE OF LYMPHOCYTE FACTORS: agranular leukocyte concentrated in lymphoid tissue; active in immunological responses, including production of antibodies

CELLULAR DEATH:

SEPTIC SHOCK: associated with overwhelming infection resulting in vascular system failure with sequestration of large volumes of blood in capillaries and veins; activation of the complement and kinin systems and the release of histamines, prostaglandins, and other mediators may be involved

DISSEMINATED INTRAVASCULAR COAGULATION (DIC): disorder characterized by a reduction in the elements involved in blood coagulation due to their utilization in widespread blood clotting within the vessels; late stages marked by profuse hemorrhaging

ORGAN NECROSIS: the sum of morphological changes indicative of cell death and caused by the progressive degradative action of enzymes

EXOTOXINS

TWO-COMPONENT (BIPARTITE) A-B TOXINS with INTRACELLULAR TARGETS: conform to general structural model; usually one component is a **binding domain (B subunit)** associated with absorption to target cell surface and transfer of active component across cell membrane, the second component is an **enzymatic or active domain (A subunit)** that enzymatically disrupts cell function

BACTERIAL CYTOLYSINS (a.k.a. Cytotoxins) with CELL MEMBRANE TARGETS: hemolysis, tissue necrosis, may be lethal when administered intravenously

EXAMPLES of BIPARTITE A-B TOXINS with INTRACELLULAR TARGETS

- **Diphtheria toxin -** ADP-ribosylation inhibits cell protein synthesis by catalyzing transfer of ADP- ribose from NAD (nicotinimamide adenine nucleotide) to EF-2 (elongation factor- 2)
- ***Pseudomonas aeruginosa* toxin -** similar action as DT
- **Cholera toxin -** A-subunit catalyzes ADP-ribosylation of the B-subunit of the stimulatory guanine nucleotide protein Gs; profound life-threatening diarrhea with profuse outpouring of fluids and electrolytes
- Enterotoxigenic *Escherichia coli* (ETEC) **heat-labile enterotoxin -** similar or identical to cholera toxin
- **Tetanus neurotoxin -** less well understood; binding domain binds to neuroreceptor gangliosides, releases inhibitory impulses with trismus
- **Botulinum neurotoxin -** among most potent of all biological toxins; binding domain binds to neuroreceptor gangliosides, inhibits release of acetylcholine at myoneural junction resulting in fatal paralysis

BACTERIAL CYTOLYSINS
with
CELL MEMBRANE TARGETS

Three Major Types:

1. Hydrolyze membrane phospholipids (**phospholipases**); e.g., *Clostridium, Staphylococcus*
2. **Thiol-activated** cytolysins (**oxygen-labile**) alter membrane permeability by binding to cholesterol; e.g., *Streptococcus, Clostridium*
3. **Detergent-like activity** on cell membranes; e.g., *Staphylococcus,* rapid rate of lysis

ENDOTOXINS	EXOTOXINS
1. Integral part of cell wall	1. Released from the cell before or after lysis
2. Endotoxin is LPS; lipid A is toxic	2. Protein
3. Heat stable	3. Heat labile
4. Antigenic; questionable immunogenicity	4. Antigenic and immunogenic
5. Toxoids not be produced	5. Toxoids can be produced
6. Many effects on host	6. Specific in effect on host
7. Produced only by gram-negative organisms	7. Produced by gram-positive & gram-negative organisms

MICROBIAL PATHOGENICITY (cont.)
RESISTANCE TO HOST DEFENSES

ENCAPSULATION and
ANTIGENIC MIMICRY, **MASKING** or **SHIFT**

- **CAPSULE, GLYCOCALYX** or **SLIME LAYER**
  - **Polysachharide capsules** *Streptococcus pneumoniae, Neisseria meningitidis, Haemophilus influenzae*, etc.
  - **Polypeptide capsule** of *Bacillus anthracis*

EVASION or **INCAPACITATION** of **PHAGOCYTOSIS** and/or **IMMUNE CLEARANCE**

- **PHAGOCYTOSIS INHIBITORS:** mechanisms enabling an invading microorganism to resist being engulfed, ingested, and or lysed by phagocytes/ phagolysosomes

RESISTANCE to **HUMORAL FACTORS**

RESISTANCE to **CELLULAR FACTORS**

MICROBIAL PATHOGENICITY (cont.)
DAMAGE TO HOST

DIRECT DAMAGE

(Tissue Damage from Disease Process):

- **Toxins**
- **Enzymes**

INDIRECT DAMAGE

(Tissue Reactions from Immunopathological Response):

Damage Resulting from Vigorous Host Immune Response (a.k.a, **immunopathogenesis; autoimmune hypersensitivy**)

- **Hypersensitivity Reactions (Types I - IV)**

HOST RESISTANCE

The degree to which a host can limit the effects of an infection, ranging from:

- **TOLERANCE** in which symptoms are suppressed or unusually large doses of a drug, toxin, or protein are able to be endured
- **HYPERSENSITIVITY** in which only a few cells surrounding the infected cell(s) are affected or an increased susceptibility to an antigen, such as an allergic reaction to a previous exposure to an antigen, the extreme case being anaphylactic shock
- **IMMUNITY** in which the microorganisms do not multiply due to any one or a combination of host immune factors or the biological condition by which a body is capable of resisting or overcoming an infection or disease

HYPERSENSITIVITY REACTIONS

TYPE I: ANAPHYLACTIC REACTION (ANAPHYLAXIS, ANAPHYLACTIC SHOCK): a life-threatening immediate hypersensitivity reaction to a previously encountered antigen, characterized by respiratory distress, vascular collapse, and shock; allergy or atopic diseases

TYPE II: CYTOTOXIC REACTION: a specific destructive action against certain cells by an invading agent; humorally mediated, autoimmune diseases, cytotoxic diseases, antibody diseases

TYPE III: IMMUNE COMPLEX REACTION: serum sickness diseases

TYPE IV: CELL-MEDIATED IMMUNE RESPONSE: delayed-type hypersensitivity, cell- mediated cytotoxic diseases, granulomatous diseases

IMMUNOPATHOLOGICAL RESPONSE with TISSUE REACTIONS

♦Type I Hypersensitivity Reactions:

- **Anaphylactic Reaction** (Anaphylaxis; Anaphylactic shock)
  - **IgE-mediated**: Cross-linking of cell-bound IgE antibodies by antigen with degranulation of mast cells or basophils
  - Life-threatening immediate hypersensitivity reaction to a previously encountered antigen, characterized by respiratory distress, vascular collapse, and shock
- **Allergy** or **atopic diseases**
  - Atopy: hereditary hypersensitivity to common environmental antigens

IMMUNOPATHOLOGICAL RESPONSE with TISSUE REACTIONS

♦**Type II Hypersensitivity Reactions**:

Humorally-Mediated Autoimmune Diseases

- Interaction of **cross-reactive antibody** with host cell surface antigen; **Autoantibodies** and **immune complexes**
- **Cytotoxic reaction** (antibody-mediated) (ADCC): Specific destructive action against certain cells presenting antigens from an invading agent

IMMUNOPATHOLOGICAL RESPONSE with TISSUE REACTIONS

♦**Type III Hypersensitivity Reactions**:

Immune Complex Reaction

- **Antibody-mediated**
- **Deposition of circulating immune complexes** in small vessels with complement activation causing damage to vessels
- **Serum sickness diseases**

IMMUNOPATHOLOGICAL RESPONSE with TISSUE REACTIONS

- **Type IV Hypersensitivity Reactions**:

  Cell-Mediated Immune Response

  - **T cells sensitized to "self" antigens** secrete lymphokines that either do direct damage to host cells (e.g., TNF) or indirect damage enhancing the inflammatory response
  - **Delayed-type hypersensitivity** (**TB test**) (CD4+ mediated)
  - **Cell-mediated cytotoxic diseases** (CD8+ mediated)
  - **Granulomatous disease**

HOST DEFENSE MECHANISMS

EXTERNAL (PRIMARY): Physical barrier of gross surface area; e.g., skin, respiratory tract, gastrointestinal tract, genitourinary tract

Mechanical and Physical Factors: sweat, fatty acids, pH, indigenous competitive flora (microbial antagonism), peristalsis, hair, cilia, urinary flushing, mucus, [tears, nasal secretions, saliva (lysozyme)], semen (spermine), mucosal secretory antibody (IgA predominant)

HOST DEFENSE MECHANISMS (cont.)

INTERNAL (SECONDARY): When an infecting parasite succeeds in penetrating the skin or mucuos membranes, cellular defense mechanisms include local macrophages and blood-borne phagocytic cells. Mononuclear phagocytes (**monocytes** and **macrophages**) and **polymorphonuclear leukocytes** (**PMNs**) are the most important phagocytic cells targeting bacterial infections.

MONONUCLEAR PHAGOCYTE SYSTEM (formerly Reticular Endothelial System): total pool of monocytes and cells derived from monocytes; predominantly **macrophages** (phagocytic cells)

HOST DEFENSE MECHANISMS (cont.)

OTHER:

NON-SPECIFIC: oxygen metabolites (superoxide anion radical, hydrogen peroxide, hydroxyl radicals, halide radicals), kinin forming system related to **clotting**

HOST-GENERATED PROTEINS: complex array of **humoral and cellular mediators**; e.g., lysosomal enzymes, lipid mediators, prostaglandins, histamine, heat-shock proteins (stress proteins)

HOST DEFENSE MECHANISMS (cont.)

CELLULAR IMMUNE RESPONSE: any immune response directed at the cellular level; includes **INFLAMMATION** and **PHAGOCYTOSIS** processes

INFLAMMATORY RESPONSE: a protective response of tissues affected by disease or injury characterized by **redness**, localized **heat**, **swelling**, **pain**, and possibly **impaired function** of the infected part

PHAGOCYTOSIS: the process by which certain phagocytes can **ingest extracellular particles** by engulfing them; particles **OPSONIZED** with antibody are more rapidly and efficiently ingested

T-LYMPHOCYTES and **CYTOKINES**

HOST DEFENSE MECHANISMS (cont.)

HUMORAL IMMUNE RESPONSE: the sum total of components of the immune response circulating in the blood or body fluids ; includes **ANTIBODY** and **COMPLEMENT** systems

COMPLEMENT PROTECTIVE SYSTEM: a protein system in serum that combines with antibodies to form a defense against cellular antigens

B-LYMPHOCYTES and
ANTIBODY PRODUCTION: a class of proteins produced as a result of the introduction of an antigen that has the ability to combine with the antigen that caused its production

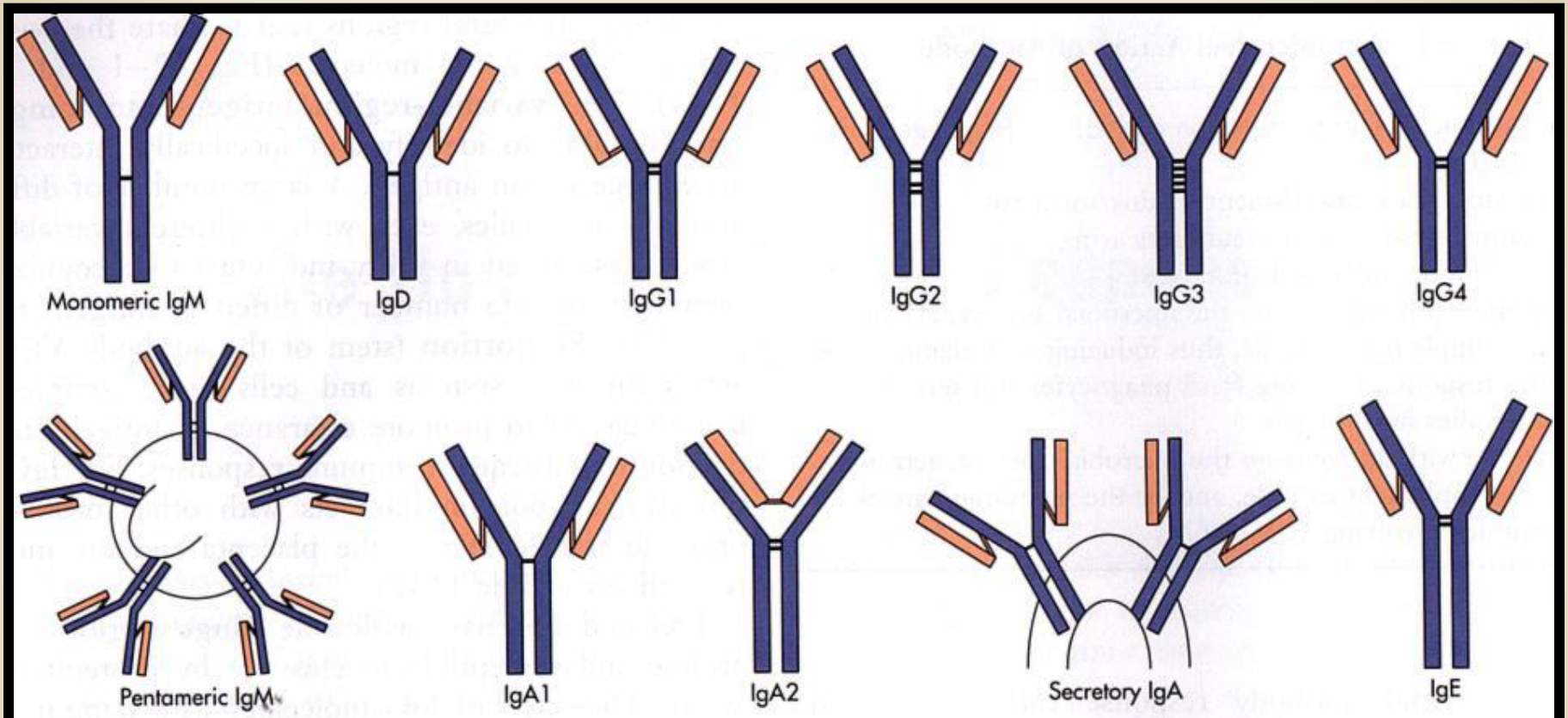
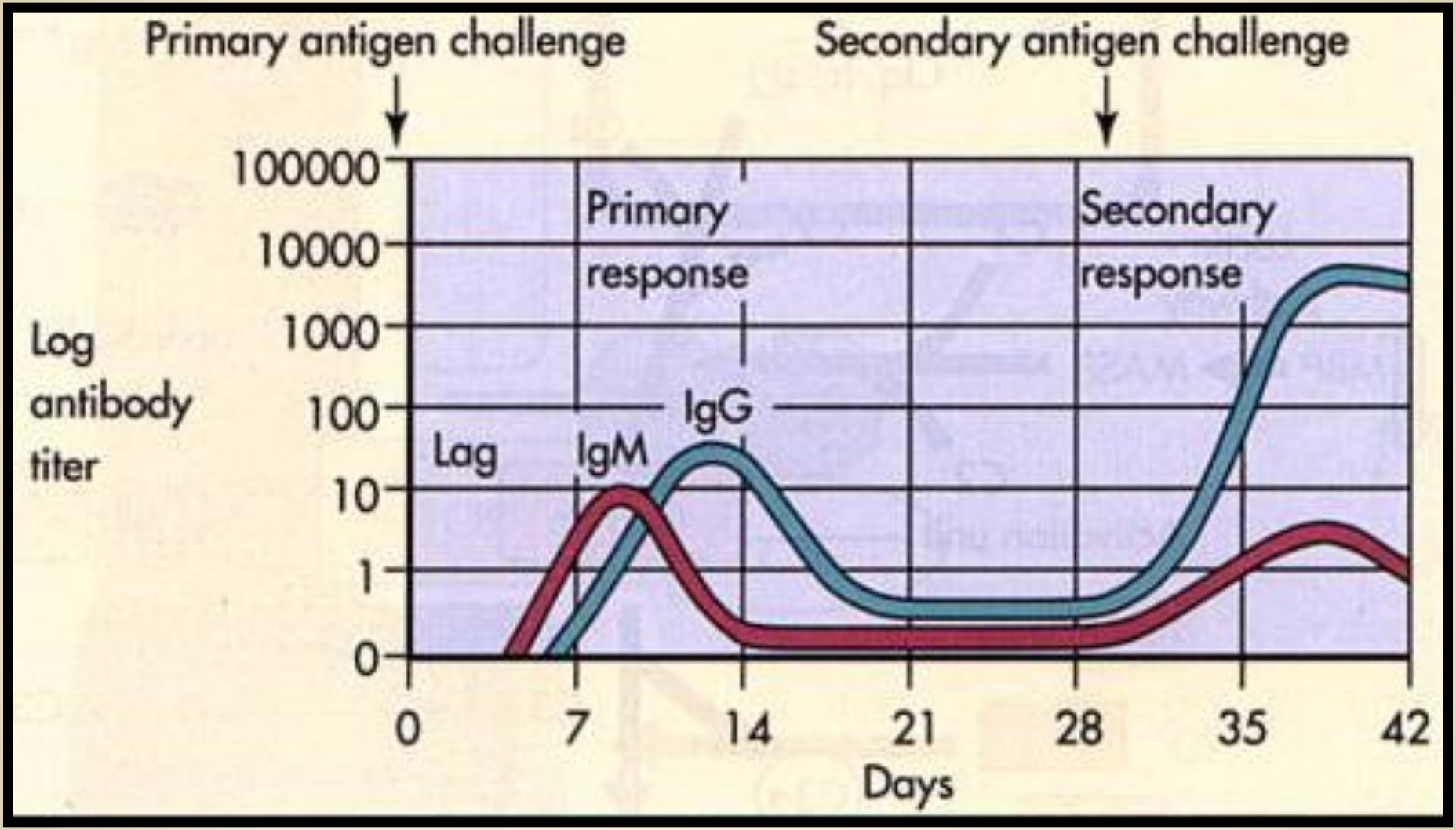
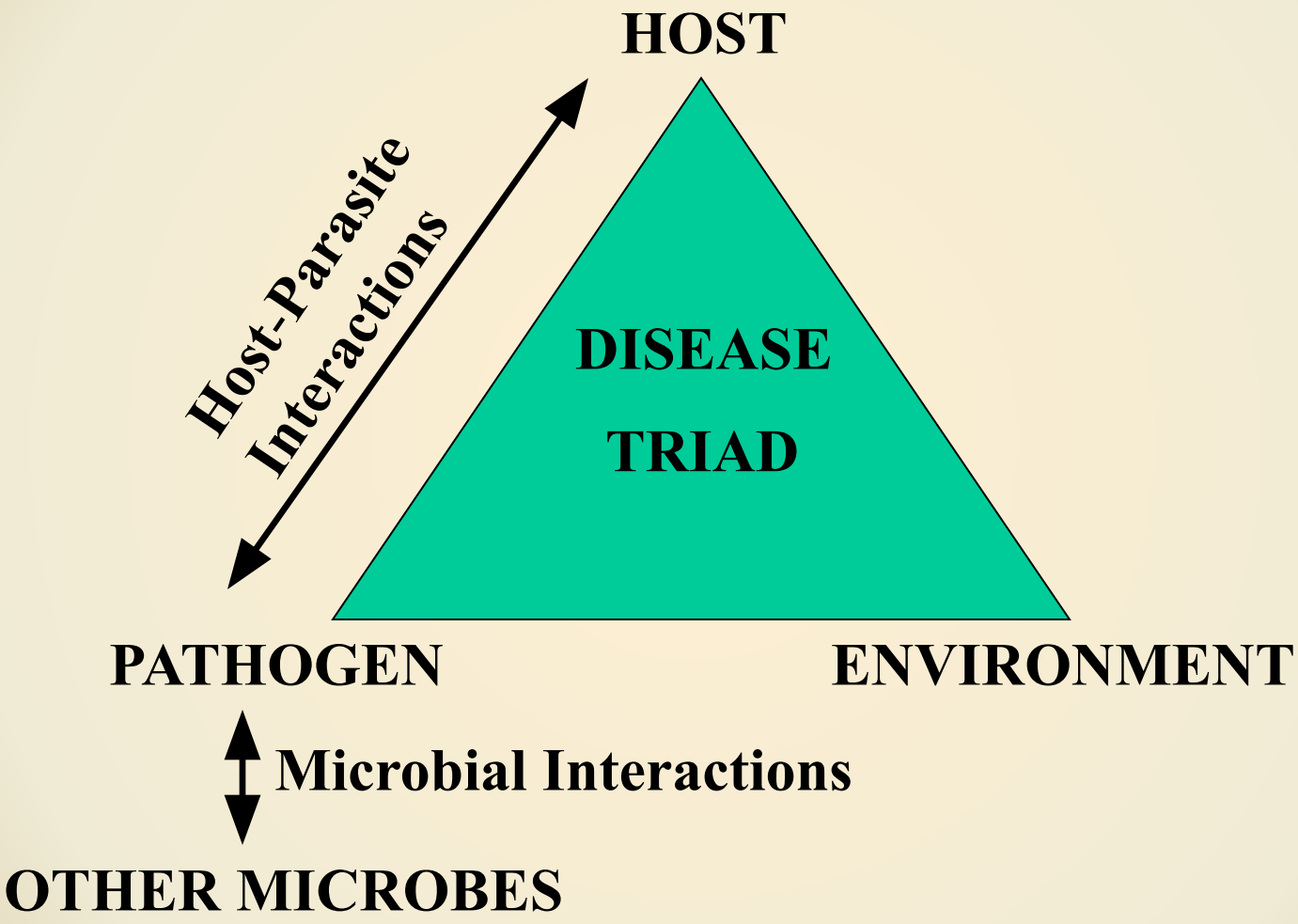


FIGURE 12–1. Comparative structures of the immunoglobulin (Ig) classes and subclasses in humans. IgA and IgM are held together in multimers by the J chain. IgA can acquire the secretory component for the traversal of epithelial cells.


Primary antigen challenge
Secondary antigen challenge
100000
10000
1000
100
10
1
0
Log antibody titer
Primary response
Secondary response
IgG
IgM
Lag
0
7
14
21
28
35
42
Days

REVIEW


HOST
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REVIEW

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- Byproducts of growth (gas, acid)
- Superantigen
- Resistance to antibiotics

REVIEW

BASIC EFFECTS of ENDOTOXIN

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Three Major Types:

1. Hydrolyze membrane phospholipids (**phospholipases**); e.g., *Clostridium, Staphylococcus*
2. **Thiol-activated** cytolysins (**oxygen-labile**) alter membrane permeability by binding to cholesterol; e.g., *Streptococcus, Clostridium*
3. **Detergent-like activity** on cell membranes; e.g., *Staphylococcus,* rapid rate of lysis

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2. Endotoxin is LPS; lipid A is toxic	2. Protein
3. Heat stable	3. Heat labile
4. Antigenic; questionable immunogenicity	4. Antigenic and immunogenic
5. Toxoids not be produced	5. Toxoids can be produced
6. Many effects on host	6. Specific in effect on host
7. Produced only by gram-negative organisms	7. Produced by gram-positive & gram-negative organisms

REVIEW

MICROBIAL PATHOGENICITY (cont.)
RESISTANCE TO HOST DEFENSES

ENCAPSULATION and
ANTIGENIC MIMICRY, **MASKING** or **SHIFT**

CAPSULE, GLYCOCALYX or **SLIME LAYER**

Polysachharide capsules *Streptococcus pneumoniae, Neisseria meningitidis, Haemophilus influenzae*, etc.

Polypeptide capsule of *Bacillus anthracis*

EVASION or **INCAPACITATION** of **PHAGOCYTOSIS** and/or **IMMUNE CLEARANCE**

PHAGOCYTOSIS INHIBITORS: mechanisms enabling an invading microorganism to resist being engulfed, ingested, and or lysed by phagocytes/ phagolysosomes

RESISTANCE to **HUMORAL FACTORS**

RESISTANCE to **CELLULAR FACTORS**

REVIEW

MICROBIAL PATHOGENICITY (cont.)
DAMAGE TO HOST

DIRECT DAMAGE

(Tissue Damage from Disease Process):

Toxins

Enzymes

INDIRECT DAMAGE

(Tissue Reactions from Immunopathological Response):

Damage Resulting from Vigorous Host Immune Response (a.k.a, **immunopathogenesis; autoimmune hypersensitivy**)

Hypersensitivity Reactions (Types I - IV)

REVIEW

HYPERSENSITIVITY REACTIONS

TYPE I: ANAPHYLACTIC REACTION (ANAPHYLAXIS, ANAPHYLACTIC SHOCK): a life-threatening immediate hypersensitivity reaction to a previously encountered antigen, characterized by respiratory distress, vascular collapse, and shock; allergy or atopic diseases

TYPE II: CYTOTOXIC REACTION: a specific destructive action against certain cells by an invading agent; humorally mediated, autoimmune diseases, cytotoxic diseases, antibody diseases

TYPE III: IMMUNE COMPLEX REACTION: serum sickness diseases

TYPE IV: CELL-MEDIATED IMMUNE RESPONSE: delayed-type hypersensitivity, cell- mediated cytotoxic diseases, granulomatous diseases

REVIEW

HOST DEFENSE MECHANISMS (cont.)

CELLULAR IMMUNE RESPONSE: any immune response directed at the cellular level; includes **INFLAMMATION** and **PHAGOCYTOSIS** processes

INFLAMMATORY RESPONSE: a protective response of tissues affected by disease or injury characterized by **redness**, localized **heat**, **swelling**, **pain**, and possibly **impaired function** of the infected part

PHAGOCYTOSIS: the process by which certain phagocytes can **ingest extracellular particles** by engulfing them; particles **OPSONIZED** with antibody are more rapidly and efficiently ingested

T-LYMPHOCYTES and **CYTOKINES**

REVIEW

HOST DEFENSE MECHANISMS (cont.)

HUMORAL IMMUNE RESPONSE: the sum total of components of the immune response circulating in the blood or body fluids ; includes **ANTIBODY** and **COMPLEMENT** systems

COMPLEMENT PROTECTIVE SYSTEM: a protein system in serum that combines with antibodies to form a defense against cellular antigens

B-LYMPHOCYTES and
ANTIBODY PRODUCTION: a class of proteins produced as a result of the introduction of an antigen that has the ability to combine with the antigen that caused its production

REVIEW