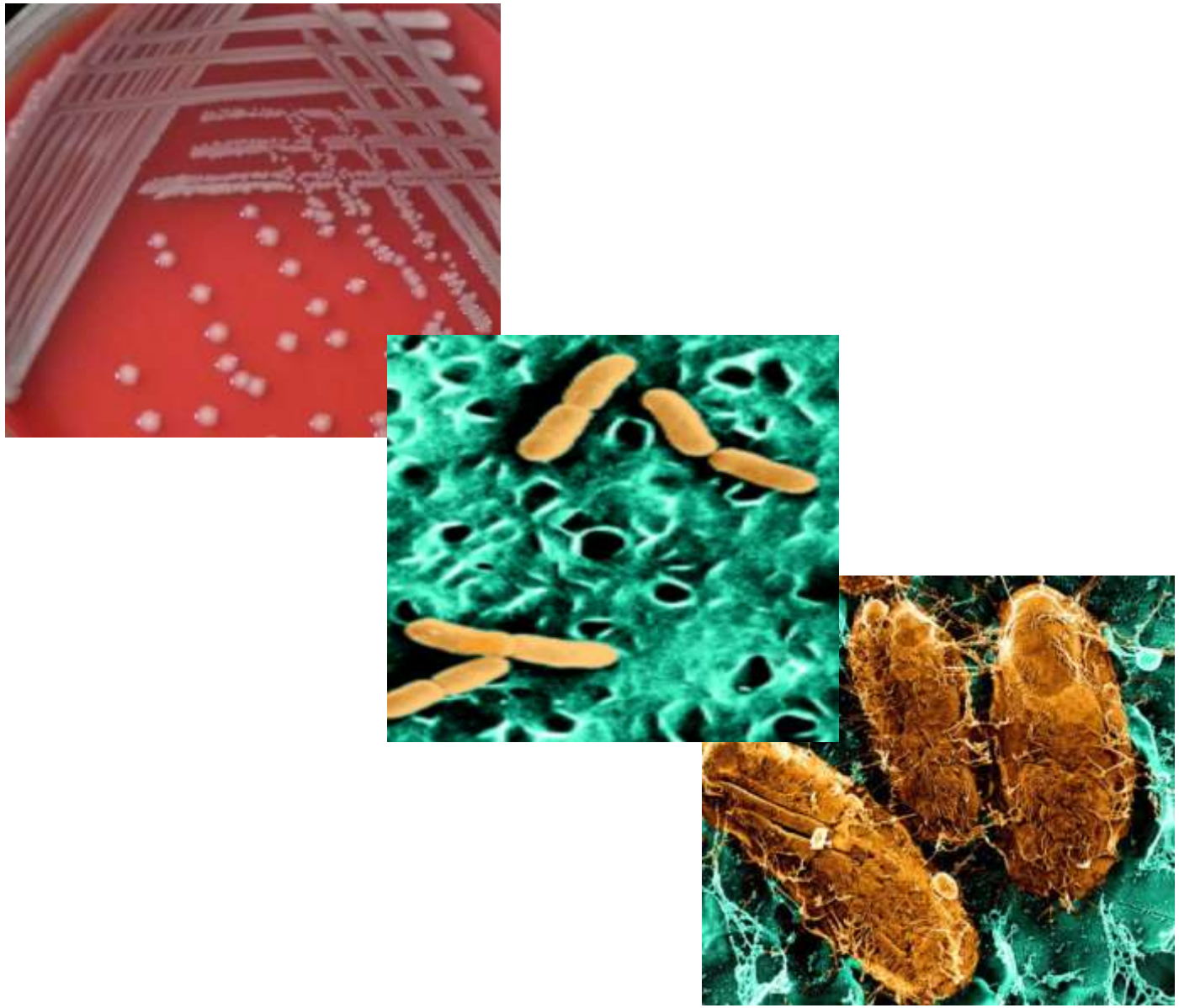
# Microbiology of Urogenital system



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

Lecture 1

## Overview

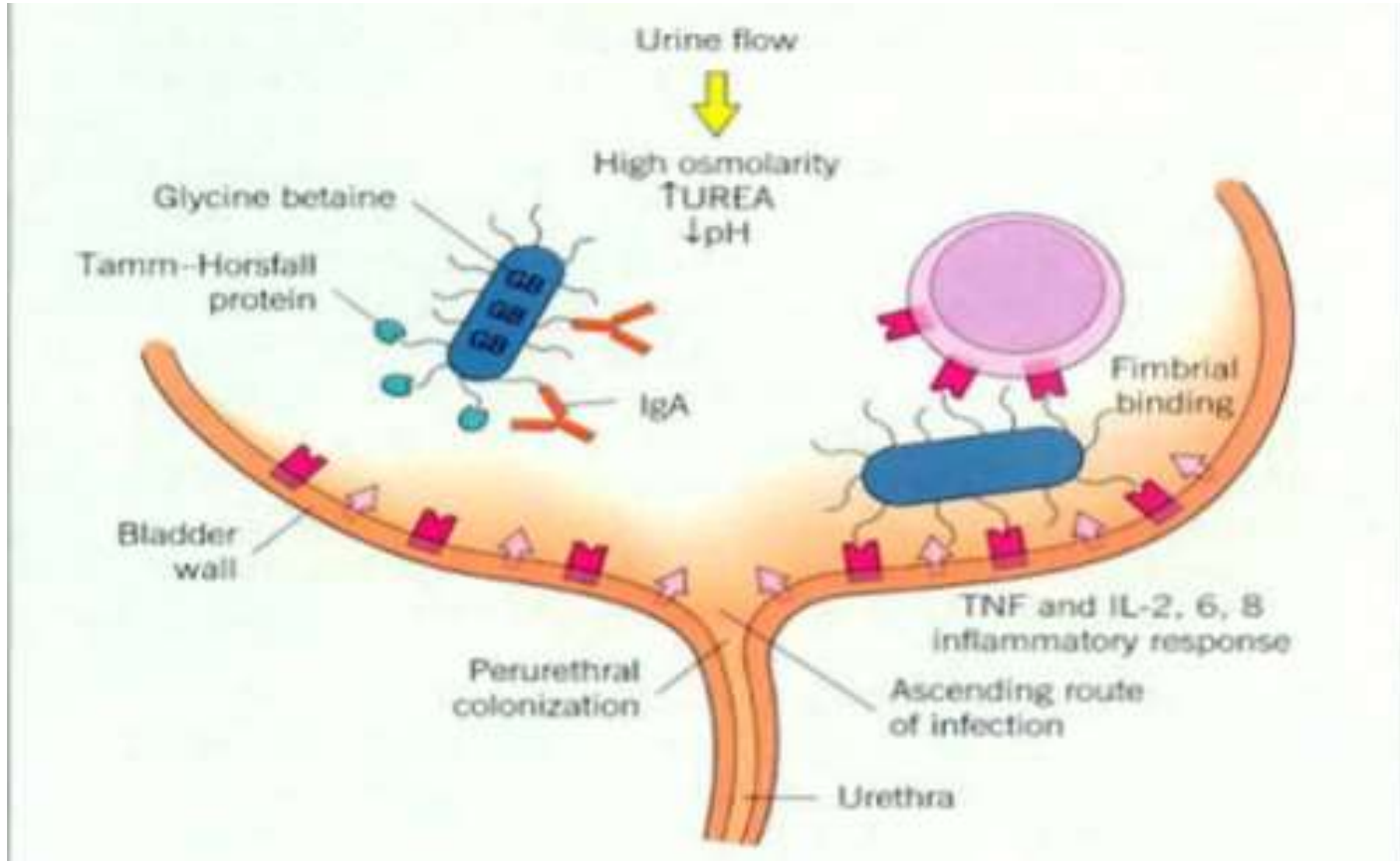
In this lecture, we will discuss the following regarding urinary tract infections (UTI):

- 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:

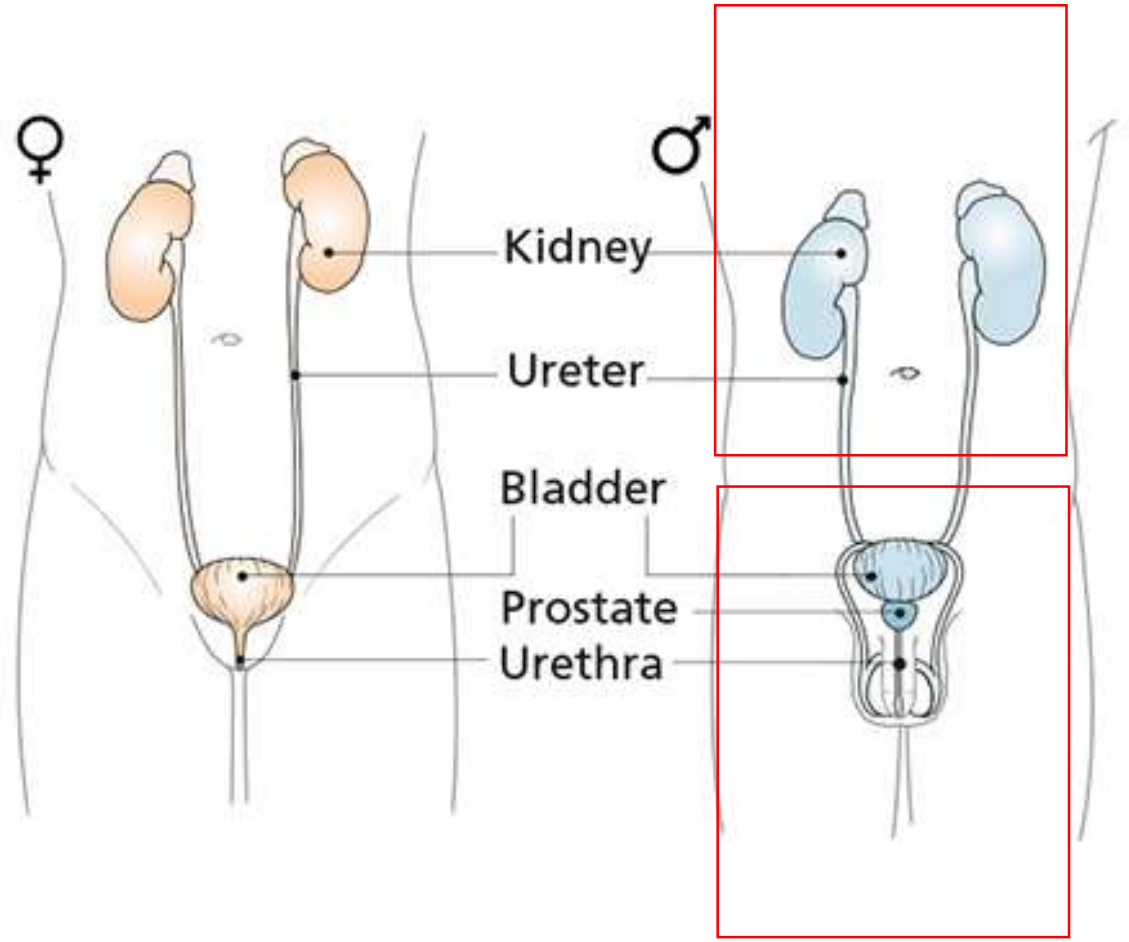
- The bulk **flow of urine** through the bladder and micturition can work to **rinse away** non-attached or weakly adherent microbes from the bladder surface
- The **low pH and osmolarity** of urine can be **inhibitory** to bacterial growth, and the **salts**, **urea**, and **organic acids** present 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.


Urine flow
High osmolarity
↑UREA
↓pH
Glycine betaine
Tamm–Horsfall protein
IgA
Fimbrial binding
Bladder wall
TNF and IL-2, 6, 8 inflammatory response
Perurethral colonization
Ascending route of infection
Urethra

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 |

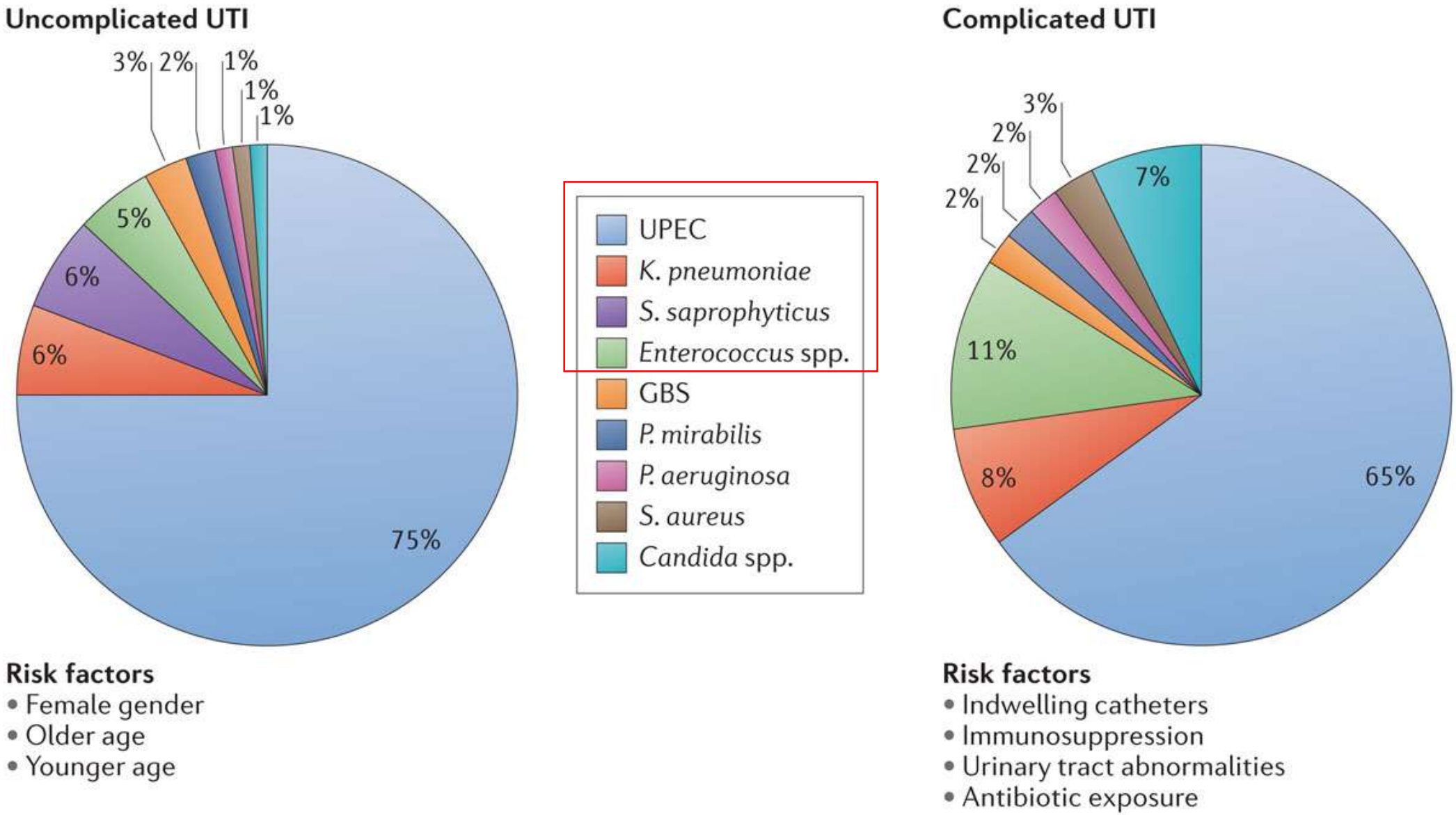
# Clinical categories of UTIs

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

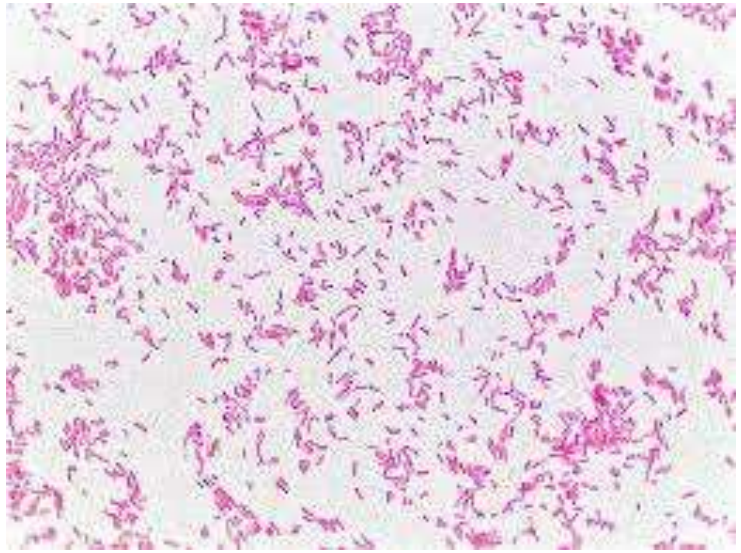


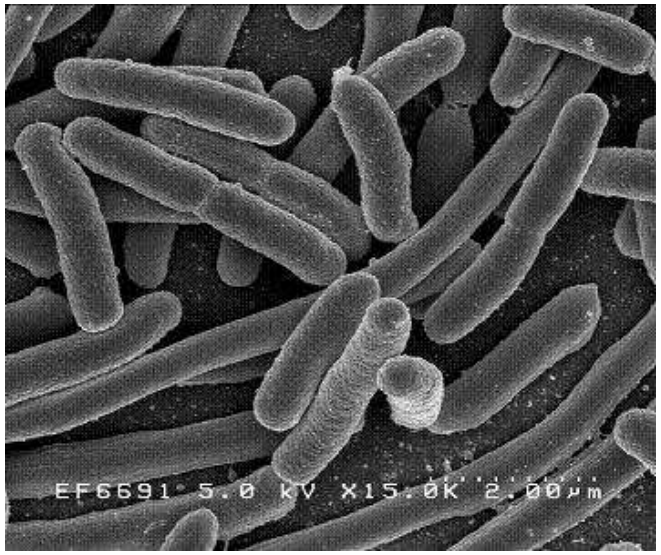

**Risk factors**
- Female gender
- Older age
- Younger age

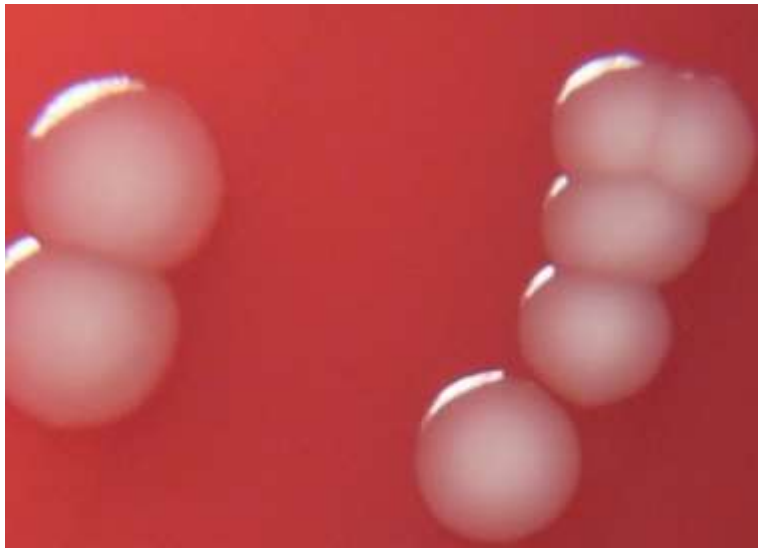
**Risk factors**
- Indwelling catheters
- Immunosuppression
- Urinary tract abnormalities
- Antibiotic exposure

Nature Reviews | Microbiology

Uropathogenic *E.coli* (UPEC)





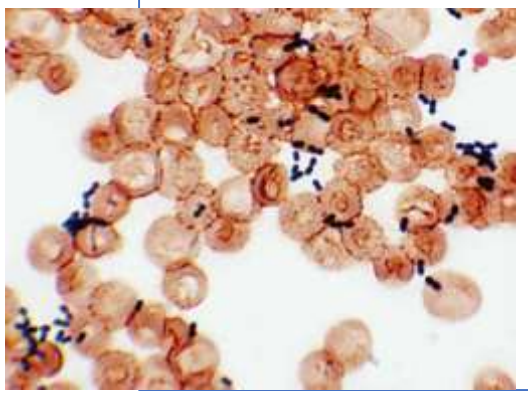



- A **gram negative rod**, facultative anaerobe. The optimum growth temperature is 37°C. On Nutrient agar, colonies are large, thick, greyish white, moist, smooth.

- 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 .**



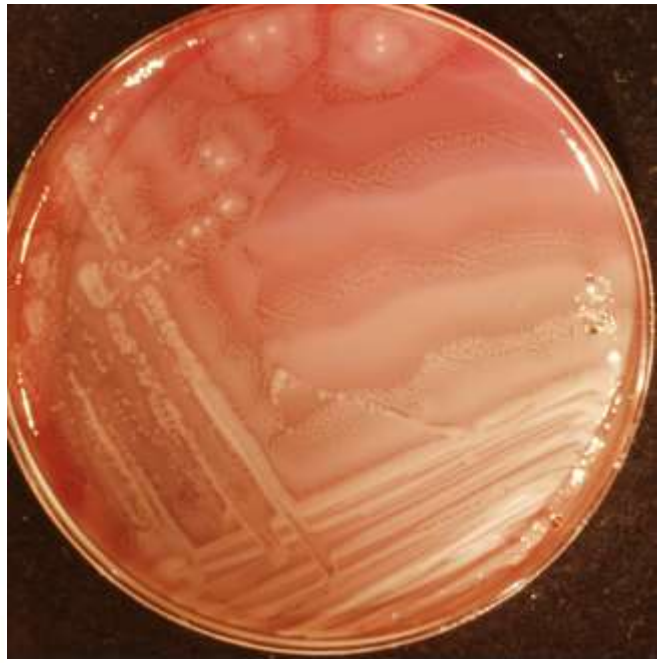
*Klebsiella pneumoniae*

- *Klebsiella* species are routinely found in the human nose, mouth, and gastrointestinal tract as normal flora.

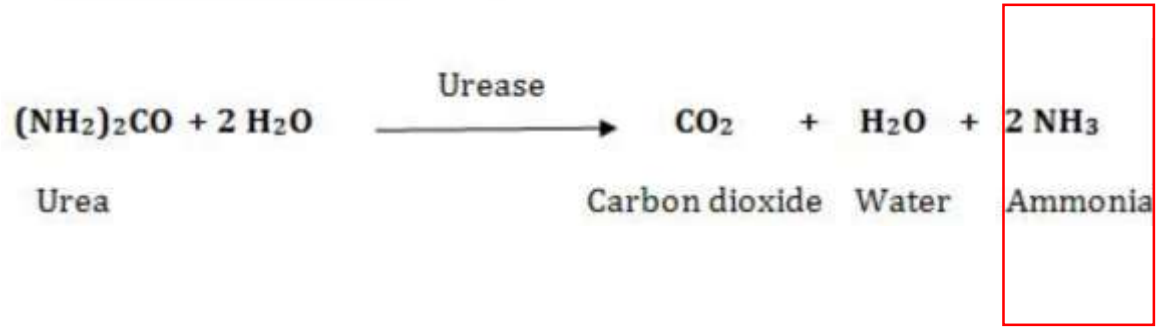
- The ability of *K. pneumoniae* to **colonize the hospital environment**, including carpeting, sinks, flowers, and various surfaces, as well as the skin of patients and hospital staff, has been identified as a major factor in the spread of **hospital-acquired infections**

*Proteus mirabilis*

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

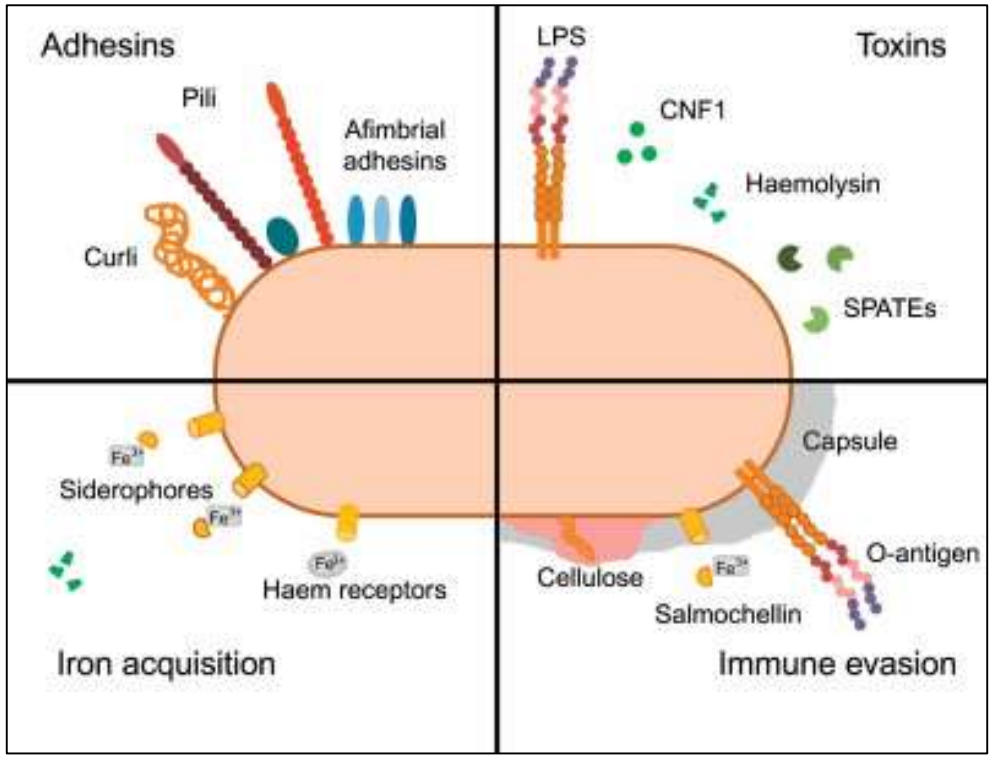


A direct result of **urease** activity and ammonia generation is an **increase in local pH**. In the urinary tract alkaline pH leads to precipitation of calcium and magnesium ions and the formation of **urinary stones** composed of magnesium ammonium phosphate (**struvite**) and calcium phosphate (**apatite**)



Virulance 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 underling 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



Pathophysiology of UTIs

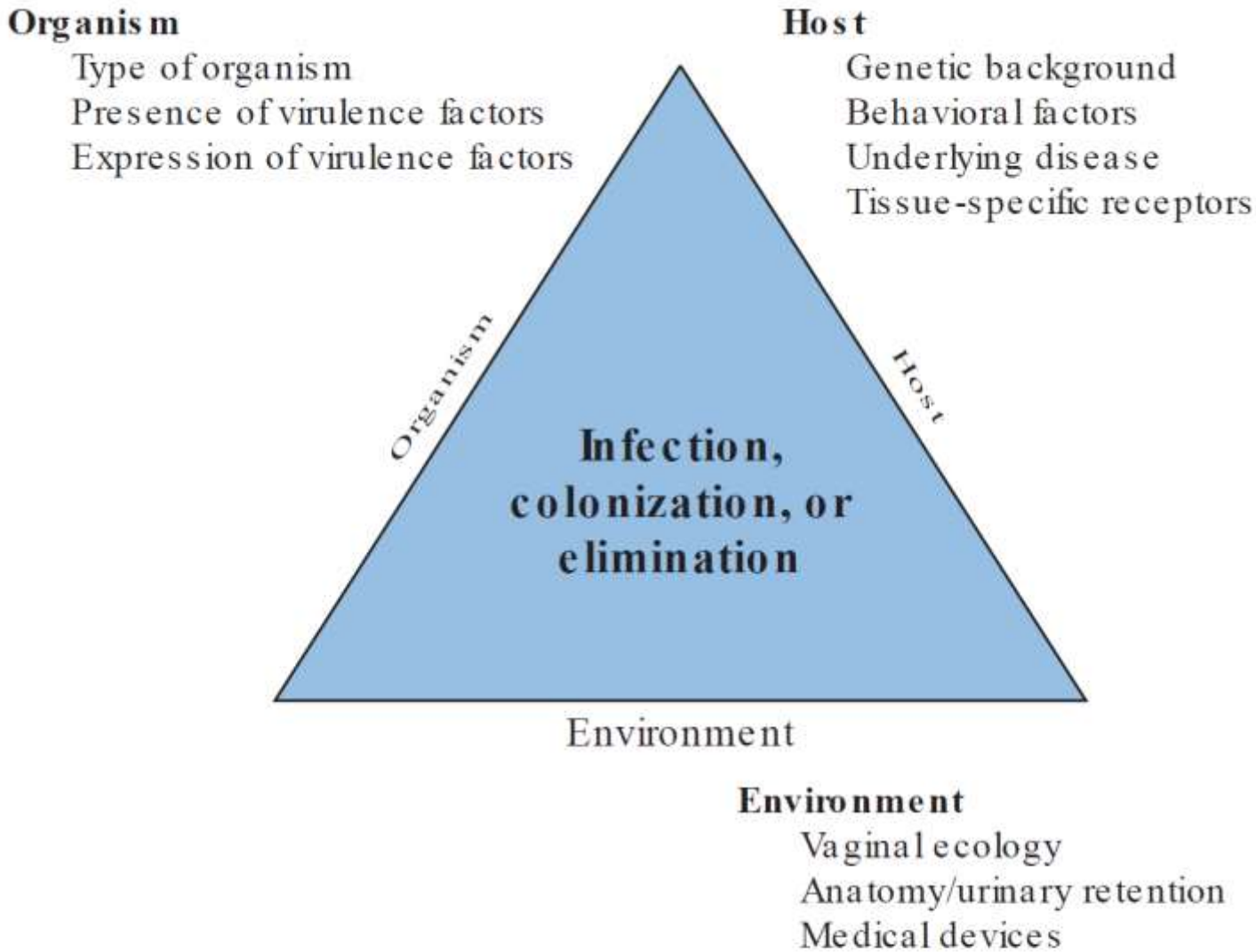



FIGURE 33-1
Pathogenesis of urinary tract infection. The relationship among specific host, pathogen, and environmental factors determines the clinical outcome.

# Pathophysiology of UTIs

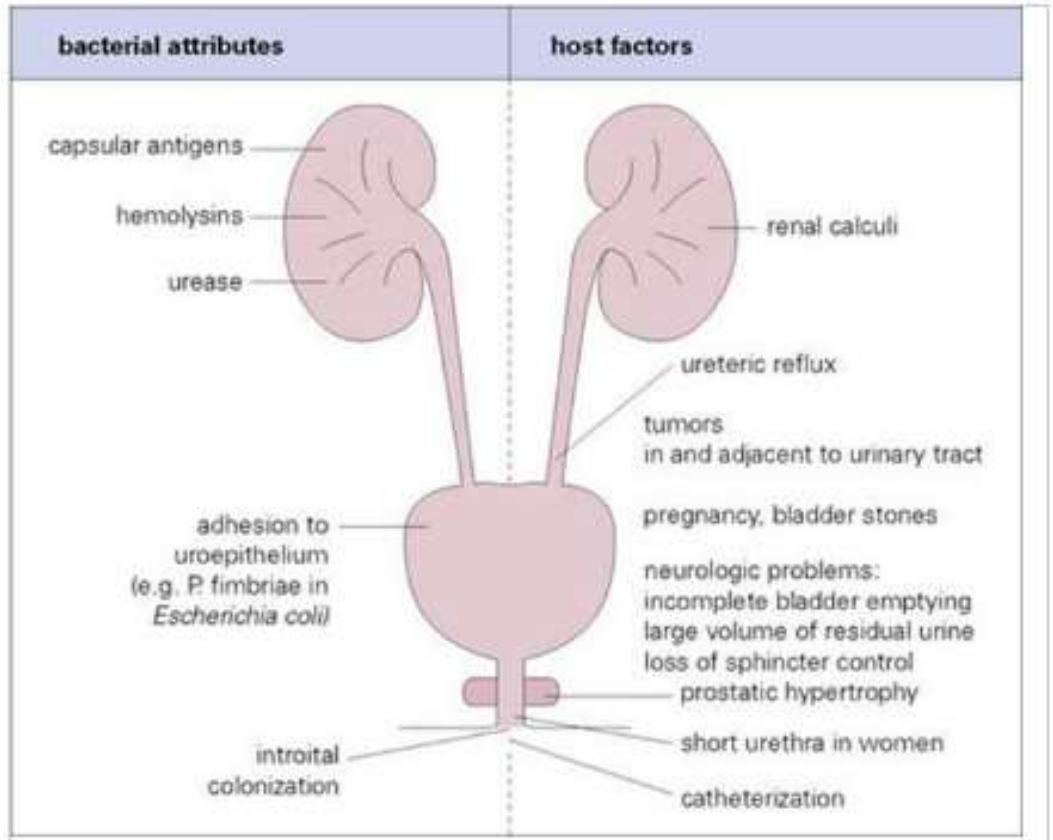
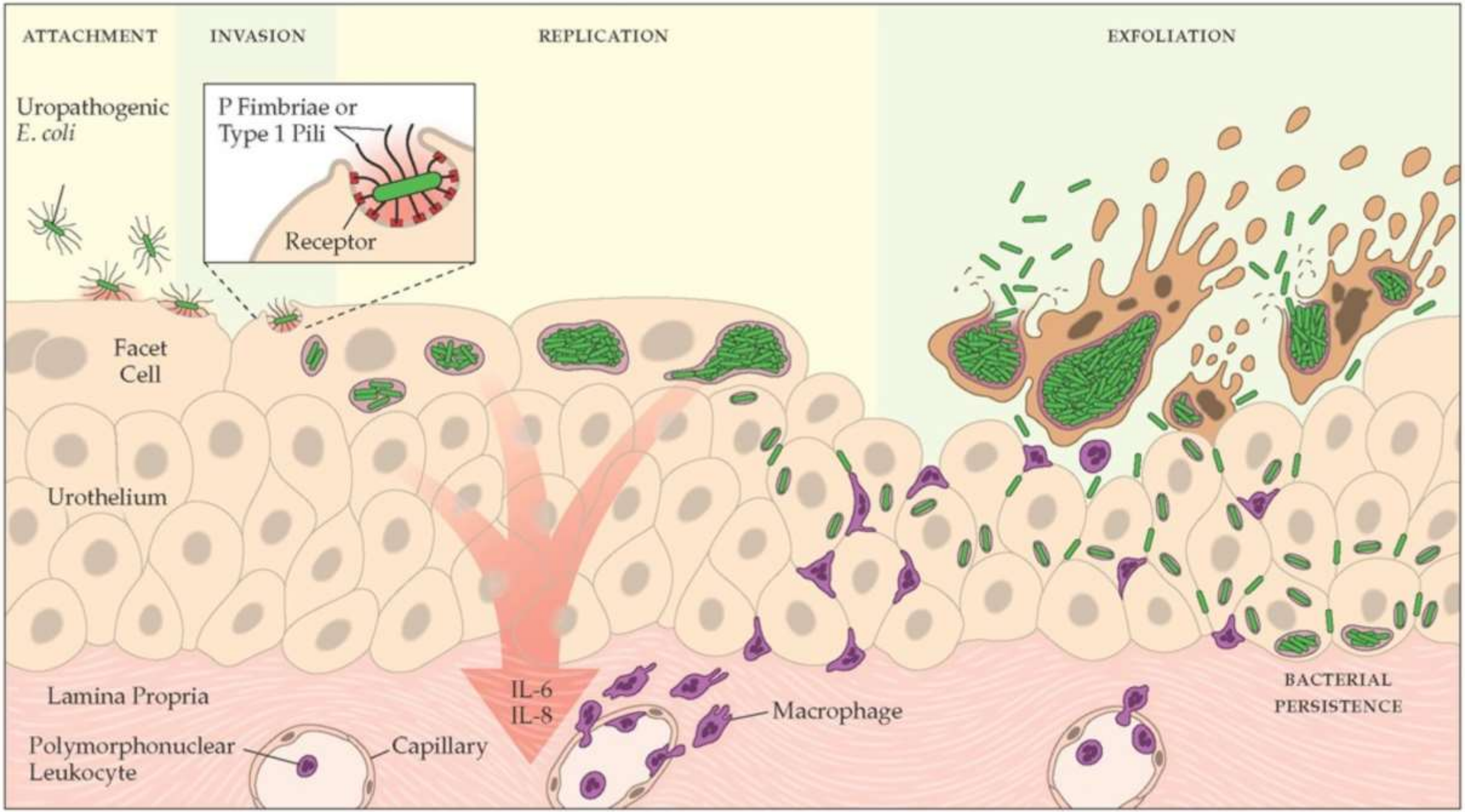
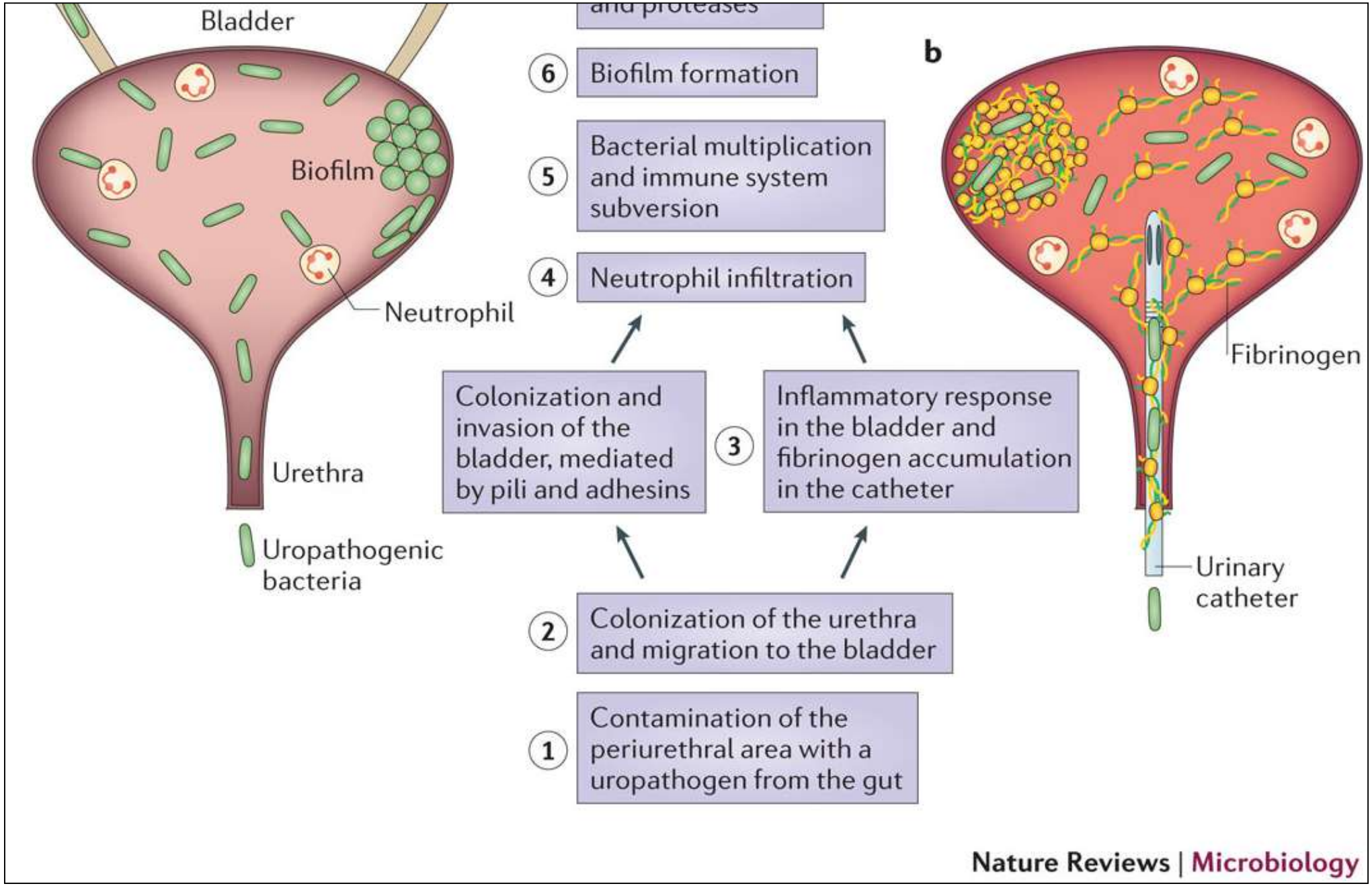


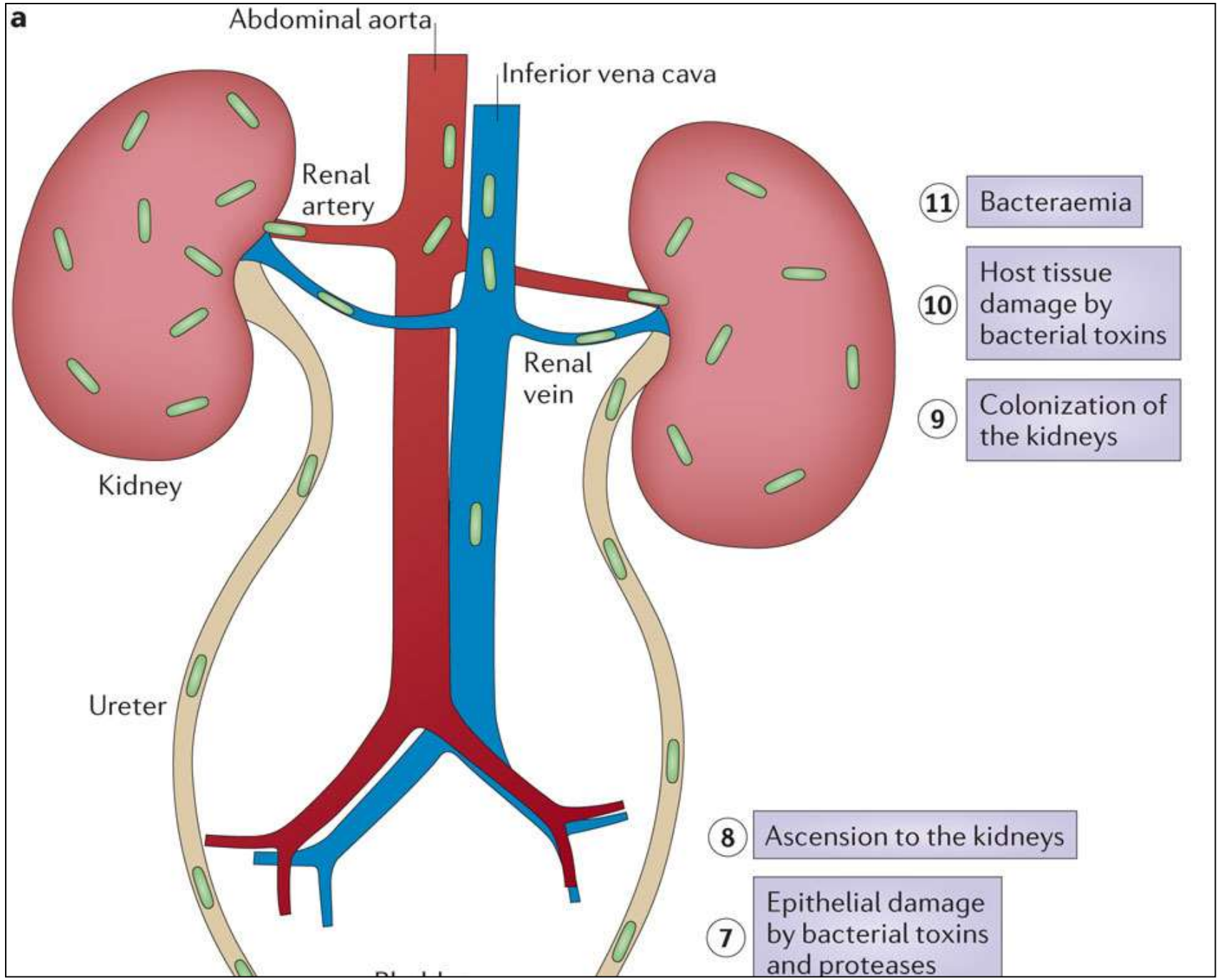

*Figure 4.* Bladder (Medical Microbiology, 2017)


ATTACHMENT
INVASION
REPLICATION
EXFOLIATION
Uropathogenic
E. coli
P Fimbriae or
Type 1 Pili
Receptor
Facet
Cell
Urothelium
Lamina Propria
IL-6
IL-8
Macrophage
BACTERIAL
PERSISTENCE
Polymorphonuclear
Leukocyte
Capillary

Pathophysiology of UTIs



Pathophysiology of UTIs



# 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