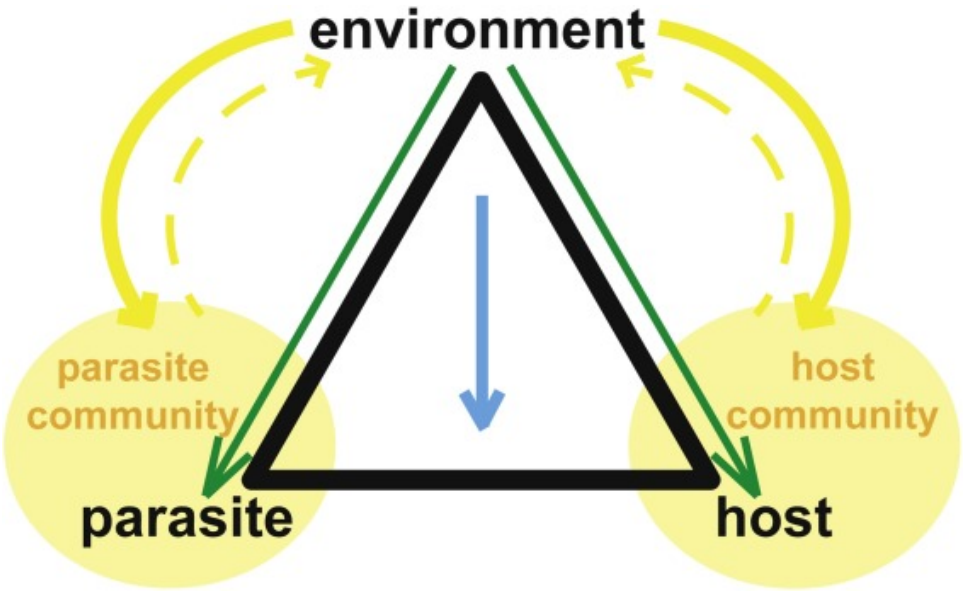
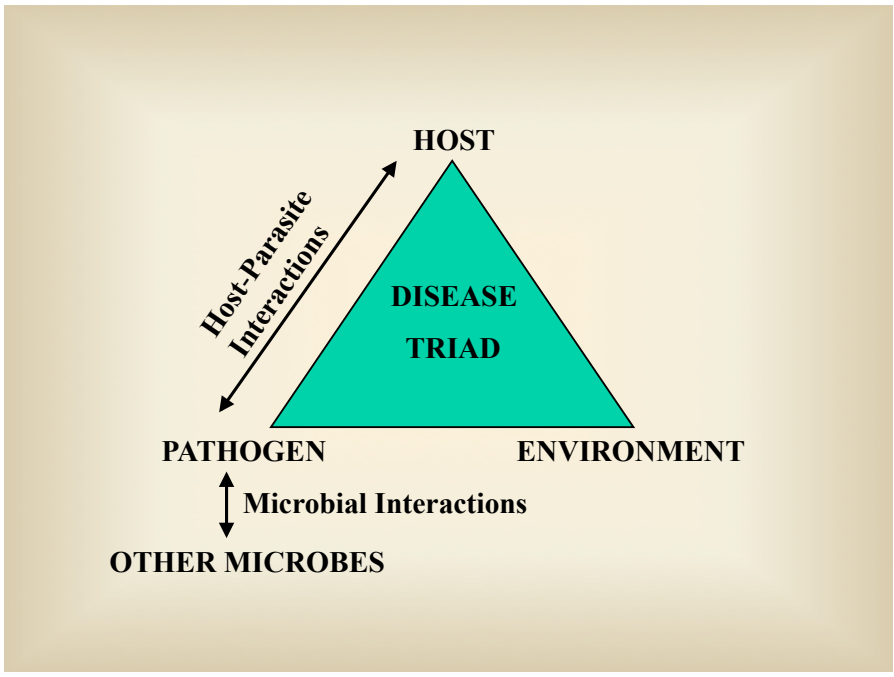
HOST-PARASITE INTERACTIONS



ECOLOGICAL RELATIONSHIPS
Microbial Interactions
Host-Parasite Interactions
Environment



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 15° to 20°C

Mesophile (mesophilic): liking moderate temperatures;
Optimal growth at 20° to 45°C

Thermophile (thermophilic): liking elevated temperatures;
Optimal growth at 50° to 70°C

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

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

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 $\mathbf{LD_{50}}$ (lethal dose 50%)

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.

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

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

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

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)