Normal host microbiota

- residents
- transients

bacteria in colon

Resident microbiota of the skin

- scalp
- outer ear
- eyes
- skin
- genitourinary/anal
- axilla
- palms
- feet

Resident microbiota of the respiratory tract

- Nose
- Mouth
- Throat
- Epiglottis
- Trachea
- Bronchial tube
- Bronchioles
Resident microbiota of the upper digestive tract

- mouth
- esophagus
- stomach
- small intestine

Resident microbiota of the lower digestive tract

- large intestine

Resident microbiota of the urinary & reproductive systems

- Uterus
- Bladder
- Ovary
- Cervix
- vagina
- Urethra (male)
Opportunistic pathogens (or, when good bugs go bad)

Immune suppression

Changes in normal microbiota

Ectopic microbiota

Pathogenicity and virulence

<table>
<thead>
<tr>
<th>mild virulent</th>
<th>moderately virulent</th>
<th>highly virulent</th>
</tr>
</thead>
<tbody>
<tr>
<td>sometimes causes</td>
<td>often causes</td>
<td>always causes</td>
</tr>
<tr>
<td>disease</td>
<td>disease</td>
<td>disease</td>
</tr>
</tbody>
</table>

How do pathogens infect host?

**Portals of entry**

- broken skin
- insect bite
- ear
- conjunctiva of eye
- nose
- mouth
- placenta
- vagina
- anus
- urethra
How do pathogens infect host?
Adhesion

- **Intestinal mucosa**
- **E. coli**
- **Microbe**
- **Ligand**
- **Receptor (glycoprotein)**
- **Cytoplasmic membrane**
- **Sugar residues**

**Invasive Enzymes**

- **Hyaluronidase & Collagenase**
- **Bacterium**
- **Hyaluronidase**
- **Collagenase**
- **Epithelial cells**
- **Collagen layer**
- **Bacteria invade deeper tissues**

*Example: collagenase from Clostridium perfringens*

**Enzymes for Evading Host Defenses**

- **Coagulase & Kinase**
- **Bacterium**
- **Clot**
- **Clotting protein**
- **Kinase**

*Example: Staphylococcus aureus*
Other Avoidance Mechanisms: Capsules

www.bact.wisc.edu/~ jarhood/structs.html

Tricks to Avoid Host Defenses: Toxins

- Toxins
- Intoxications
- Toxemia

More Virulence Factors: Exotoxins

bacterium cytotoxin
also neurotoxin, enterotoxin
Exotoxins: botulin toxin

Clostridium botulinum

Exotoxins: Tetanus Toxin

Clostridium tetanus
blocks synaptic transmission to inhibitory neurons needed to relax antagonist muscles

More Virulence Factors: Endotoxins
### Pathogenesis

<table>
<thead>
<tr>
<th>Source</th>
<th>Exotoxin</th>
<th>Endotoxin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gram + and Gram −</td>
<td>Gram −</td>
<td>Gram −</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relation to bacteria</th>
<th>Exotoxin</th>
<th>Endotoxin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metabolic product secreted from living cell</td>
<td>Protein or short peptide</td>
<td>Portion of O.M. released upon cell death</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemical nature</th>
<th>Exotoxin</th>
<th>Endotoxin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein or short peptide</td>
<td>Lipid A</td>
<td>Lipid A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Toxicity</th>
<th>Exotoxin</th>
<th>Endotoxin</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Low but may be fatal in high doses</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heat stability</th>
<th>Exotoxin</th>
<th>Endotoxin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstable &gt; 60°C</td>
<td>Stable for up to 1 hour at 121°C</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effect on host</th>
<th>Exotoxin</th>
<th>Endotoxin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyto-, neuro-, or enterotoxity</td>
<td>Fever, lethargy, shock, malaise, blood coagulation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pyrogenic?</th>
<th>Exotoxin</th>
<th>Endotoxin</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Antigenicity?</th>
<th>Exotoxin</th>
<th>Endotoxin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong</td>
<td>Weak</td>
<td></td>
</tr>
</tbody>
</table>

### Disease progression

- **Ear (ear wax)**
- **Broken skin (blood)**
- **Mouth (saliva, sputum)**
- **Tears**
- **Nose (secretions)**
- **Feces**
- **Urine**
- **Semen**

### Periods of disease

- **Period of incubation**
- **Period of prodromal symptoms**
- **Period of acme**
- **Period of decline**
- **Convalescence**

### Notes

- I'm breathing out lots of measles viruses.
- This is terrible. I'm missing microbiology class.
- Back to school! And perhaps I'll get a new hairstyle.
- I'm breathing out lots of measles viruses.

### Portals of exit

- **Ear (ear wax)**
- **Broken skin (blood)**
- **Mouth (saliva, sputum)**
- **Tears**
- **Nose (secretions)**
- **Feces**
- **Urine**
- **Semen**