

General Principles of Microbiology

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Micro = small

Bio = life

Logy = study (of) or science

Immunology: study of our protection from foreign macromolecules or invading organisms and our responses to them

Different Classes of Organisms:

- Viruses/chlamydia (grow only in living cells)
- Mycoplasma (grown on non-living media)
- Bacteria (no separate nucleus; unicellular)
- Parasites
 - Small (microscopic)
 - 1-2 microns (1mm = 1000 microns)

What are they made of?

- Viruses
 - Nucleic acid (either RNA or DNA, not both)
 - Surrounded by protein shell (capsid)
 - Attach, inject nucleic acid (penetration), hijack synthetic processes inside cells to make more viruses, package, get out while going is good
- Bacteria
 - Prokaryotes
 - Rigid cell wall to keep things in place
 - Genetic material -circular chromosome
 - No nucleus (nucleoid)
 - Both DNA and RNA
 - Binary fission
 - Some bacteria do not have a rigid cell wall and are more fragile (mycoplasmas)
- Eukaryotes
 - Unicellular and multicellular animals and plants

- Unicellular and multicellular animals and plants
- Genetic material is organized into a nucleus

Are all bacteria bad?

- Biotechnology, spoilage of foods, bioremediation, functional foods, etc...

Can we live without bacteria?

"Normal" Flora - They Good Guys

- Resident vs. Transient
- GI tract: colon is inhabited by anaerobes and coliform (resident)
- Skin: mostly coagulase negative staphylococci (transient)
- Transient flor is found in specific locations
- Where should there be no bacteria?
- Protect from invasive (bad) bacteria
- Used in metabolism (vitamin K), immune stimulation, balance normal flora
- Controlled by host defences

Bacterial Infections

- Occur when a single species becomes predominate at a site.
- Outcome determined by the bacterial pathogenicity factors and host response

What protects us from the bad guys?

- Mechanical barriers
 - Skin, saliva, mucous, tears, hairs, etc.
- Other helpers include
 - Adherence
 - Phagocytosis: macrophages, neutrophils
 - Ingest bacteria (killing them)
 - Attach to and form vacuole around bacteria
 - Some bacteria have capsule to prevent this
 - Antibodies
 - For bacteria that have capsule - antibodies bind to alter the surface of the capsule, allowing the bacteria to be ingested by phagocytes (opsonization)
 - Can kill orgnaisms directly
 - Complements:
 - Complex system of plasma proteins that work together to resist bacterial infection

- Roles: kill bacteria and enhance immune response
- Immune cells (T-cells, NK cells, macrophages)
- Immune system (cell mediated; humoral)
 - Cell mediated: macrophages
- Endo/exo-toxin production
 - Exotoxin: bacteria produce this to damage host tissue; host defence against is antibody

Interactions Between Pathogenicity Mechanisms and Host Defences

- Metastatic spread: bacteria distributed around body (via blood); primary infection focused on first (by immune system) than infection in the blood stream)

How do the bad guys get in?

- Adherence: bacteria must adhere to the host
 - Via Ligands (able to bind to specific receptors on the cell surface)
 - Must happen to initiate an infection
- Toxin production (destroys some of our defenses)
- Opportunism
- Compromised host (how does this happen?): may be due to a disease process or medical/surgical procedure (+ medication)

Bacteraemia versus septicaemia? (aemia = blood)

Infectious disease and the human (immune) response is to become sick to work out the toxins

Microbial disease

- Interaction between microorganisms and the host (us) is a continuous battle
 - They need to enter-live-multiply
- In order to enter, they need to colonize (establish and multiply) in/on body; clinical infection (disease) can result when damage occurs to host [contamination = disposition without multiplication]
- Clinical disease = easy to recognize
- Sub-clinical infection = hard to diagnose (no symptoms)

How do we measure how dangerous a bacteria/virus/ parasite is?

- Pathogenicity = ability to produce disease

- Virulence = relative capacity to cause damage (i.e. the degree of pathogenicity)
- Opportunistic = do not normally cause disease but can do so when defense mechanism(s) breached or compromised

Pathogenesis of infectious disease

- A pathogenic microorganism enters your body... two things happen:
 - a. Microorganisms (invader) tries to multiply/invade and cause disease (second degree response)
 - b. Host tries to prevent this
- Whether the invader wins or not is dependent on several factors
 - Transmission: the transfer of an effective challenge amount from a source to a host
 - Inhalation, ingestion, break in protective barrier, direct deposit
 - Pathogenicity: capacity to inflict damage; result of -
 - Invasiveness (adherence, persistence, avoidance of immune system)
 - Toxinogenicity (ability to make toxins)
 - Invasiveness: A bacteria needs to adhere, evade and invade the host
 - Tools used to achieve these huge objectives
 - Surface structures (pili, fimbriae): adhere to specific receptors on cell surfaces
 - Capsules: polysaccharides, protect against leucocytes
 - Enzymes:
 - ◆ Coagulase: accelerates clotting of plasma; barrier against leukocytes and body fluids around infection
 - ◆ Hyaluronidase: hydrolyses the polymerized hyaluronic acid; helps bacteria by liquefying the viscous polymer and facilitating the spread of fluids carrying the bacteria

Toxinogenicity

- Toxins are substances (usually proteins) secreted by bacteria with the hope to cause damage
- Two classes
 - Exotoxins
 - Excreted by living cells
 - Specific affinities
 - Small concentrations
 - Thermolabile (sensitive to heat)
 - Potent

○ **ENDOTOXINS**

- Liberated only when cell wall disintegrates
- Less specific, causes fever, malaise, shock
- Thermostable (resistant to heat)
- Less potent than exotoxins