**Virulence**

I - Invasiveness

A - Increase spread (penetration)

1 - Enzymatic factors

a- Hyaluronidase-enzyme which increases microbe's invasiveness by breaking down hyaluronic acid (connective tissue matrix cement).

b- Collagenase-enzyme which breaks down collagen.

c- Streptokinase-a fibrinolysin (lyses fibrin) which dissolves clots.

d- Lecithinase-enzyme which breaks down lecithin (phospholipid component of cell membranes).

e- Hemolysins-special lecithinases which can break down erythrocyte plasma membranes. Destruction of RBCs will ultimately favor and promote the growth of bacterial anaerobes.

B - Resist phagocytosis

1 - Enzymatic factors

a- Leukocidin-Streptococcal (some Staphylococci too) WBC (leukocyte) killing factor. WBCs (phagocytes specifically) are literally exploded when they engulf organisms capable of elaborating leukocidin.

b- Coagulase-enzyme which clots fibrin (reverse activity of streptokinase). Creates walled off areas such as boils (furuncles). *Staphylococci* can elaborate this enzyme.

2 - Capsule production-well organized and firmly attached glycocalyx forms a capsule. The bacterial organism with its capsule is too large for engulfment by a phagocyte.

3 - Cell wall components

a- M protein-protein that helps bacteria stick to host epithelial cells. This makes phagocytosis difficult.

b- A protein-see M protein.

4 - Flagellation-motile organisms can literally move away from phagocytic cells.
C – Other factors

1 - Necrotizing factor-kills body cells and in doing so, can create anaerobic conditions.

2 - Hypothermic factor-decreases body temperatures and decreases immune cell activity.

3 - Edema producing factors-makes capillaries more permeable. Bacteria can more readily leave these capillaries.

II - Toxigenicity

A - Exotoxins- Extremely lethal in some cases. 1 mg. of botulinum toxin can kill approximately 1 million guinea pigs.

1 - Produced by mostly Gram positives and some Gram negatives

2 - Secreted into fluids by living cells

3 - Chemically they are polypeptides

4 - Specific tissue affinities and functions

   a – cytotoxins - kill host cells directly or affect functions of cells which are ultimately fatal. Impetigo which is typically caused by Staphylococci in the newborn and Streptococci in toddlers and grade school children is spread by contact and is characterized by pustules that become crusted and rupture. These organisms are producing cytotoxins that can damage RBC's and injure tissues.

   b - neurotoxins – interfere with nerve impulse transmission. Clostridium botulinum can secrete a neurotoxin which can cause muscle paralysis.

   c – enterotoxins affect cells lining the G. I. tract. Escherichia coli can produce an enterotoxin that is associated with the symptoms of Traveler's Diarrhea.

5 – Can be denatured by heat or U.V. and inactivated by chemicals. They are not stabile. Therefore, they can be made into a type of vaccine known as toxoids. Toxoids can be injected and will trigger the body into antibody production against the original active exotoxin.

6 – Febrile reactions are minimal
B – Endotoxins – located in cell walls of Gram negative bacteria.

1 – Produced by Gram negatives only

2 – Released upon lysis of dead cells (walls)

3 – Chemically they are lipopolysaccharides (LPS component of Gram negative cell walls)

4 – Produce non-specific or generalized reactions. Proteus, for example, can cause urinary tract infections (UTI’s) with the associated symptoms of endotoxins.
   a – fever (can be quite pronounced)
   b – weakness and aches
   c – shock (endotoxic shock from vasodilation and capillary permeability)

5 – Endotoxins are heat stable and cannot be made into toxoids.