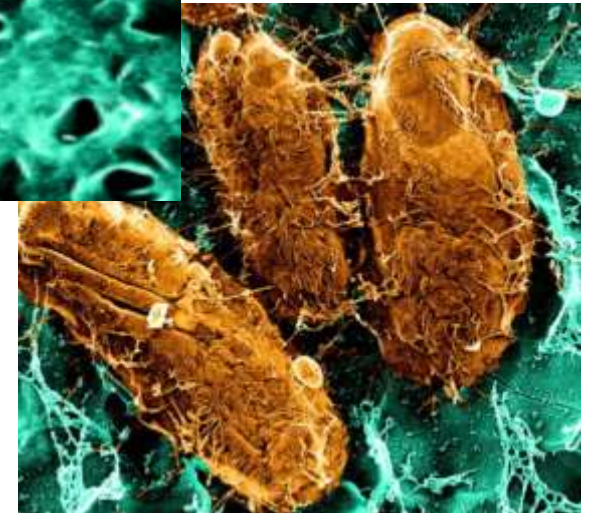
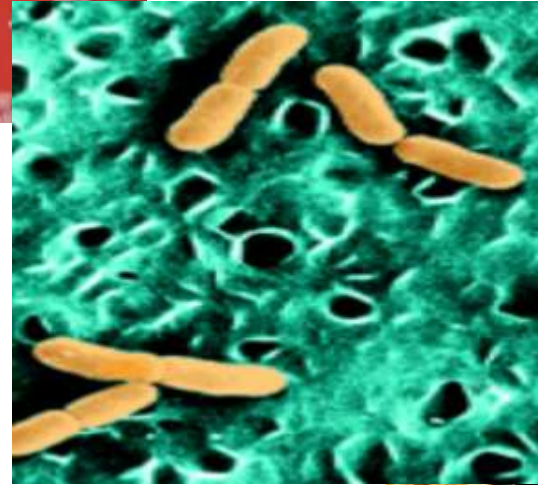
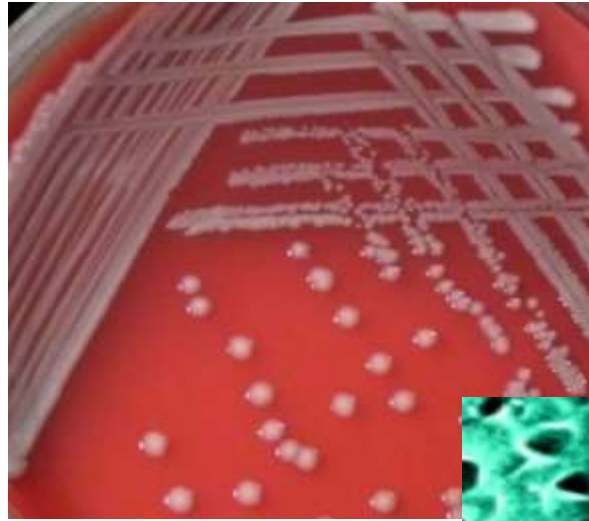


Microbiology of Urogenital system



Anas Abu-Humaidan
M.D. Ph.D.

Overview

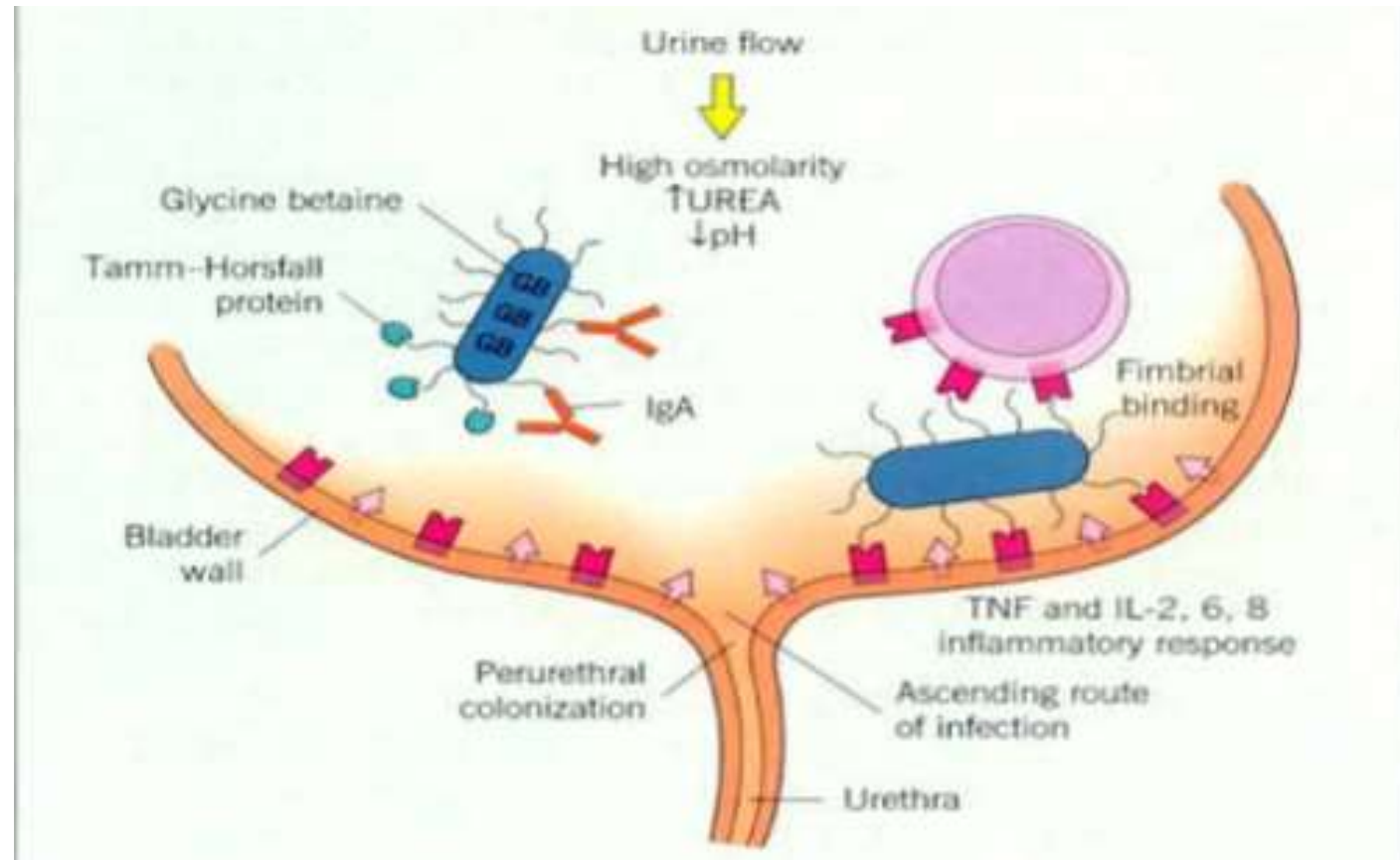
In this lecture, we will discuss the following regarding urinary tract infections (UTI):

- Urinary tract defenses.
- UTI clinical entities.
- UTI epidemiology and predisposing factors.
- UTI etiology and pathophysiology.

Urinary tract defenses

The urinary tract is typically a **sterile environment**, and bacterial colonization of the bladder epithelium does not go unchallenged. This happens in several ways:

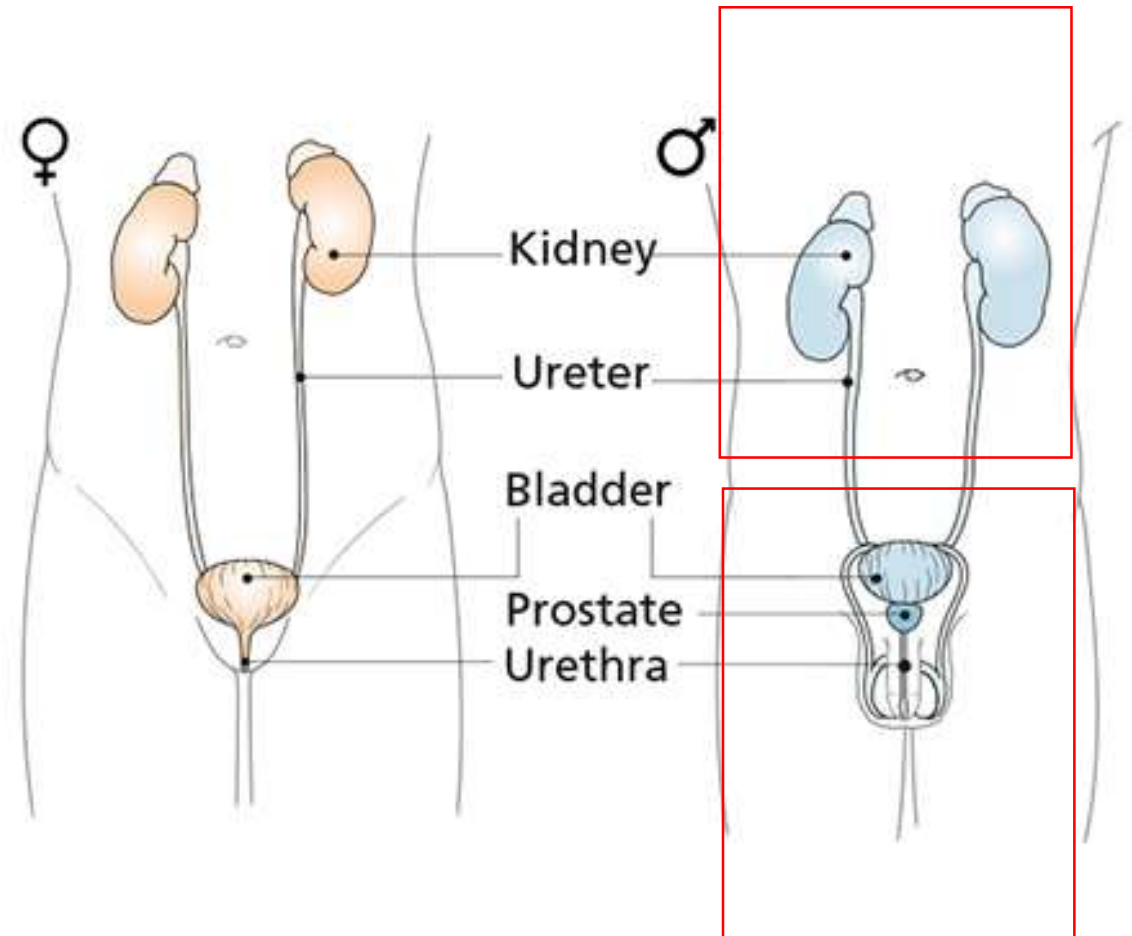
- The bulk **flow of urine** through the bladder and micturition can work to **rinse away** non-attached or weakly adherent microbes from the bladder surface
- The **low pH and osmolarity** of urine can be **inhibitory** to bacterial growth, and the **salts, urea, and organic acids** present in urine can reduce bacterial survival
- **Lactoferrin** within urine can scavenge essential iron away from incoming microbes.
- A number of soluble and cell associated factors within the bladder, including Tamm-Horsfall protein, low molecular weight sugars, **secretory IgA**, and uromucoid, can act as **anti-adherence factors**, competitively inhibiting bacterial attachment to the bladder surface.



Definitions

The term urinary tract infection (UTI) encompasses a variety of clinical entities, including :

- **Asymptomatic bacteriuria (ASB)**
- **Cystitis**
- **Prostatitis**
- **Pyelonephritis.**



Epidemiology of UTIs in the community

- As many as **50–80%** of women in the general population **acquire at least one UTI during their lifetime**—uncomplicated cystitis in most cases.
- About **20–30%** of women who have had one episode of UTI will have **recurrent episodes**.
- Early recurrence (within 2 weeks) is usually regarded as relapse rather than reinfection and may indicate the need to evaluate the patient or a sequestered focus.
- Asymptomatic bacteriuria occurs in all age groups and does not necessarily result in clinical infection.
- Asymptomatic bacteriuria occurs in 1– 3% of non- pregnant women and 2– 9.5% of pregnant women.

Epidemiology of UTIs in the hospital

- Urinary tract infections are the **most common type of healthcare-associated infection**, accounting for more than 30% of infections reported by acute care hospitals.
- Virtually all healthcare-associated UTIs are caused by instrumentation. (**Catheter-associated urinary tract infection (CAUTI)**)
- The source of microorganisms causing CAUTI can be **endogenous**, typically via meatal, rectal, or vaginal colonization, or **exogenous**, such as via contaminated hands of healthcare personnel or equipment.

Table 1 Incidence of Urinary Tract Infection According to Age and Sex

Age Group	Incidence (%)	Approximate Sex Ratio (Male:Female)
Neonatal	1.0	1.5:1.0
Preschool age	1.5-3.0	1:10
School age	1.2	1:30
Reproductive age	3-5	1:50
Geriatric	10-30	1:1.5

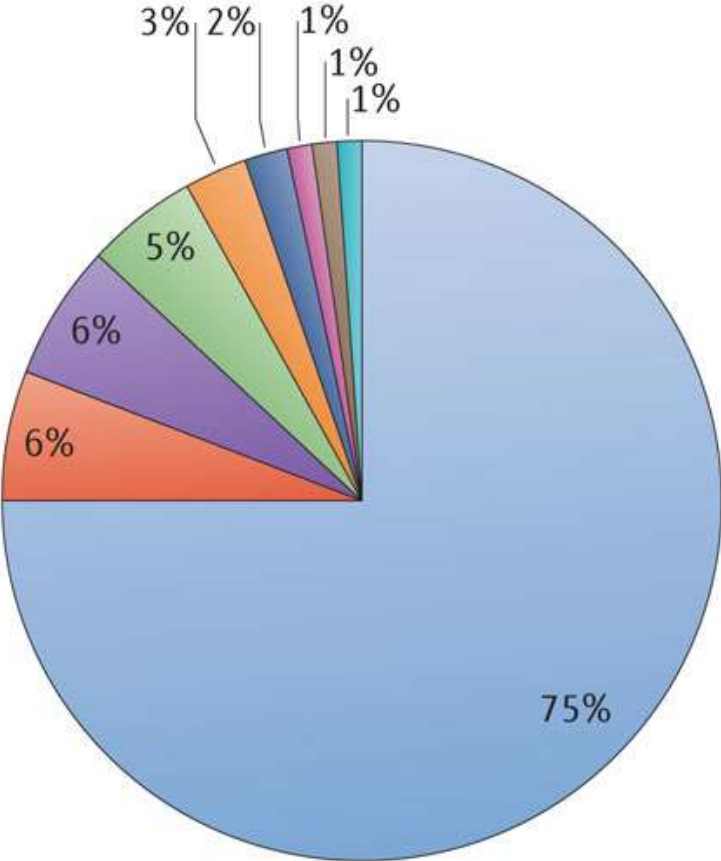
Clinical categories of UTIs

Clinically, UTIs are categorized as uncomplicated or complicated:

- **Uncomplicated UTIs** typically affect individuals who are otherwise healthy and have **no structural or neurological urinary tract abnormalities**
- **Complicated UTIs** are defined as UTIs associated with factors that compromise the urinary tract or host defence, including **urinary obstruction, urinary retention** caused by neurological disease, **immunosuppression**, renal failure, renal transplantation, pregnancy and the **presence of foreign bodies** such as calculi or indwelling catheters .

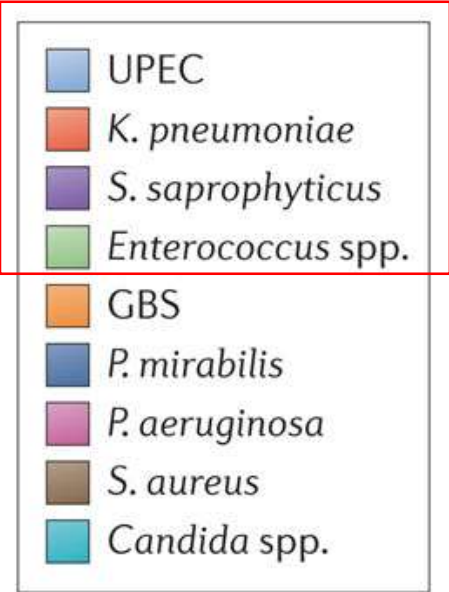
Etiology of UTIs

Uncomplicated UTI

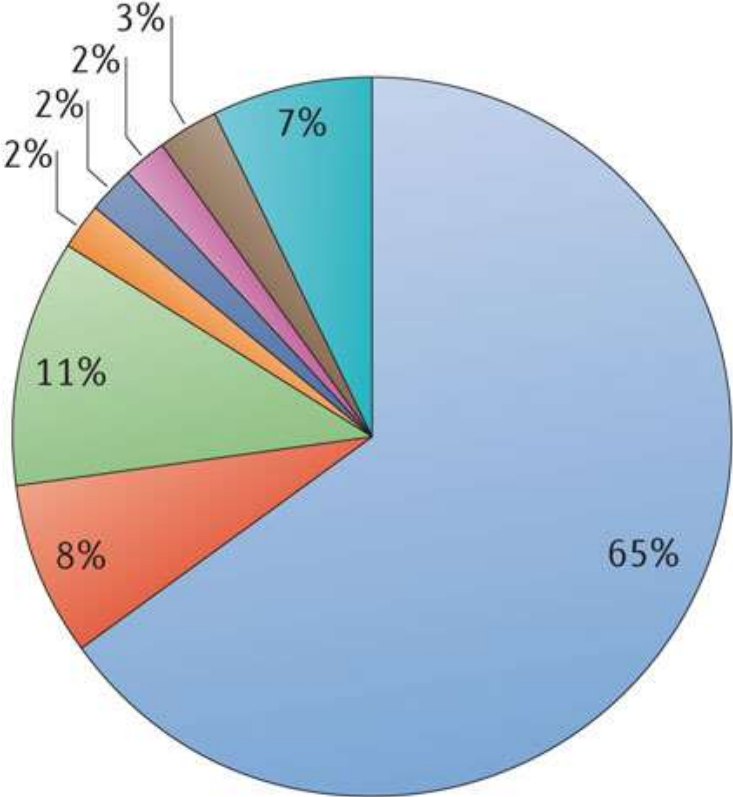


Risk factors

- Female gender
- Older age
- Younger age



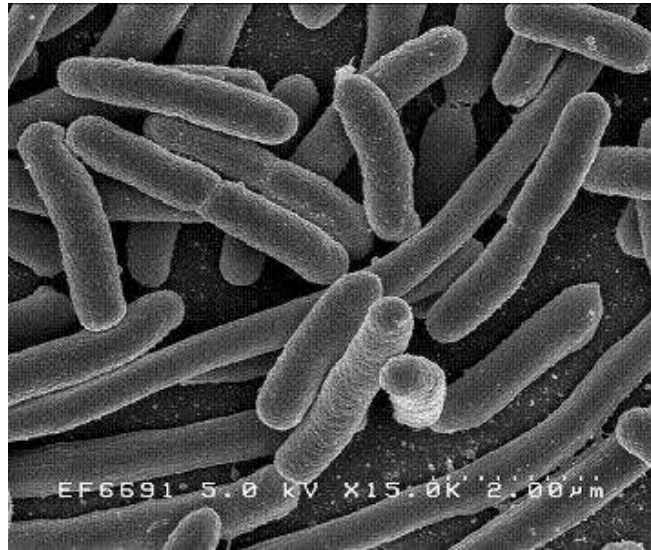
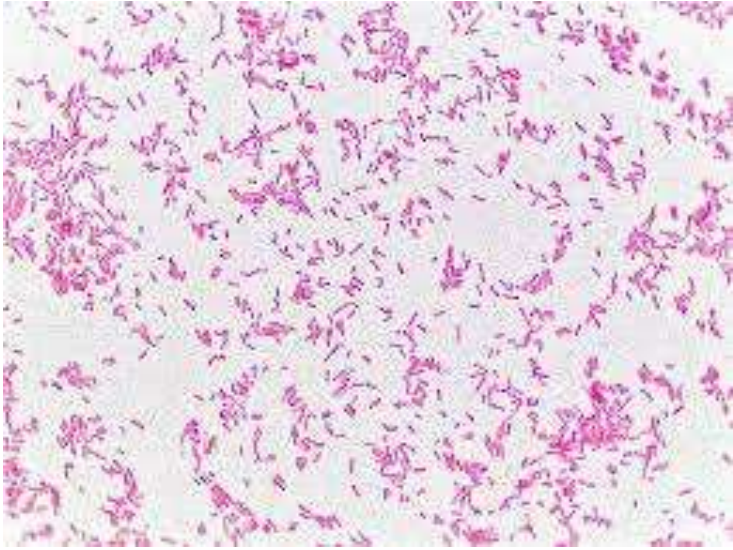
Complicated UTI



Risk factors

- Indwelling catheters
- Immunosuppression
- Urinary tract abnormalities
- Antibiotic exposure

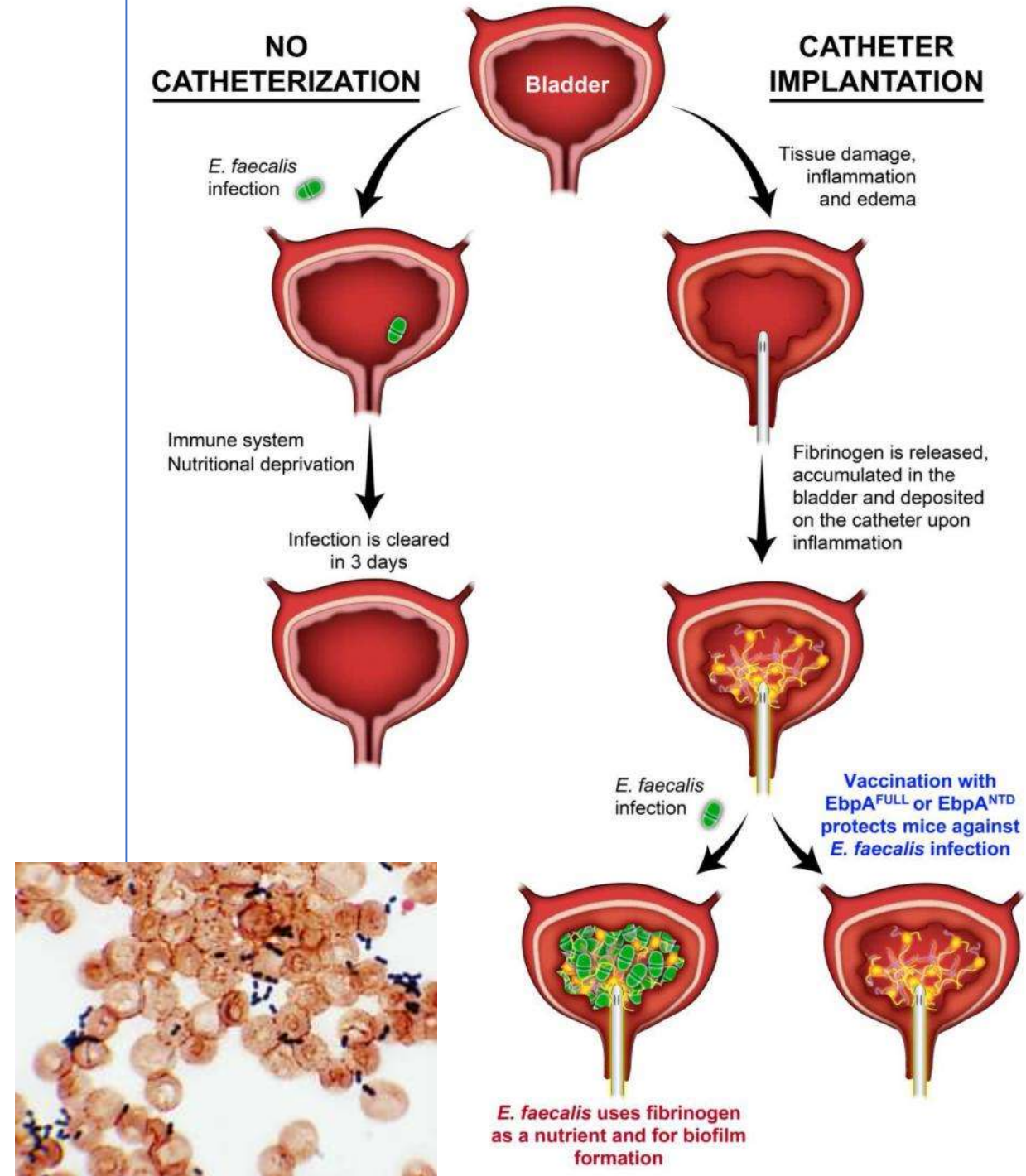
Uropathogenic *E. coli* (UPEC)



- A **gram negative rod**, facultative anaerobe. The optimum growth temperature is 37°C. On Nutrient agar, colonies are large, thick, greyish white, moist, smooth.
- *E. coli* and other facultative anaerobes constitute about 0.1% of **gut microbiota**.

Enterococcus faecalis

- The enterococci are gram-positive cocci, typically arranged in **pairs and short chains** .
- *E. faecalis* is found in the **large intestine** in high concentrations (e.g., 10^5 to 10^7 organisms per gram of feces) and in the **genitourinary tract**.
- enterococci are one of the most common causes of infections acquired in the hospital (**nosocomial infection**). The **urinary tract is the most common site of enterococcal infections**, and infections are **frequently associated with urinary catheterization or instrumentation** .



Klebsiella pneumoniae

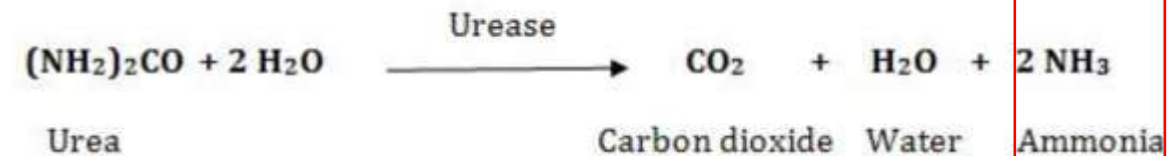
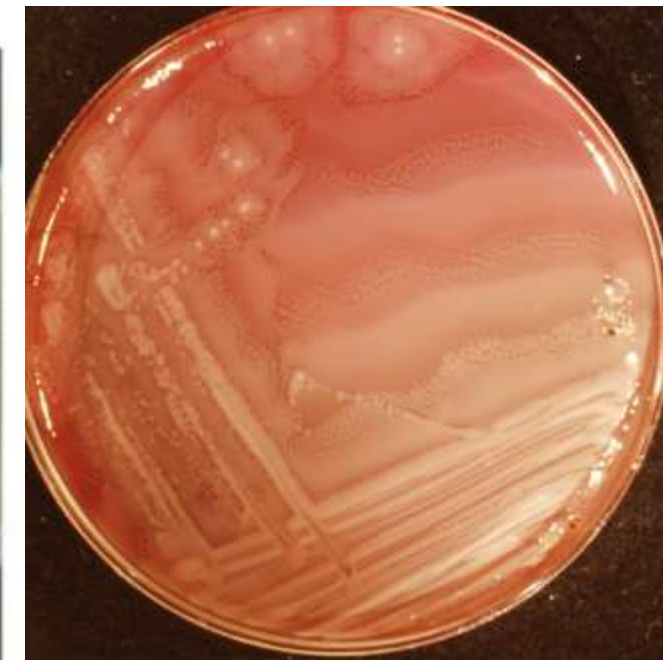
- *Klebsiella* species are routinely found in the human nose, mouth, and gastrointestinal tract as normal flora.
- The ability of *K. pneumoniae* to **colonize the hospital environment**, including carpeting, sinks, flowers, and various surfaces, as well as the skin of patients and hospital staff, has been identified as a major factor in the spread of **hospital-acquired infections**



Proteus mirabilis

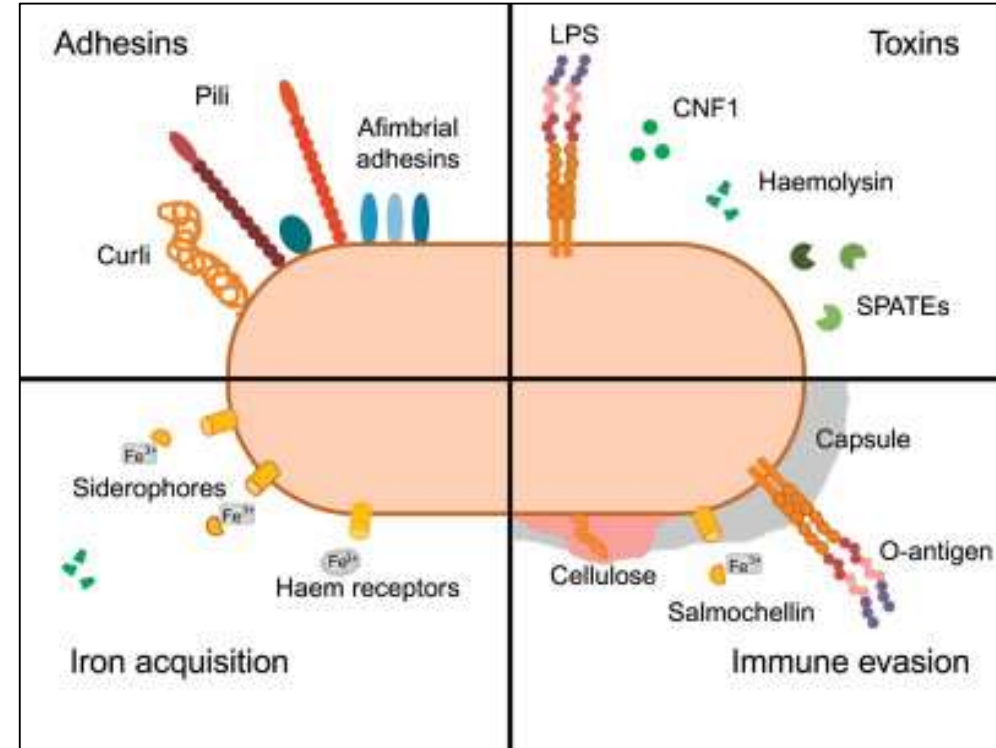
Proteus mirabilis is a **Gram-negative**, facultatively anaerobic, **rod-shaped** bacterium. It shows **swarming motility** and **urease** activity.

A direct result of **urease** activity and ammonia generation is an **increase in local pH**. In the urinary tract alkaline pH leads to precipitation of calcium and magnesium ions and the formation of **urinary stones** composed of magnesium ammonium phosphate (**struvite**) and calcium phosphate (**apatite**)



Virulence factors in UPEC (many factors are shared with other bacteria causing UTI)

- adhesive **fimbriae**, which enable bacteria to adhere avidly to specific receptors on the urothelium.
- **flagella** that enable bacteria to swim along the urinary tract including 'upstream' from the bladder to the kidneys.
- **toxins**, such as haemolysin and cytotoxic necrotizing factor, which disrupt the epithelial barrier and enable access to the underlying tissue
- **siderophores**, which enable bacteria to chelate iron that is important for growth
- expression of cell surface **capsules**, which enable them to resist the bactericidal actions of complement and phagocytic cells



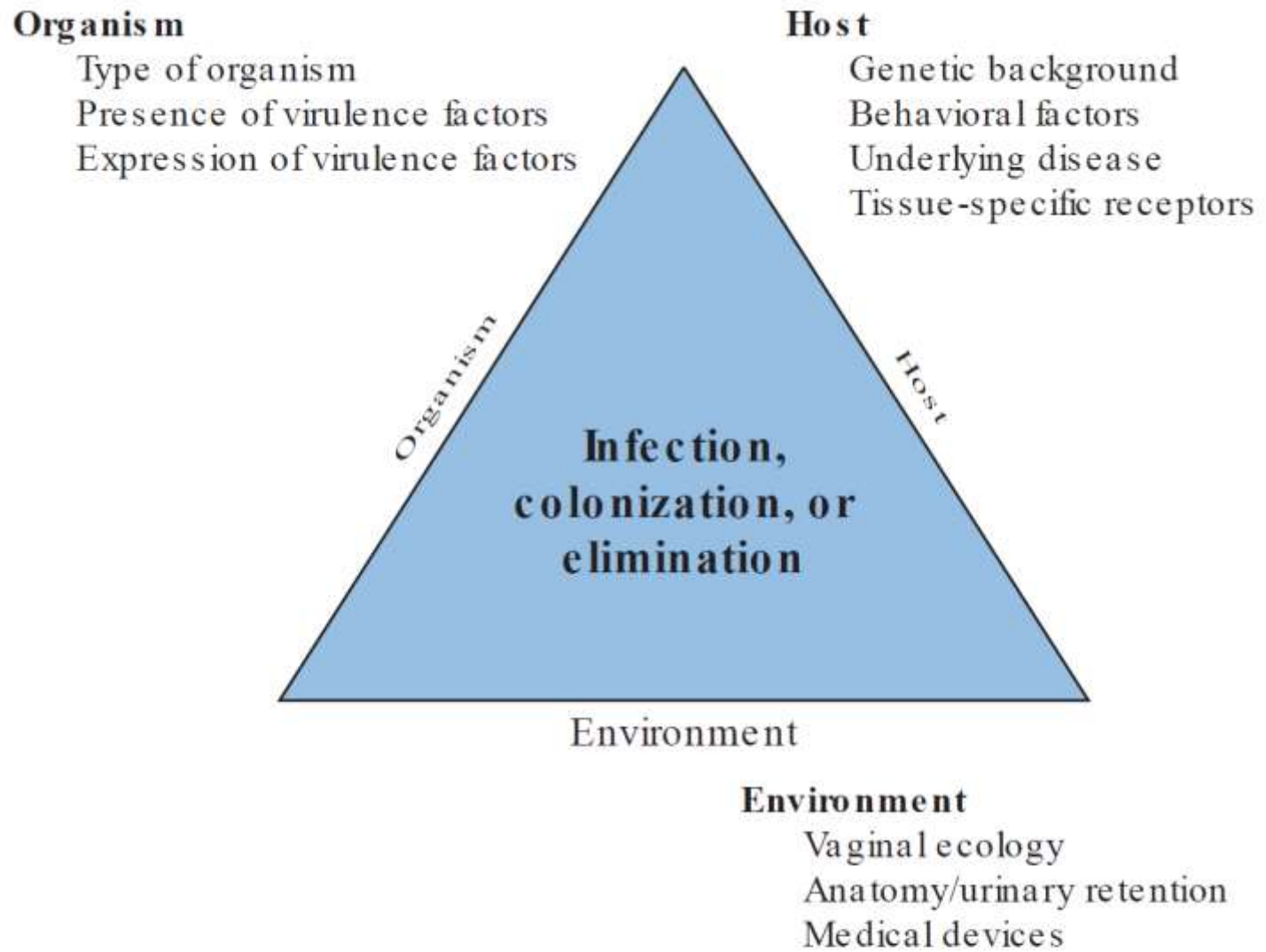
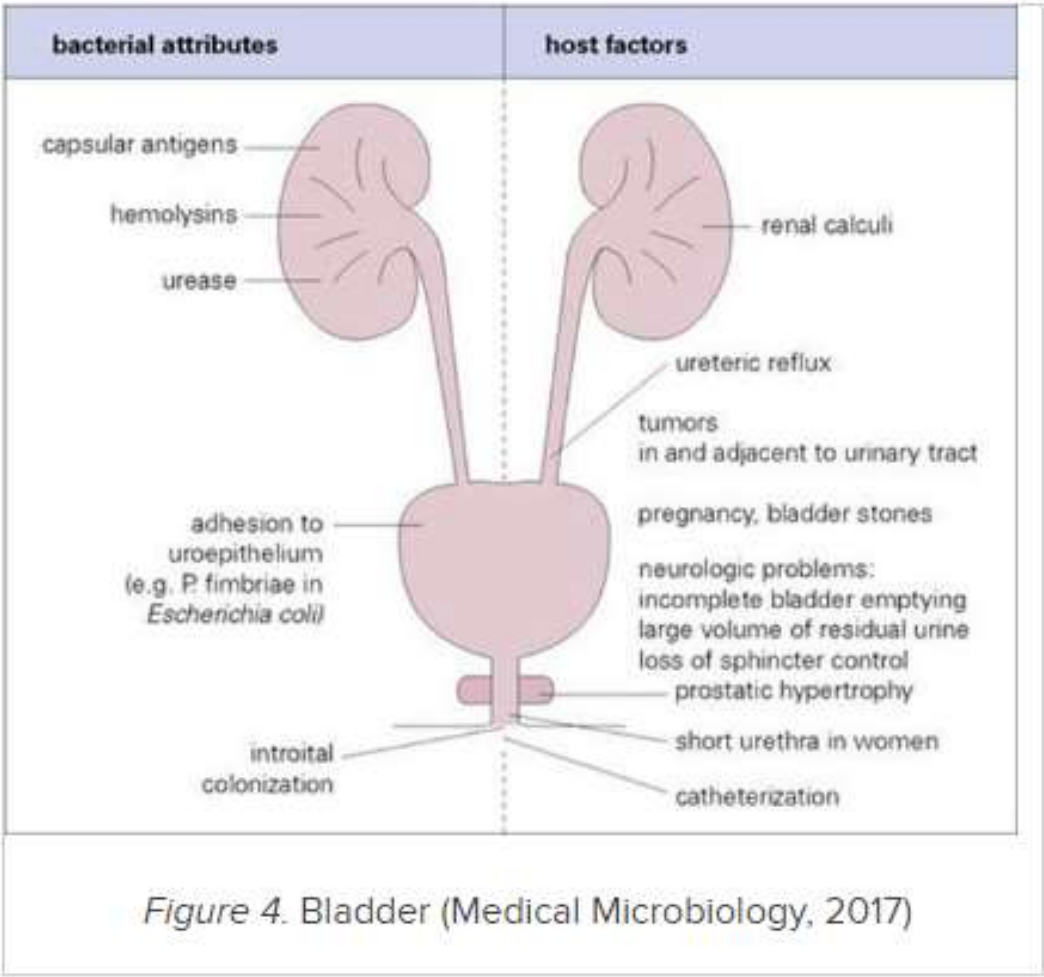
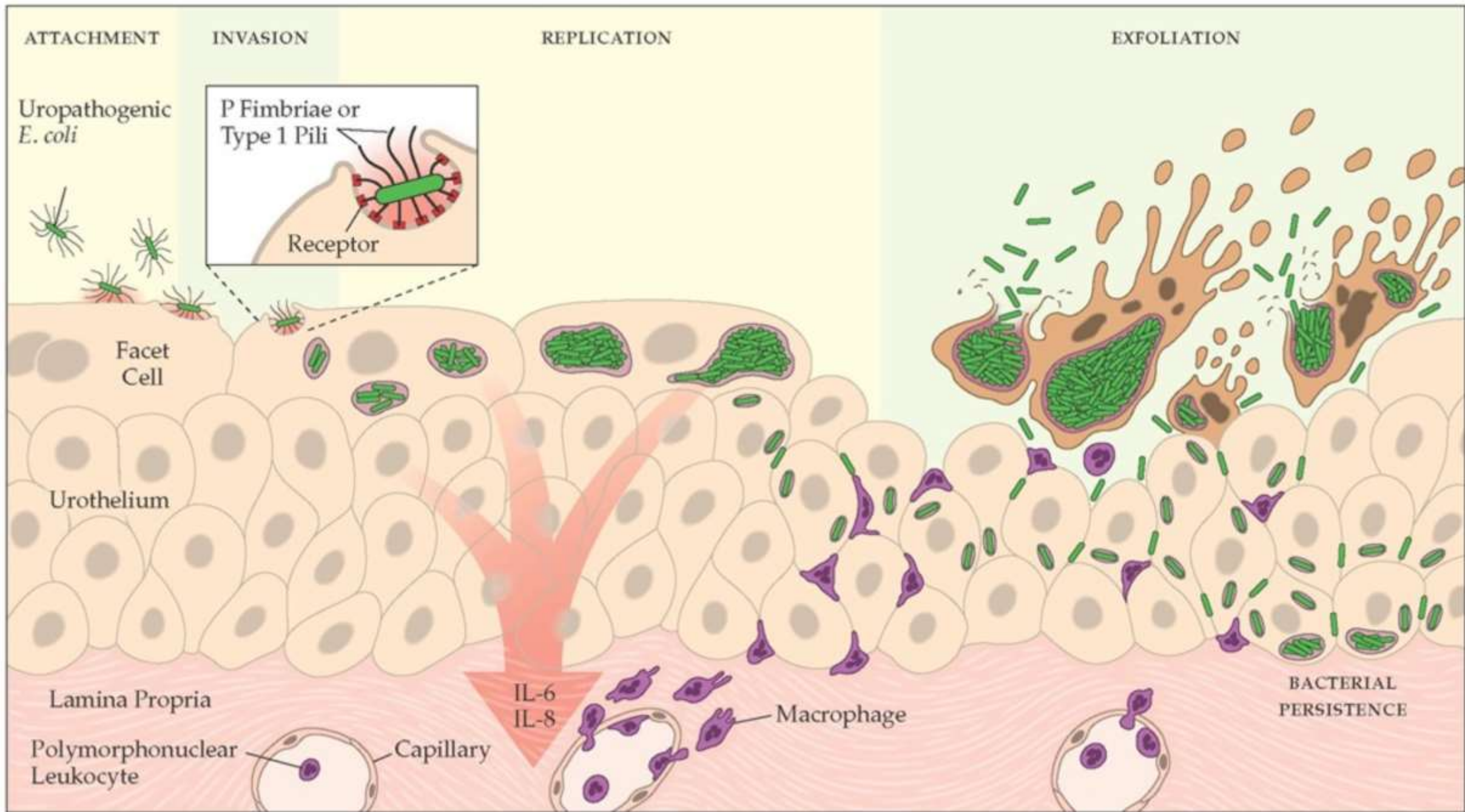


FIGURE 33-1

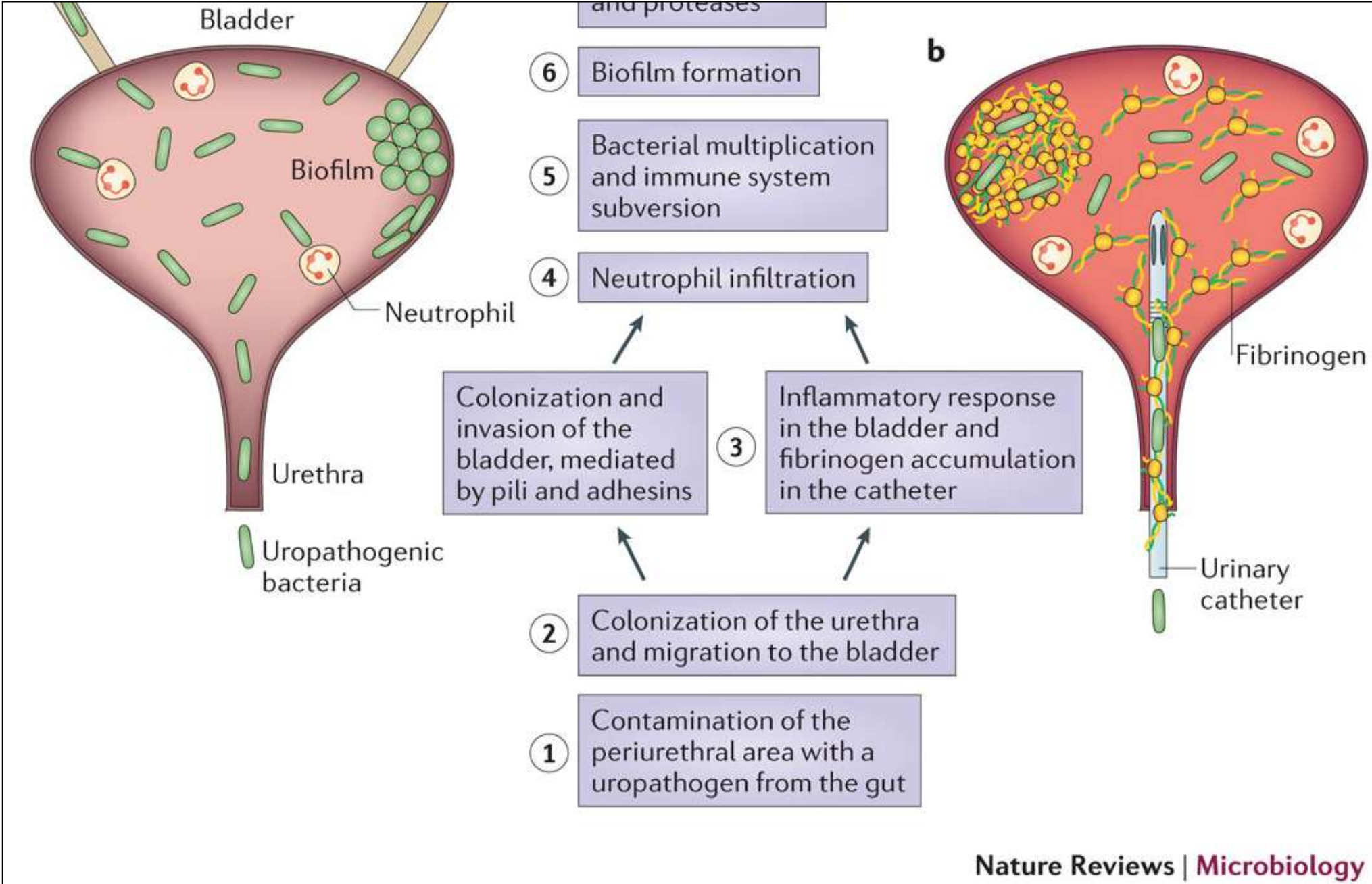
Pathogenesis of urinary tract infection. The relationship among specific host, pathogen, and environmental factors determines the clinical outcome.

Pathophysiology of UTIs

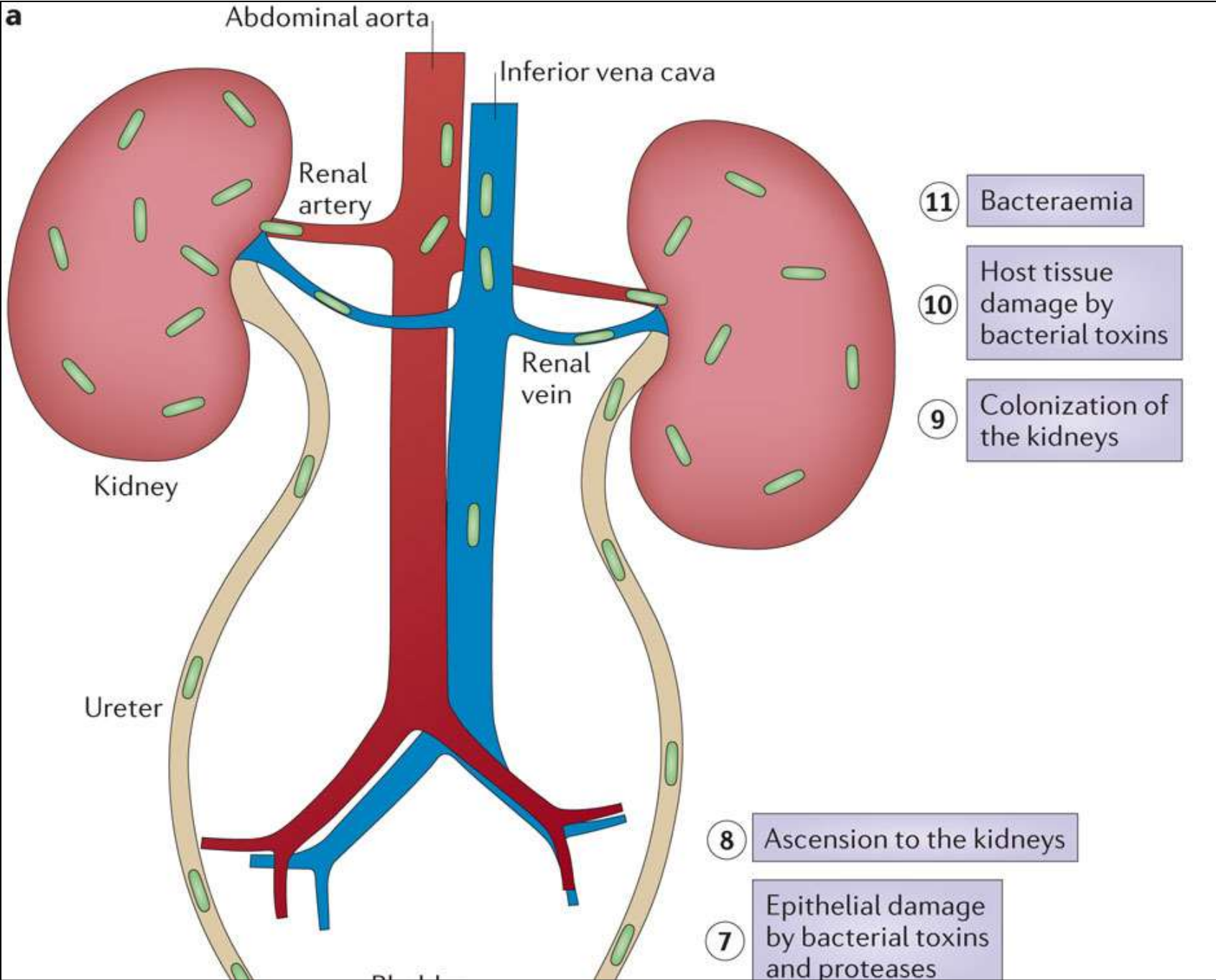




Pathophysiology of UTIs



Pathophysiology of UTIs



1. What is the most common pathogen responsible for UTIs in women? a) Escherichia coli b) Klebsiella pneumoniae c) Staphylococcus aureus d) Streptococcus pyogenes

Answer: a) Escherichia coli

2. Which age group is most commonly affected by UTIs? a) Infants and toddlers b) Adolescents c) Young adults d) Older adults

Answer: d) Older adults

3. Which gender is more prone to develop UTIs? a) Males b) Females c) Both genders are equally affected d) It depends on the age group

Answer: b) Females

4. Which anatomical factor increases the risk of developing UTIs in women? a) Shorter urethra b) Longer urethra c) Narrower urethra d) Wider urethra

Answer: a) Shorter urethra

5. Which condition is a risk factor for recurrent UTIs? a) Hypertension b) Diabetes mellitus c) Hypothyroidism d) Asthma

Answer: b) Diabetes mellitus

6. What is the most common mode of transmission for UTIs? a) Airborne transmission b) Direct contact transmission c) Vector-borne transmission d) Foodborne transmission

Answer: b) Direct contact transmission

7. What is the most common site of infection in UTIs? a) Kidneys b) Bladder c) Ureters d) Urethra

Answer: d) Urethra

Further reading:

- Oxford handbook of infectious diseases and microbiology-
Part4: Clinical syndroms
Chapter 17 Urinary tract infections
- Harrison's Infectious Diseases 3rd Edition
SECTION III Infections in organ systems
Chapter 33