Bacterial pathogens - Topics

Pathogens vs. “normal” bacteria

Some components/aspects of pathogenic bacteria

Host cell adhesion and invasion

Survival inside cells

Bacterial toxins and methods of cell killing

Antibiotics

Pathogens vs. “normal” bacteria

Commensalism
10^{13} mammalian cells
10^{14} “others”

Parasitism/Pathogenesis
No benefit
Use up resources
Cause disease

A successful parasite –

Does minimal damage to the host

Uses host’s respiratory, excretory and reproductive systems to reach other hosts

Role of immune system

Example of pathogenic bacterial diseases: Tetanus

Disease causing organism	symptoms	Reservoir	Mode of transmission
Clostridium tetani	Severe spasms, rigidity of muscles, lockjaw	Soil	Puncture wounds contaminated by bacterial spores

Source: Royal College of Surgeons of Edinburgh, Scotland

Example of pathogenic bacterial diseases: Anthrax (Pulmonary/Gastrointestinal/Cutaneous)

Disease causing organism	symptoms	Reservoir	Mode of transmission
Bacillus anthracis	1) Pulmonary: Pneumonia 2) Gastrointestinal: GI difficulties, vomiting of blood 3) Cutaneous: Skin lesions, toxemia	Soil, Animals	Ingestion, puncture wounds contaminated by bacterial spores

Source: US army

Example of pathogenic bacterial diseases: Plague (Bubonic/Septicemic/Pneumonic)

Disease causing organism	symptoms	Reservoir	Mode of transmission
Yersinia pestis	1) Bubonic: Swelling of lymph nodes, gangrene of extremities, spread 2) Septicemic: Blood clots, necrosis 3) Pneumonic: Severe infection of lungs	Rodents	Rat flea bites, air, direct contact

Source: The guardian

Example of pathogenic bacterial diseases: Cholera

Disease causing organism	symptoms	Reservoir	Mode of transmission
Vibrio cholerae	Severe diarrhea, vomiting, dehydration, electrolyte imbalance	Humans, water	Contaminated food, water

Source: CDC, Public Health images

Example of pathogenic bacterial diseases: Typhoid

Disease causing organism	symptoms	Reservoir	Mode of transmission
Salmonella typhi	High grade fever, rashes, intestinal perforations	Humans	Contaminated water, bad sanitation

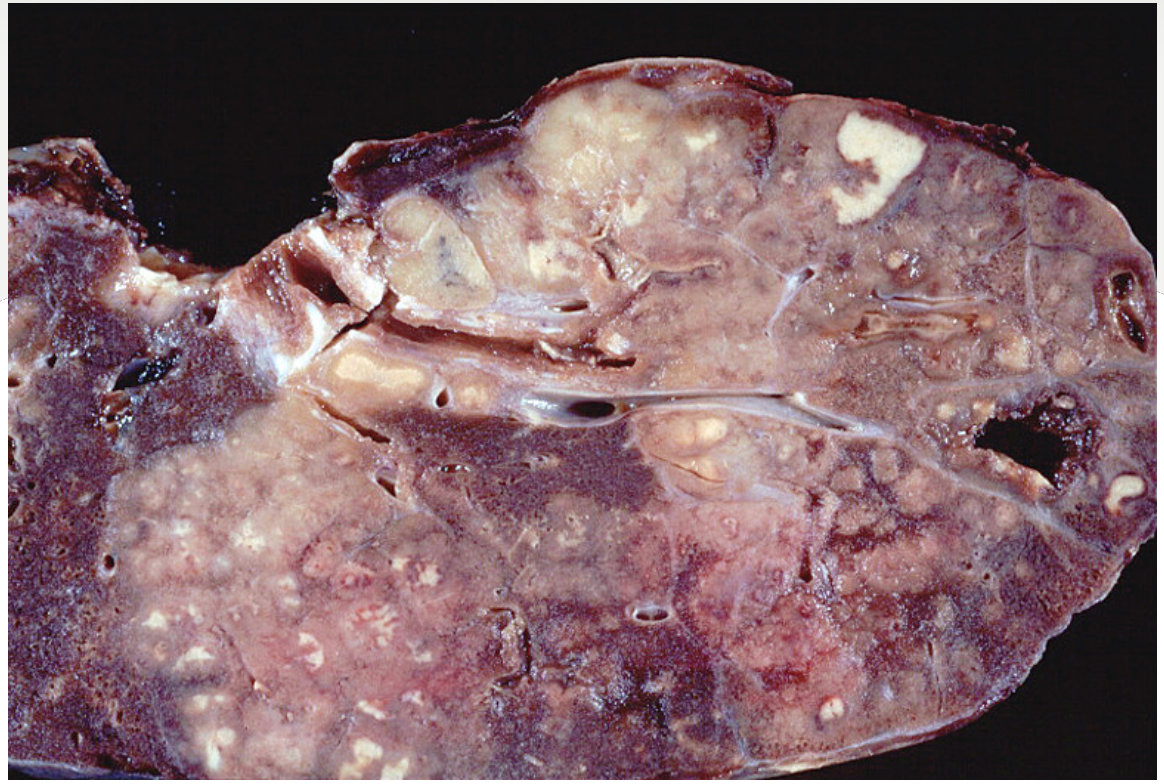
Source: zipheal.com

Example of pathogenic bacterial diseases: Listerosis

Disease causing organism	symptoms	Reservoir	Mode of transmission
Listeria monocytogenes	Gastrointestinal disorder, meningitis, spontaneous abortions	Humans, food	Contaminated food

Source: Listeria forum

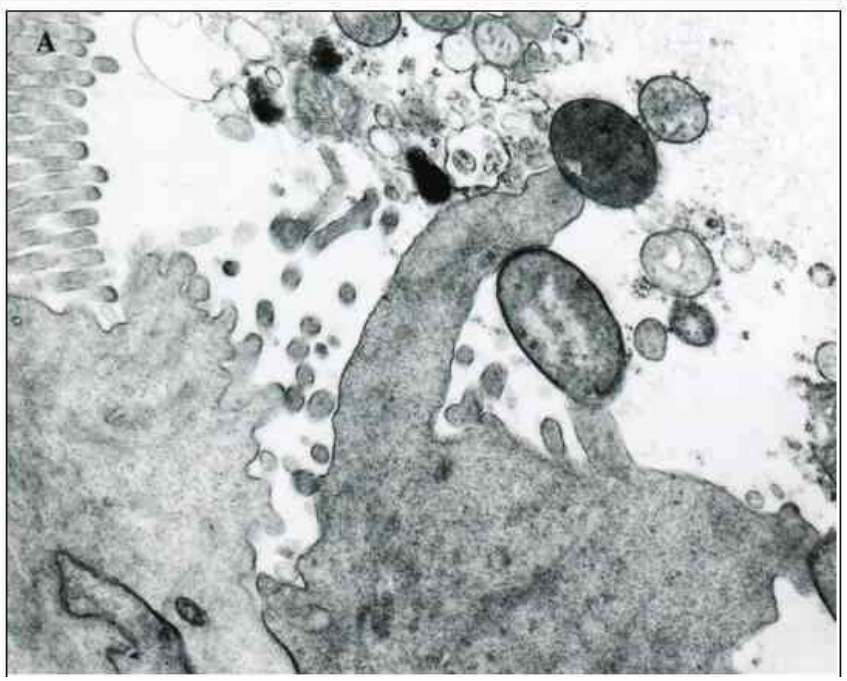
Example of pathogenic bacterial diseases: Tuberculosis



Disease causing organism	symptoms	Reservoir	Mode of transmission
Mycobacterium tuberculosis	Fever, cough, weight loss, chest pain	Humans	Air

Source: www.emedicinehealth.com

Example of pathogenic bacterial diseases: Enteropathogenic *E.coli* infections



Disease causing organism	symptoms	Reservoir	Mode of transmission
Enteropathogenic *E.coli* (EPEC)	Gastrointestinal disorder, severe diarrhea	Humans, food	Contaminated food, water

Source: CDC

Examples of disease-causing “normal” bacteria

Infection	*Causative organism(s)*
Urinary tract infection	*E. Coli* *Staphylococcus epidermis*
Pharyngitis	*Streptococcus pyogenes*
Toxic shock syndrome	*Staphylococcus aureus*
Gas gangrene	*Clostridium perfringes*

Reasons for opportunistic infections by “normal” bacteria

Damage to the epithelium

Presence of a foreign body

Suppression of immune system by drugs or radiation

Impairment of host defenses due to infection by an exogenous pathogen

Disruption of normal microflora by antibiotics

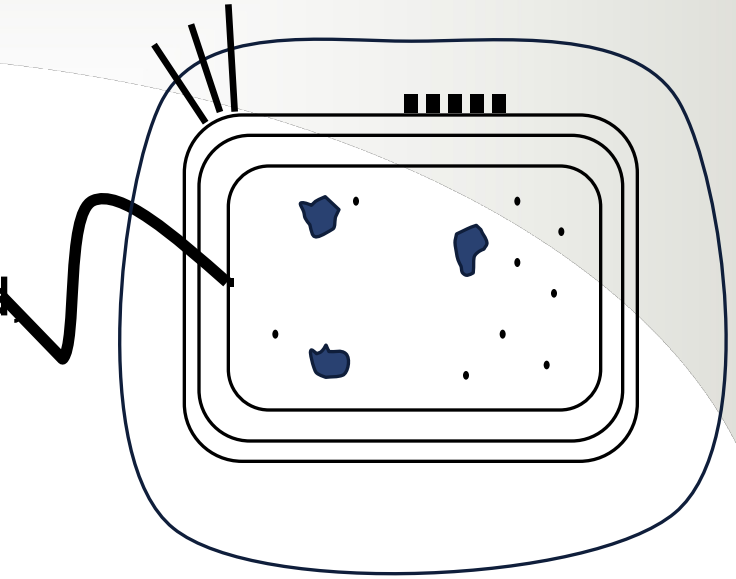
Some components of pathogenic bacteria

Diameter ~ 1 µm

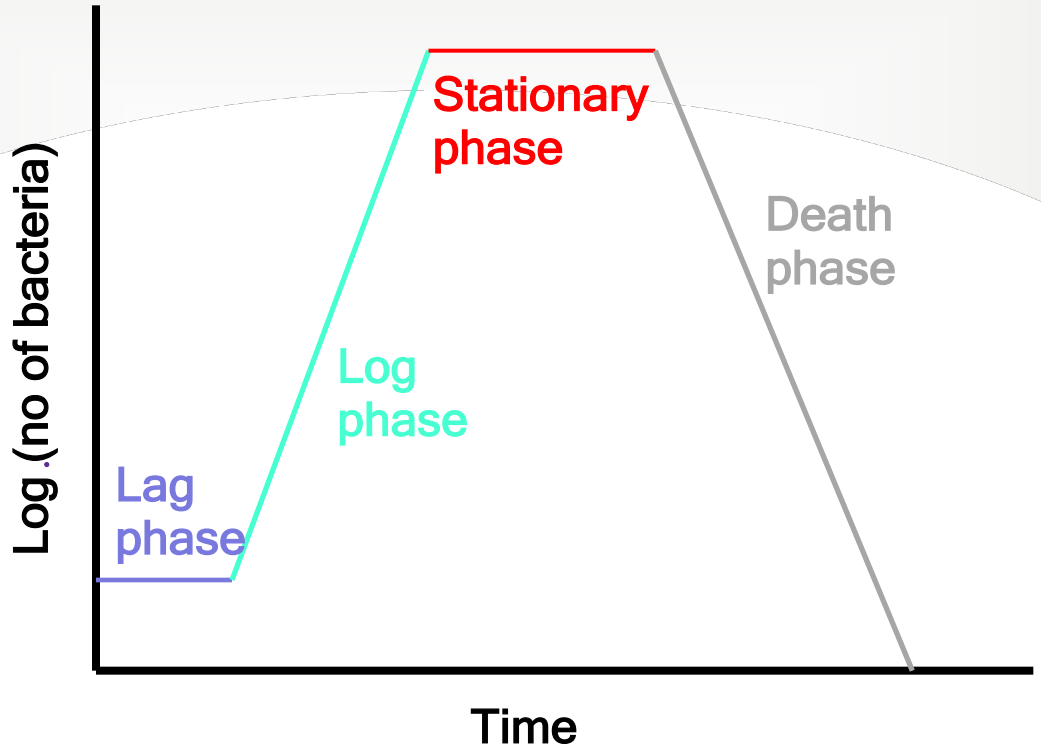
Nanobacteria (?) ~ 0.05 – 0.5 µm

Epulopiscium fishelsoni ~ 50 mm

Shape: spherical, rod-shaped, curved, coiled, pairs, chains, bunches, singles etc.



Bacterial growth curve in batch culture

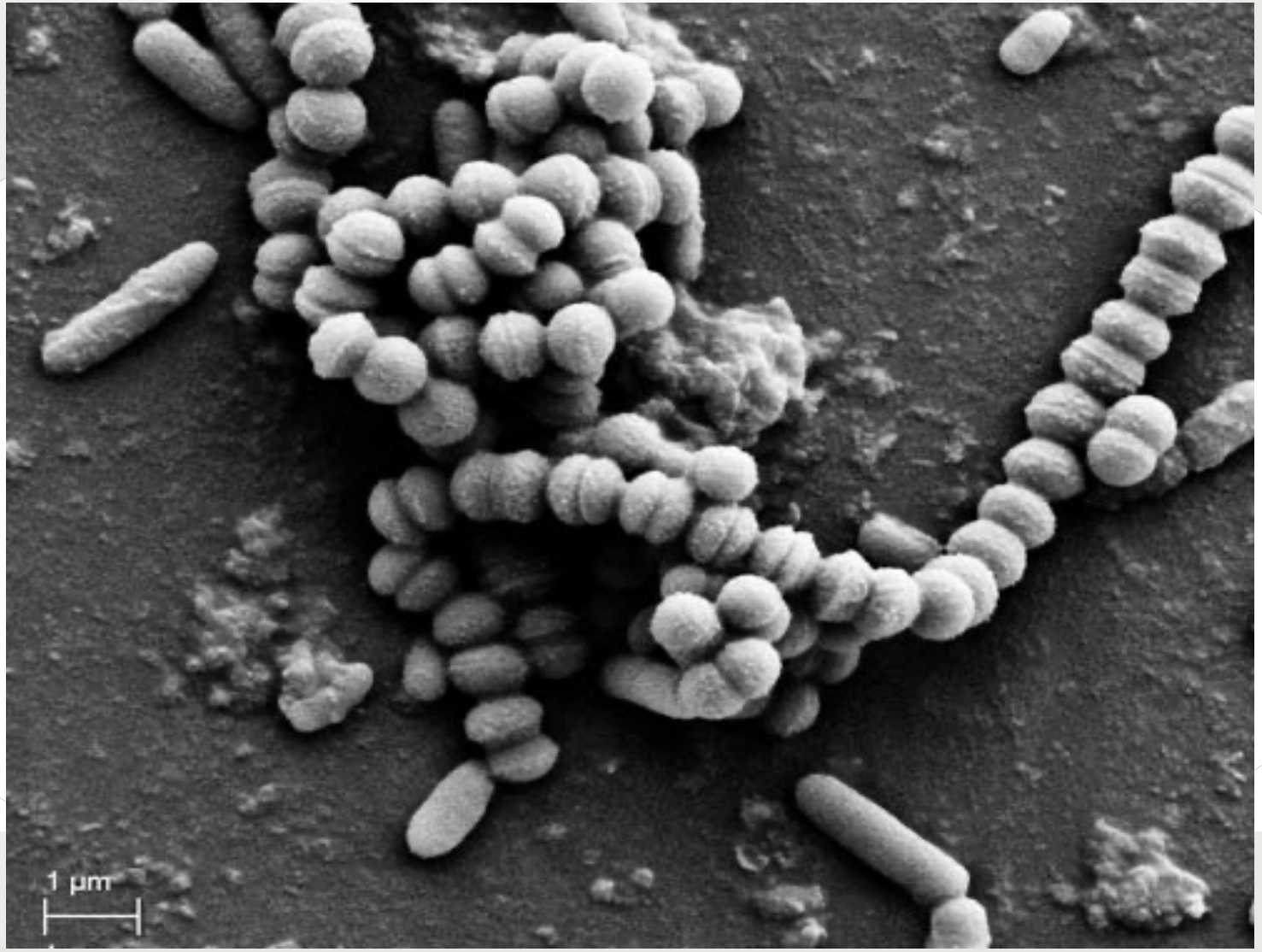


Generation time g = t/n = t/3.3 log b/B

Where B = no of bacteria present in the beginning point
b = no of bacteria present after a time period t
n = number of generations

Bacterial biofilms

An accumulation of bacteria and their products on a surface



Genetic aspects of bacterial virulence

Fast gene regulation – Gene to mRNA to protein synthesis in ~ 2 min, rapid turnover

Antigenic and phase variation – Effector proteins may be produced or not, or produced in different forms

Pathogenicity islands and plasmids – Most genes required for pathogenicity, drug resistance etc. grouped in one area, smart gene organization

Molecular chain of events in bacterial pathogenesis

Adhesion and entry into host cells

Survival inside cells

Circumventing host defense mechanisms

Growth and multiplication

Escape and further transmission

What do bacteria adhere to?

Skin
Mucosal layer of respiratory tract,
gastrointestinal tract
Urogenital tract

Adherence to internal surfaces – Connective tissues
Endothelial cells of blood vessels,
Lymphatic vessels

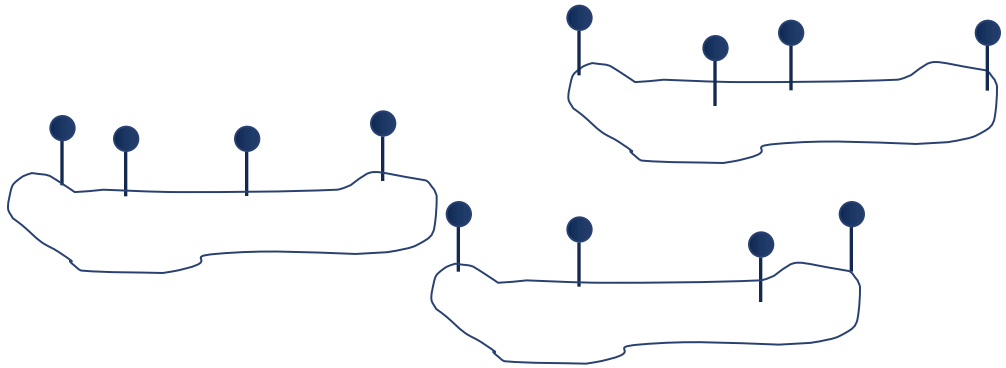
Host defense mechanism – Dryness, pH of skin
Removal of mucosal layer/shedding surfaces

What do bacteria adhere to?

Extracellular matrix components (ECM) – collagen, elastic, fibronectin, heparin

Lipid bilayer - Phosphatidylcholine, phosphatidylserine, phosphatidylinositol, sphingomyelin, cholesterol, glycolipids

Protein receptors on the cell surface – Integrins, growth factor receptors (some bacteria bring their own receptors – Intimin-Tir system of EPEC)



Infections may or may not spread through the body

Bacterial pathogens which disseminate throughout the body:
Listeria monocytogenes
Yersinia pestis
Mycobacterium
Salmonella typhi

Bacterial pathogens which do not disseminate throughout the body:
Helicobacter pylori
Vibrio cholerae
Clostridium tetani
Neisseria gonorrhoeae