Opportunistic Enterobacteriaceae

OPPORTUNISTIC INFECTIONS OF ENTEROBACTERIACEAE

- GRAM NEGATIVE SEPSIS
- URINARY TRACT INFECTIONS
- PNEUMONIA
- ABDOMINAL SEPSIS
- MENINGITIS
- SPONTANEOUS BACTERIAL PERITONITIS
- ENDOCARDITIS

OPPORTUNISTIC INFECTIONS (cont.)

GRAM NEGATIVE SEPSIS

- **Life-threatening**
- Usually **nosocomial**
- Commonly caused by ***E. coli***

PATHOGENESIS:

Early Phase (REVERSIBLE)

Decreased arterial resistance; Increased cardiac output

Kinins (protein vasodilators & mediators of inflammation) in plasma due to tissue damage, endotoxin, AG-AB complexes

Second Phase (REVERSIBLE)

Increased arterial resistance; Decreased cardiac output

Third Phase (IRREVERSIBLE)

Vascular collapse with organ failure

Endotoxin induced DIC, hemorrhage and death

OPPORTUNISTIC INFECTIONS (cont.)

URINARY TRACT INFECTIONS

- Usually **ascending infection**, not hematogenous route
- Greatest incidence in **young** & **middle-aged females**
- Incidence increases with **age in males**
- Most commonly caused by ***E. coli***
- Diagnosis by microscopic & cultural **exam of urine**
- Obtain urine by catheter through urethra into bladder, clean catch midstream (CCMS) or suprapubic tap

PNEUMONIA

- **Nosocomial**; Spread by personnel and equipment
- Frequently caused by ***K. pneumoniae***
- Often in middle-aged males who **abuse alcohol**
- Difficult to diagnose due to **commensals in sputum**

OPPORTUNISTIC INFECTIONS (cont.)

ABDOMINAL SEPSIS

- Caused by **flora of the GI tract**
- Infections usually **polymicrobial**

MENINGITIS

- Usually **nosocomial**
- Frequently caused by ***E. coli***
- Diagnosis by microscopic & cultural **exam of CSF**

OPPORTUNISTIC INFECTIONS (cont.)

SPONTANEOUS BACTERIAL PERITONITIS

- Usually in patients with **liver ailments**
- Commonly caused by ***E. coli***, but also **anaerobes** & **Gram-positive cocci** (*S. pneumoniae)*

ENDOCARDITIS

- **Vascular endocardial surface inflammation**
- Mostly caused by **Gram-positive cocci**, but 1-3% caused by aerobic Gram-negative rods
- Diagnosis by **blood culture**
- Difficult to treat; **Treatment is of long duration**

Virulence Factors Associated with Enterobacteriaceae

Common Virulence Factors

- Endotoxin
- Capsule
- Antigenic phase variation
- Sequestration of growth factors
- Resistance to serum killing
- Antimicrobial resistance

Factors Associated with Specific Pathogens

- Exotoxin production
- Expression of adhesion factors
- Intracellular survival and multiplication

Endotoxin-Mediated Toxicity

- **Fever**
- **Leukopenia** (reduced # of WBCs) (<5000/mm^3) followed by **leukocytosis** (increased # of WBCs)(>10-12,000/mm^3)
- Activation of **complement**
- **Thrombocytopenia** (reduced # of platelets)
- **DIC** (Disseminated intravascular coagulation)
- **Decreased peripheral circulation and perfusion** (blood flow) to major organs
- **Shock**
- **Death**

See Handout on
Enterobacteriaceae
General Information

Summary of Escherichia coli Infections

Physiology and Structure

Gram-negative bacilli.
Facultative anaerobe.
Fermenter.
Oxidase negative.
Outer membrane makes the organisms susceptible to drying.
Lipopolysaccharide consists of outer somatic O polysaccharide, core polysaccharide (common antigen), and lipid A (endotoxin).

Virulence

Refer to Boxes 29–2 and 29–3.
Endotoxin.
Permeability barrier of outer membrane.
Adhesins (e.g., colonization factor antigen, Dr adhesins).
Exotoxins (e.g., heat-stabile and heat-labile enterotoxins, Shiga toxins).
Invasive capacity.

Epidemiology

Most common aerobic, gram-negative bacilli in the gastrointestinal tract.
Most infections are endogenous (patient's normal microbial flora).
Strains causing gastroenteritis are generally acquired exogenously.

Diseases

Bacteremia (most commonly isolated gram-negative bacillus).

Summary of Escherichia coli Infections (cont.)

Urinary tract infection (most common cause of bacterial UTIs; limited to bladder (cystitis) or can spread to kidneys (pyelonephritis) or prostate (prostatitis).

At least six different pathogenic groups cause gastroenteritis (ETEC, EPEC, EIEC, EHEC, EAEC, DAEC); most cause diseases in developing countries, although EHEC is an important cause of hemorrhagic colitis (HC) and hemolytic uremic syndrome (HUS) in the United States.

Neonatal meningitis (usually with strains carrying the K1 capsular antigen).

Intra-abdominal infections (associated with intestinal perforation).

Diagnosis

Organisms grow rapidly on most culture media.

Treatment, Prevention, and Control

Treatment guided by in vitro susceptibility tests.

Infections are controlled by use of appropriate infection-control practices to reduce the risk of nosocomial infections (e.g., restricting use of antibiotics, avoiding unnecessary use of urinary tract catheters).

Maintenance of high hygienic standards to reduce the risk of exposure to gastroenteritis strains.

Proper cooking of beef products to reduce risk of EHEC infections.

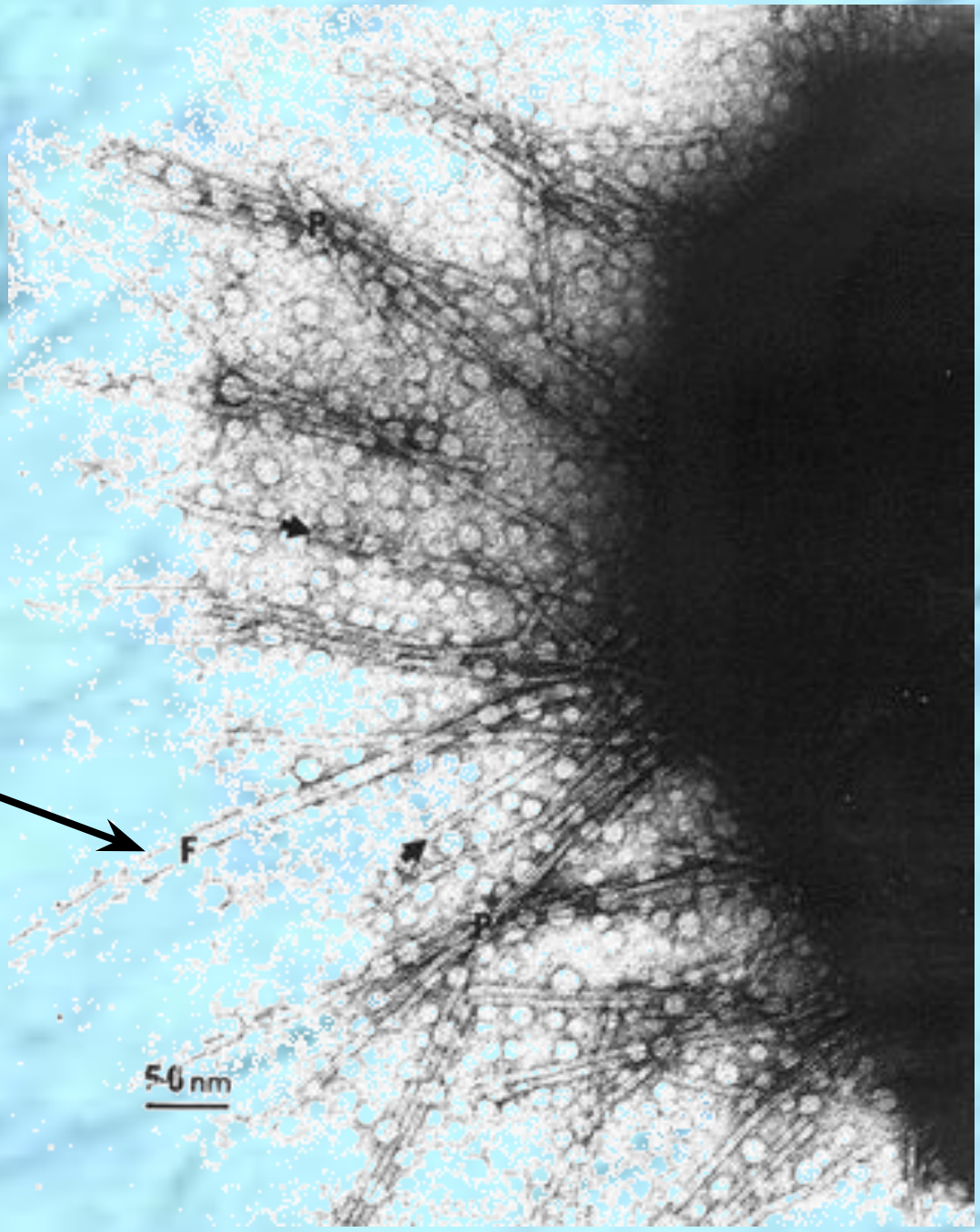
Gastroenteritis Caused by E. coli

Organism	Site of Action	Disease	Pathogenesis
Enterotoxigenic *E. coli* (ETEC)	Small intestine	Traveler's diarrhea; infant diarrhea in underdeveloped countries; watery diarrhea, vomiting, cramps, nausea, low-grade fever	Plasmid-mediated heat-stable and/or heat-labile enterotoxins that stimulate hypersecretion of fluids and electrolytes
Enteropathogenic *E. coli* (EPEC)	Small intestine	Infant diarrhea in underdeveloped countries; fever, nausea, vomiting, nonbloody stools	Plasmid-mediated A/E histopathology with disruption of normal microvillus structure resulting in malabsorption and diarrhea
Enteroinvasive *E. coli* (EIEC)	Large intestine	Disease in underdeveloped countries; fever, cramping, watery diarrhea; may progress to dysentery with scant, bloody stools	Plasmid-mediated invasion and destruction of epithelial cells lining colon
Enterohemorrhagic *E. coli* (EHEC)	Large intestine	Hemorrhagic colitis (HC) with severe abdominal cramps, initial watery diarrhea, followed by grossly bloody diarrhea; little or no fever; may progress to hemolytic uremic syndrome (HUS)	Mediation by cytotoxic Shiga toxins (Stx-1, Stx-2), which disrupt protein synthesis; A/E lesions with destruction of intestinal microvillus resulting in decreased absorption
Enteroaggregative *E. coli* (EAEC)	Small intestine	Infant diarrhea in underdeveloped countries; persistent watery diarrhea with vomiting, dehydration, and low-grade fever	Plasmid-mediated aggregative adherence of bacilli ("stacked bricks") with shortening of microvilli, mononuclear infiltration, and hemorrhage; decreased fluid absorption
Diffuse aggregative *E. coli* (DAEC)	Small intestine	Watery diarrhea in infants 1 to 5 years of age	Stimulates elongation of microvilli

Specialized Virulence Factors Associated with E. coli

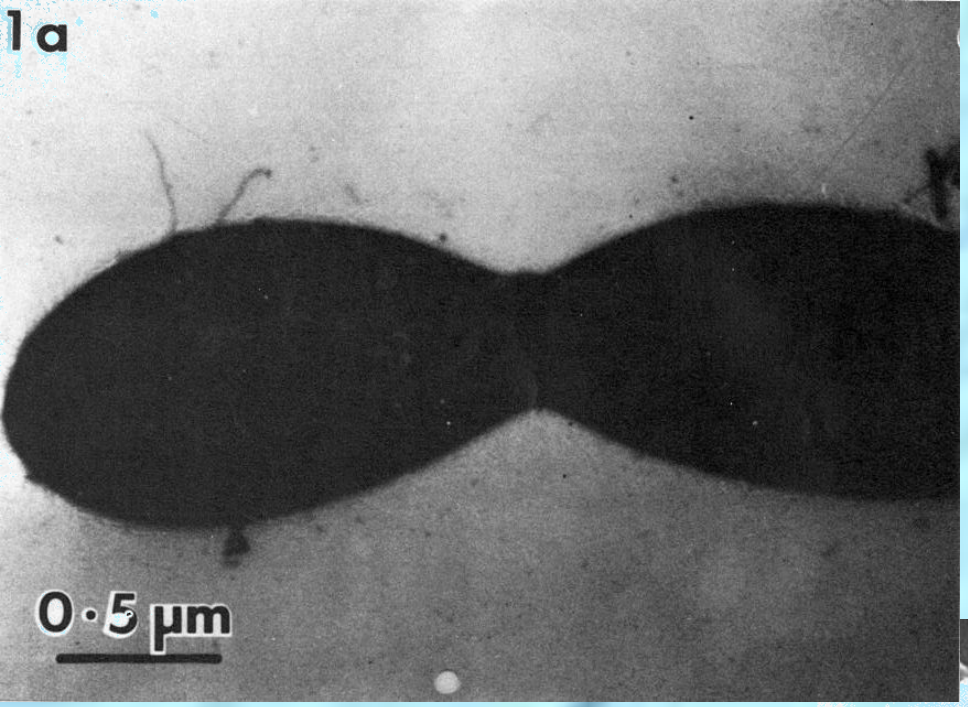
	Adhesins
	Type 1 pili
ETEC	Colonization factor antigens CFA/I, CFA/II, and CFA/III.
EAEC	Aggregative adherence fimbriae'AAF/I and AAF/II.
UPEC	
EPEC	Bundle-forming protein (Bfp).
	Intimin.
UPEC	P pili.
EIEC	Ipa protein.
UPEC	Dr fimbriae.
	Exotoxins
ETEC	Heat-stable toxins STa and STb.
EHEC	Shiga toxins Stx-1 and Stx-2.
UPEC	Hemolysin HlyA.
ETEC	Heat-labile toxins LT-I and LT-II.

Fimbriated Bacterial Cell

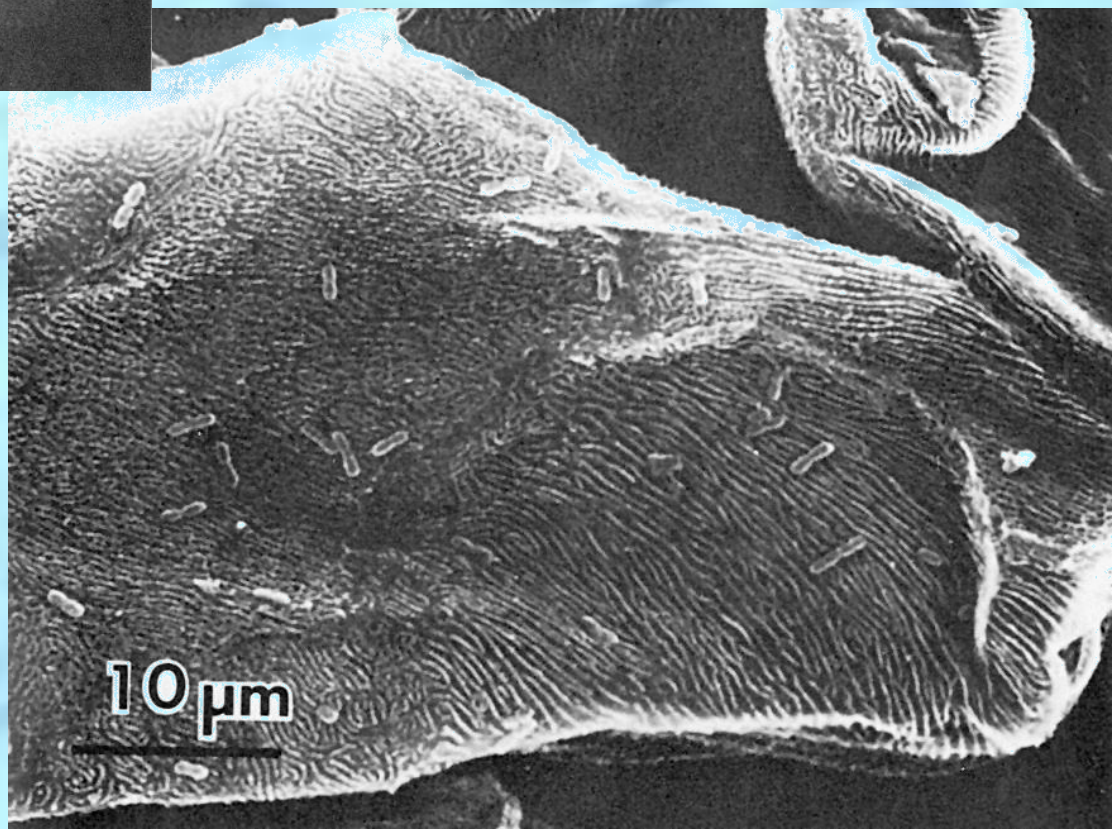


F = Flagellum

Note: All other appendages are fimbriae (a.k.a., pili)



Afimbriated
Bacterial Cells



Nonadherent
Afimbriated
Bacterial Cells
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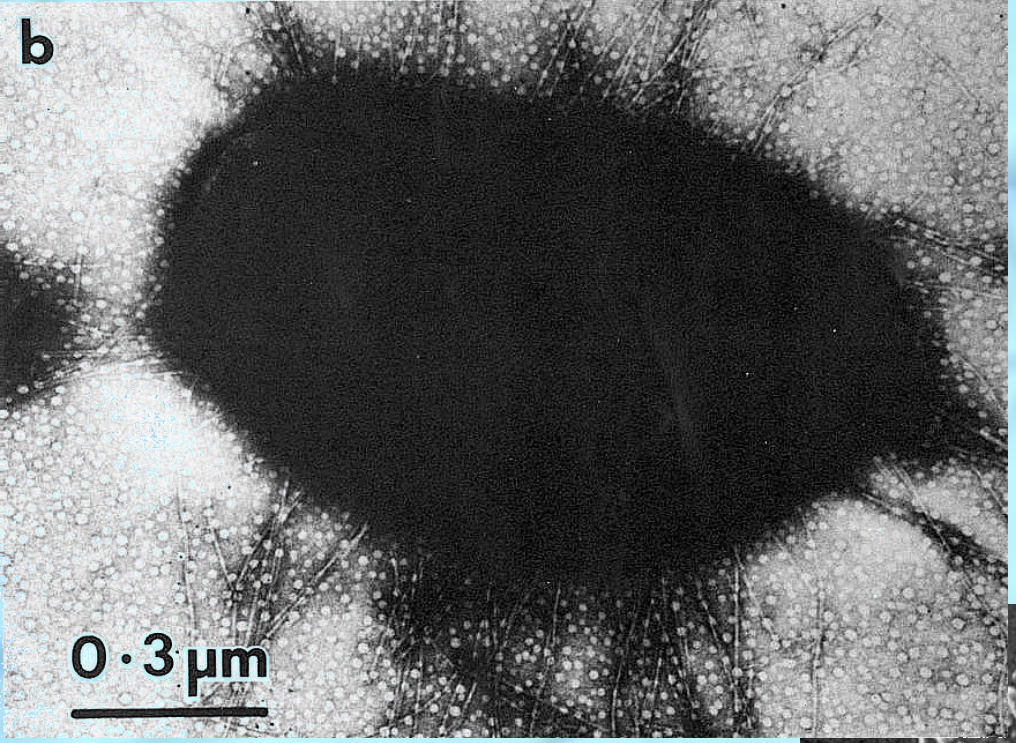

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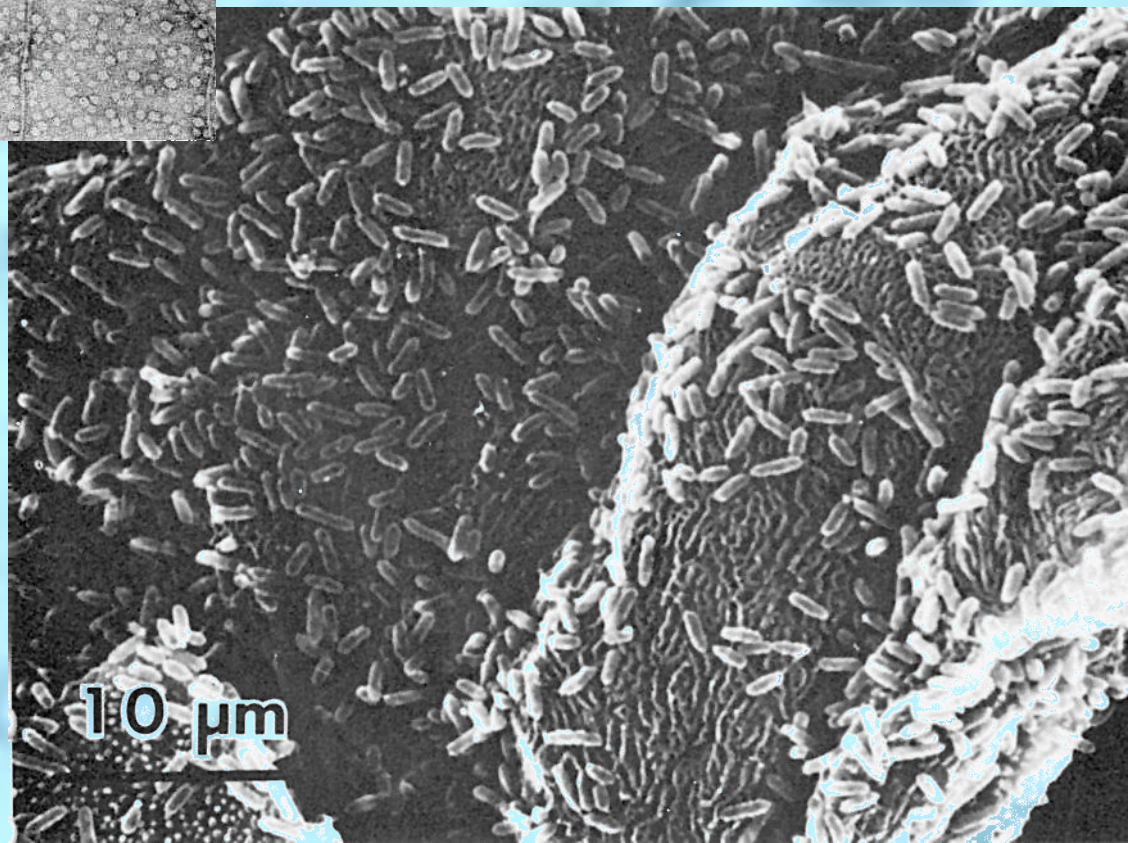

MICROBIAL PATHOGEN	ADHESIN		RECEPTOR
Staphylococcus aureus	**Lipoteichoic acid**		Unknown
Staphylococcus spp.	**Slime layer**		Unknown
Group A *Streptococcus*	**LTA-M protein complex**		**Fibronectin**
Streptococcus pneumoniae	Protein		N-acetylhexosamine-gal
Escherichia coli	Type 1 **fimbriae**	⟷	D-**Mannose**
	CFA 1 fimbriae	⟷	GM **ganglioside**
	P fimbriae	⟷	P blood grp glycolipid
Other Enterobacteriaceae	Type 1 fimbriae	⟷	D-Mannose
Neisseria gonorrhoeae	Fimbriae		GD_1 ganglioside
Treponema pallidum	P_1, P_2, P_3		Fibronectin
Chlamydia spp.	Cell surface lectin		N-acetylglucosamine
Mycoplasma pneumoniae	Protein P1		Sialic acid
Vibrio cholerae	Type 4 pili		Fucose and mannose

TABLE 19-3 Properties of A-B Type Bacterial Toxins

TOXIN	ORGANISM	GENETIC CONTROL	SUBUNIT STRUCTURE	TARGET CELL RECEPTOR	BIOLOGICAL EFFECTS
Anthrax toxins	*Bacillus anthracis*	Plasmid	Three separate proteins (EF, LF, PA)	Unknown, probably glycoprotein	EF + PA: increase in target-cell cAMP level, localized edema; LF + PA: death of target cells and experimental animals
Bordetella adenylate cyclase toxin	*Bordetella* species	Chromosomal	A-B	Unknown, probably glycolipid	Increase in target cell cAMP level, modified cell function or cell death
Botulinum toxin	*C. botulinum*	Phage	A-B	Possibly ganglioside (GD_{1b})	Decrease in peripheral, presynaptic acetylcholine release, flaccid paralysis
Cholera toxin	*V. cholerae*	Chromosomal	A-5B	Ganglioside (GM_1)	Activation of adenylate cyclase, increase in cAMP level, secretory diarrhea
Diphtheria toxin	*C. diphtheriae*	Phage	A-B	Probably glycoprotein	Inhibition of protein synthesis, cell death
Heat-labile enterotoxins	*E. coli* (ETEC)	Plasmid	Similar or identical to cholera toxin		
Pertussis toxin	*B. pertussis*	Chromosomal	A-5B	Unknown, probably glycoprotein	Block of signal transduction mediated by target G proteins
Pseudomonas exotoxin A	*P. aeruginosa*	Chromosomal	A-B	Unknown, but different from diphtheria toxin	Similar or identical to diphtheria toxin
Shiga toxin	*Shigella dysenteriae*	Chromosomal	A-5B	Glycoprotein or glycolipid	Inhibition of protein synthesis, cell death
Shiga-like toxins	*Shigella* species, *E. coli* (EHEC)	Phage	Similar or identical to Shiga toxin		
Tetanus toxin	*C. tetani*	Plasmid	A-B	Ganglioside (GT_1) and/or GD_{1b}	Decrease in neurotransmitter release from inhibitory neurons, spastic paralysis

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REVIEW

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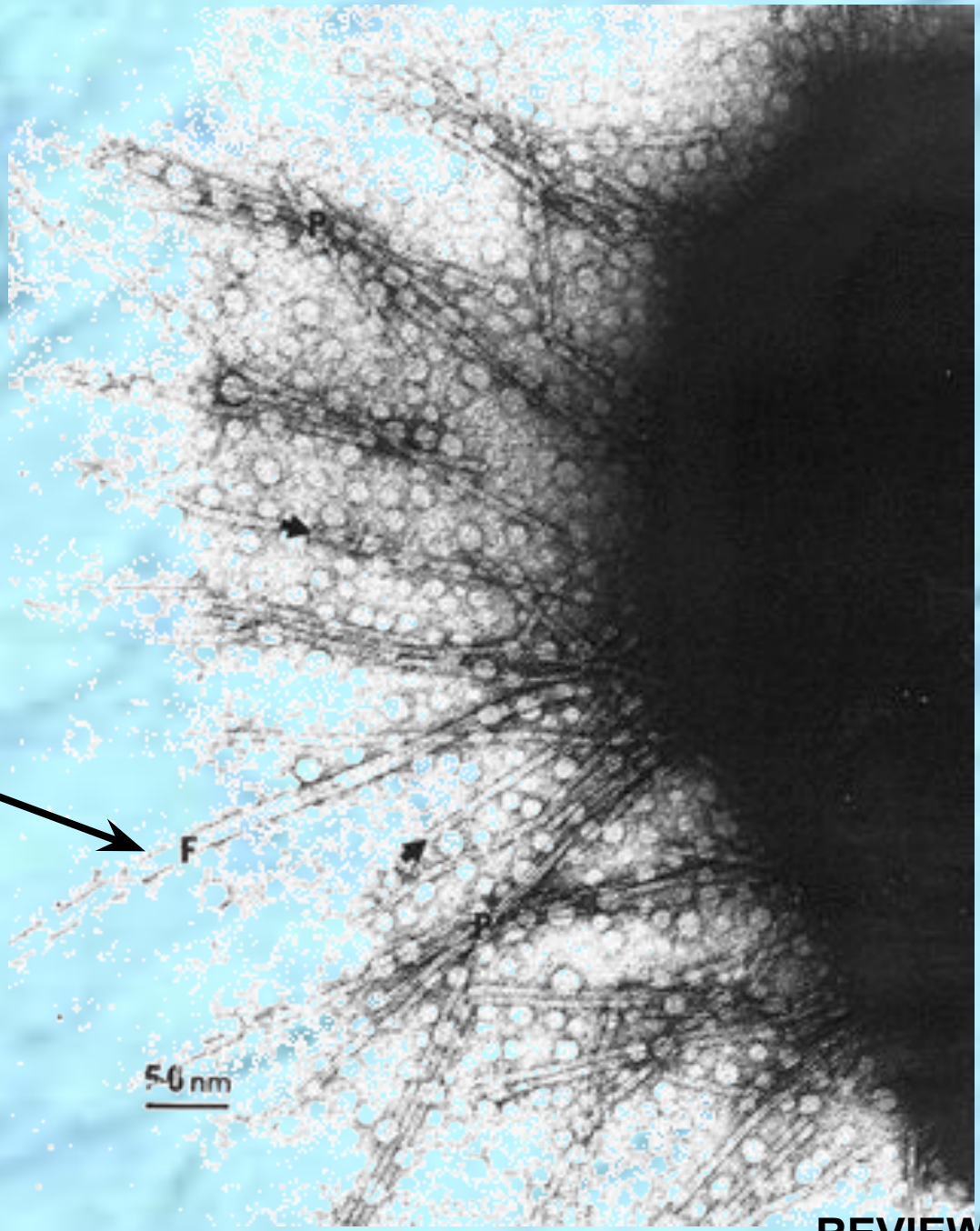

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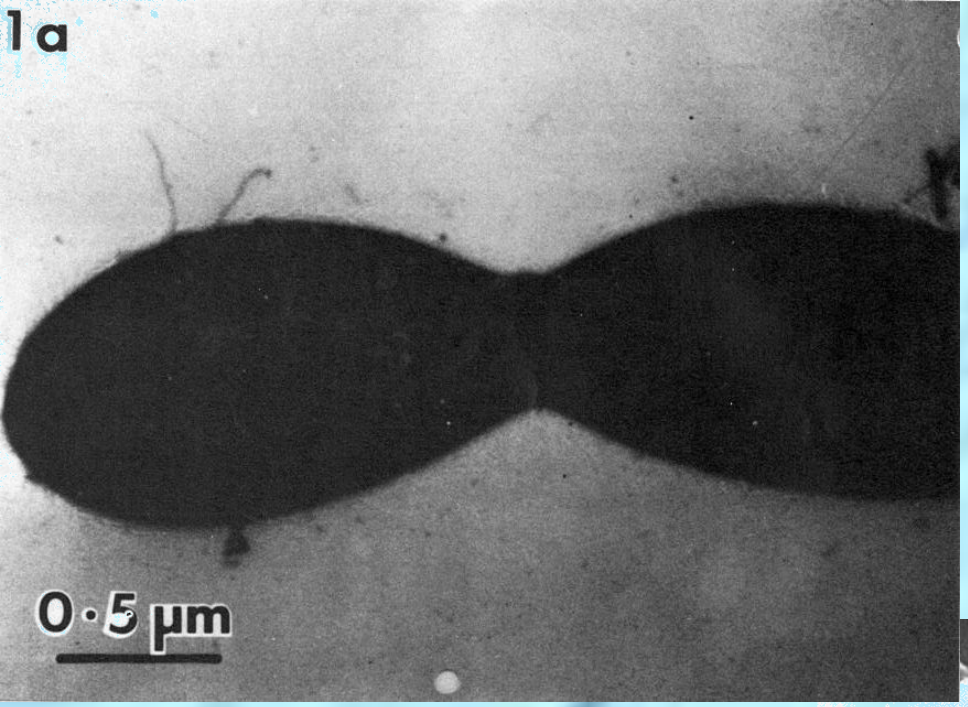

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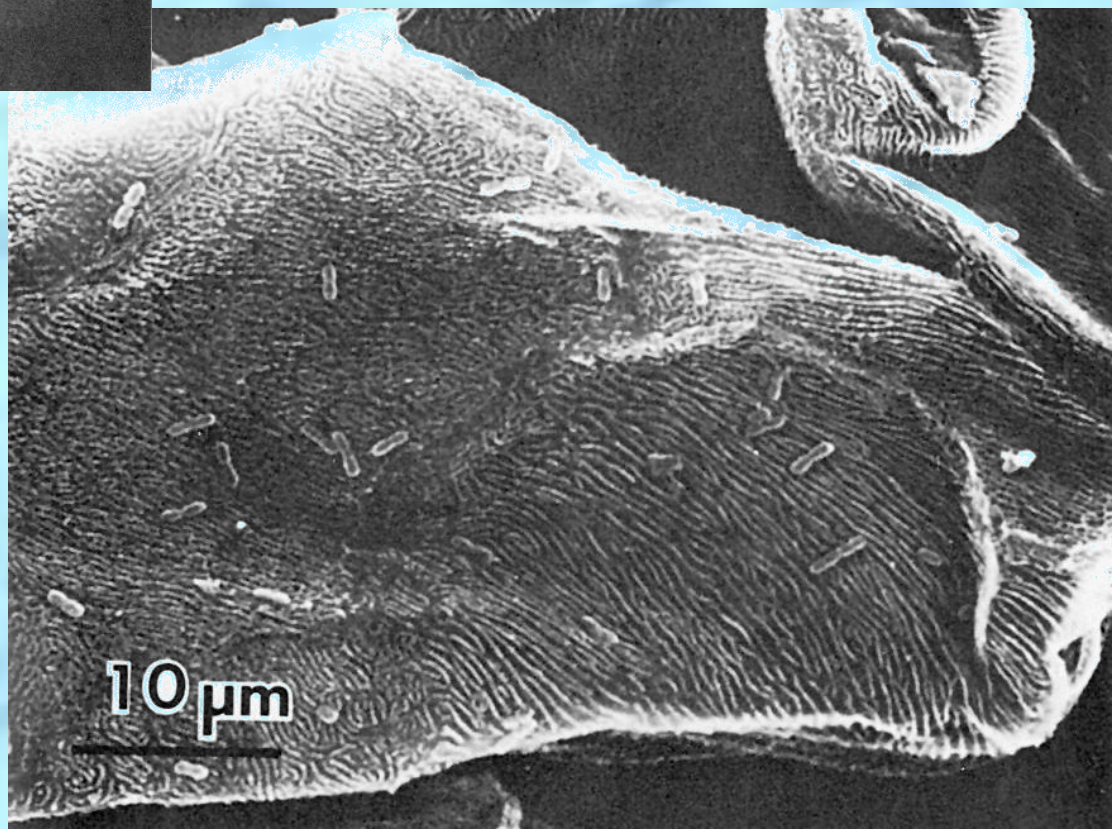

Nonadherent Afimbriated Bacterial Cells and Buccal Cells

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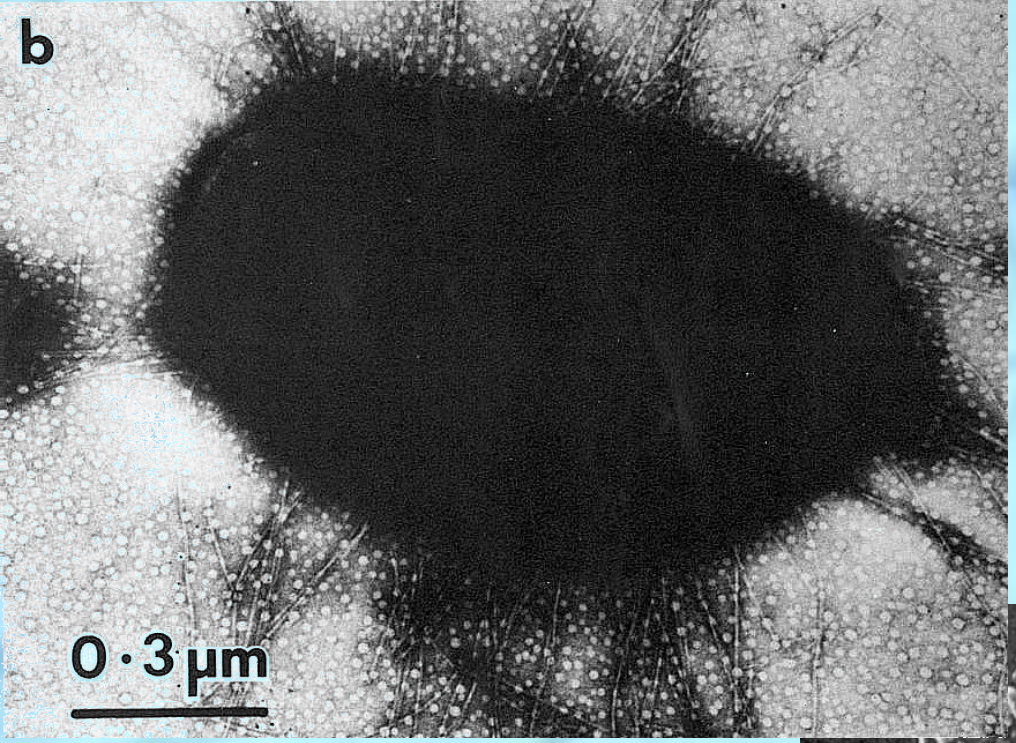

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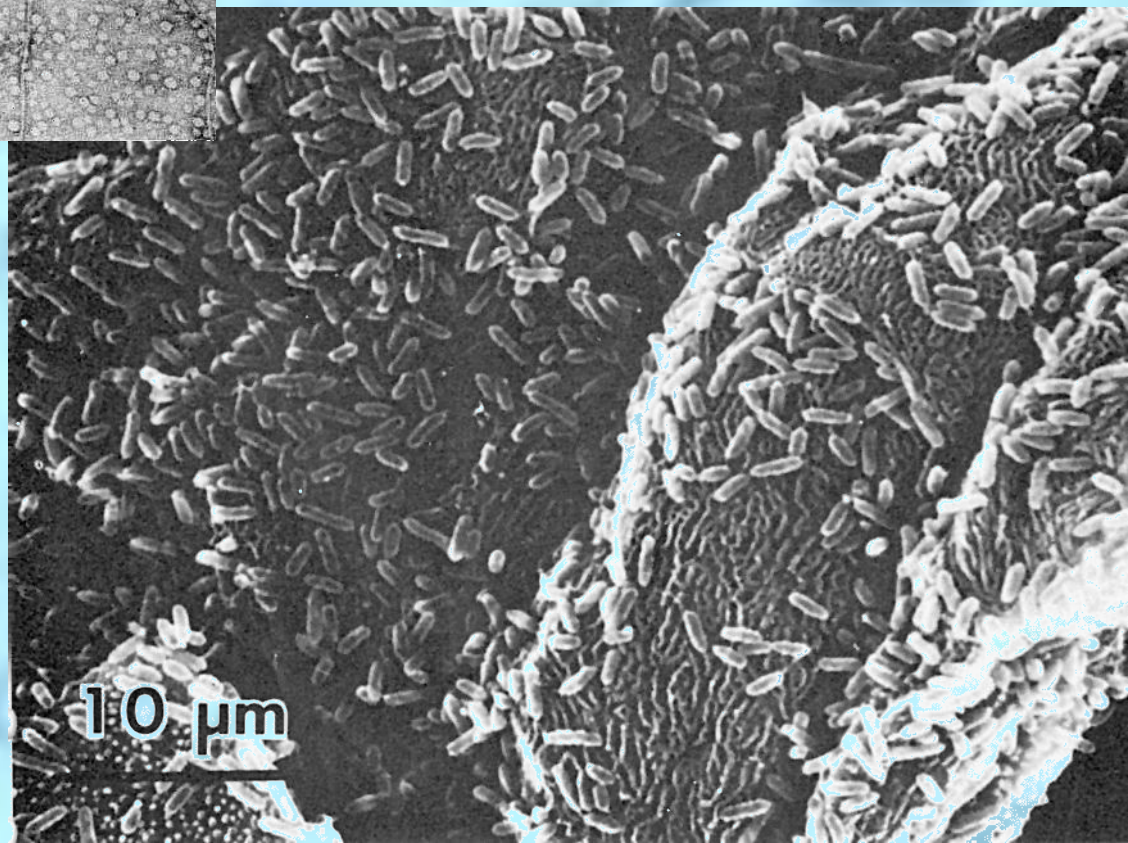

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