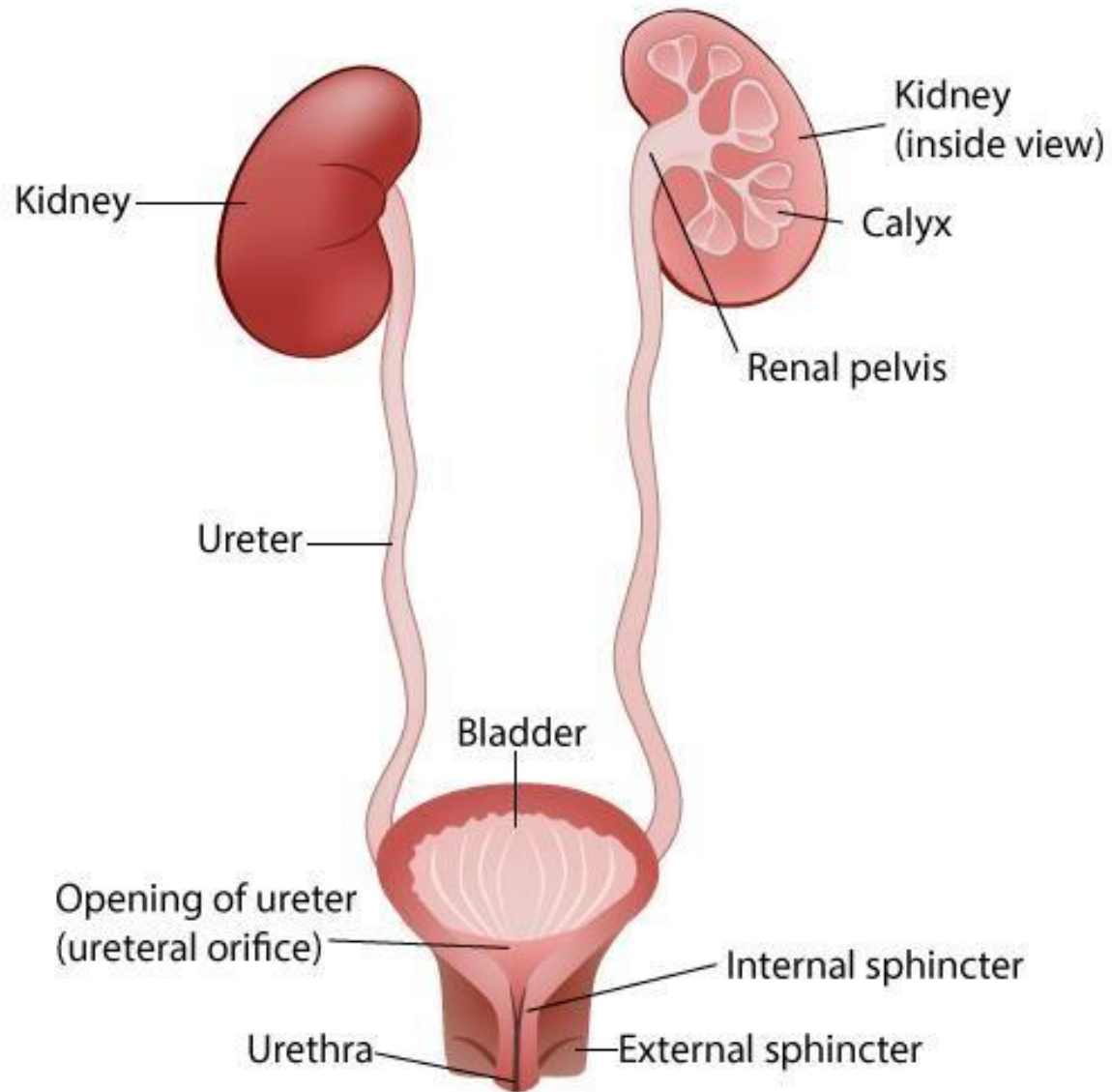


RENAL TRACT PATHOGENS



LECTURE OUTLINE

- Clinical diseases associated with UT
- Specific pathogens involve
- Specific conditions

Sterile pyuria

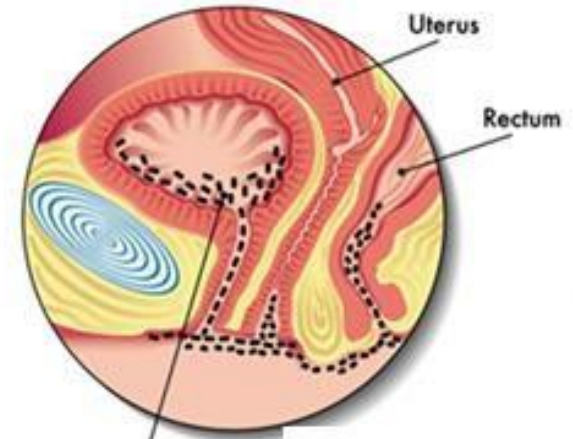
Asymptomatic bacteriurea

Catheter related UTI

Terms Used for Specific Urinary Tract Infections.

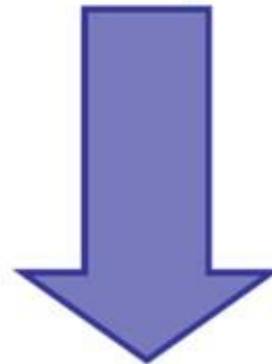
Urinary tract infection	Microbial (bacterial, viral, fungal, etc.) infection that affects any part of the urinary tract
Lower urinary tract infection	Infection of either the bladder or the urethra.
Upper urinary tract infection	Although the upper urinary tract is composed of the kidneys and ureters, upper urinary tract infection generally affects the kidneys
Pyelonephritis	Infection affecting the kidneys
Cystitis	Infection affecting the bladder
Urethritis	Infection affecting the urethra. Common pathogens causing urethritis include <i>Chlamydia trachomatis</i> and <i>Neisseria gonorrhoeae</i>
Cervicitis	Infection affecting the cervix. Mostly due to pathogens causing sexually transmitted diseases such as <i>Chlamydia trachomatis</i> and <i>Neisseria gonorrhoeae</i>
Prostatitis	Infection of the prostate
Renal abscess	Infection of the renal parenchyma which forms purulent collection within or around the renal parenchyma
Bacteruria	Presence of bacteria in the urine. Does not necessarily indicate presence of infection. Does not need to be treated in most instances, if patient is asymptomatic.
Pyuria	Presence of white blood cells in the urine. Indicates inflammation, not necessarily from infection.

How do organisms gain entry to UT



Bacteria (*Escherichia coli*) coming from the rectum found in bladder and urethra

Ascending route



Haematogenous route



Urinary Tract Infection

Lymphatic route



Virulence Factors in Uropathogens.

Virulence Factors
Adherence
Calculi formation
Toxin production
Lipopolysaccharides
Capsular polysaccharide
Hemolysins
Biofilm
Aerobactins

Specific pathogens involve

E. coli

- The most common pathogen causing UTIs (**70-95%** of urinary tract infections).
- *E. coli* serogroups 01, 02, 04, 06, 07 and 075 are the most common agents of urinary tract infections (**uropathogenic *E. coli*** clones).

Specific pathogens involve

E. coli

- Cystitis and pyelonephritic *E. coli* isolates are genetically distinct, exhibiting **differences in O, K, and H antigens**
- The most important virulence factor for these bacteria is the **enhanced ability to adhere to uroepithelial cells.**

Specific pathogens involve

E. coli

- This attachment is mediated by specific **pilus adhesins** on the surface of *E. coli*.
- The **mucosal epithelial cells** of women and children with recurrent urinary tract infections have been shown to have an **increased avidity for attachment of E. coli**.
- **Motility** has been shown to **facilitate ascending** infection and bacterial **endotoxins** can **decrease urethral peristalsis**

Specific pathogens involve

E. coli

- The presence of higher quantity of **K antigen** in capsules (K1, K5, K12) **protects bacteria from leukocyte phagocytosis**
- Most uropathogenic strains produce **hemolysin**, which facilitates **tissue invasion** and causes renal tubular epithelial and parenchymal cell damage, possibly **making iron available** to invading *E. coli*.

Specific pathogens involve

E. coli

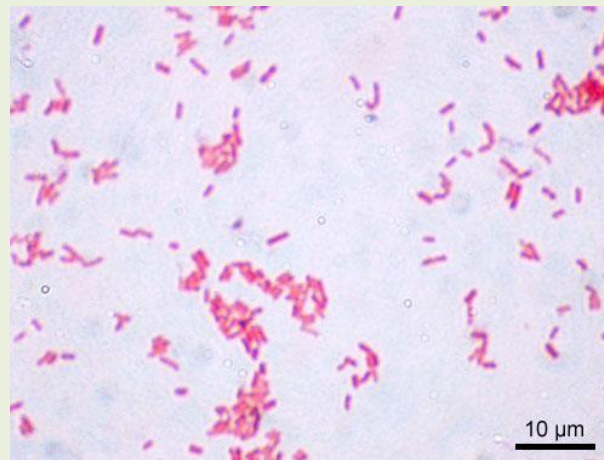
Other virulence factors

- Resistance to serum bactericidal activity
- Presence of aerobactin
- Cytotoxic necrotizing factor type 1
- Siderophore receptor

Specific pathogens involve

E. coli

- How to identify?



Specific pathogens involve

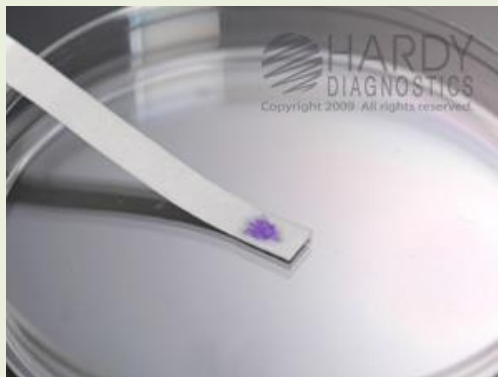
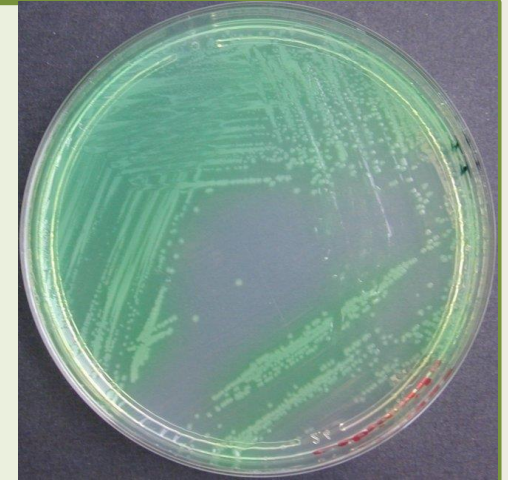
P. aeruginosa

- *P. aeruginosa* is the third most common pathogen associated with hospital-acquired, catheter associated UTIs
- *P. aeruginosa* has a tendency to form biofilms on the surface of urinary catheters

Specific pathogens involve

Pseudomonas aeruginosa

- How to identify?



Specific pathogens involve

Proteus spp

- In *Proteus* spp., the production of **urease** by infecting microorganisms has been correlated with the ability to cause **pyelonephritis**.
- Hydrolysis of urea by bacteria (e.g., *Proteus mirabilis*) can cause the **formation of renal stones**.

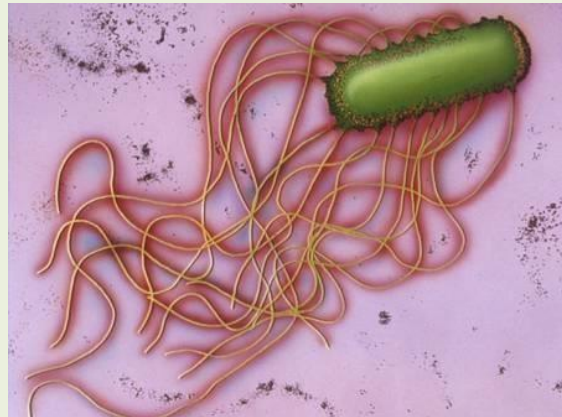
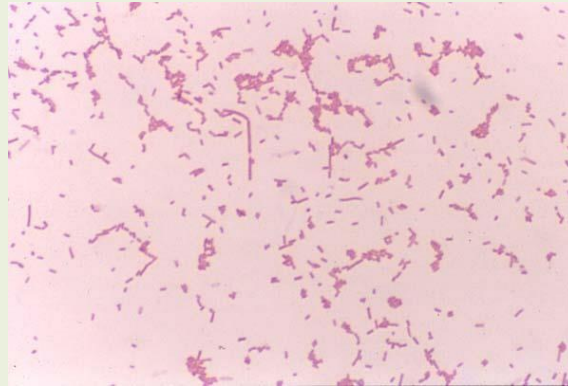


Plain film; multiple renal calculi (arrows)

Specific pathogens involve

Proteus spp

- How to identify?



Specific pathogens involve

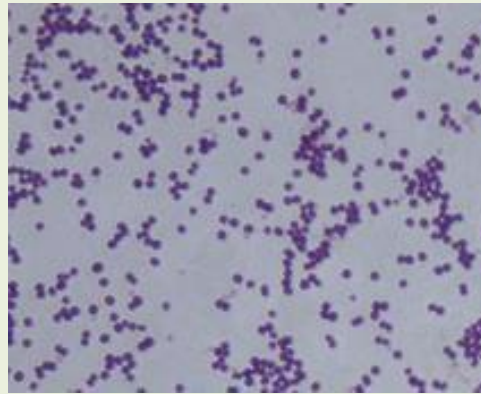
Staphylococcus saprophyticus

- *Staphylococcus saprophyticus* is a frequent cause of lower urinary tract infections.
- Tends to cause infection in young females who are sexually active, accounting for 5% to 15% of acute cystitis
- *S. saprophyticus* adheres significantly better to uroepithelial cells than *S. aureus* or *Staphylococcus epidermidis*.

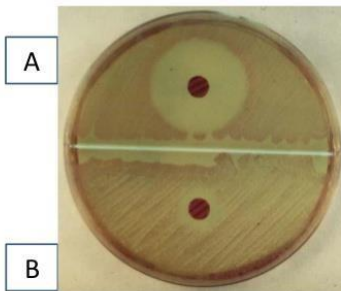
Specific pathogens involve

Staphylococcus saprophyticus

- How to identify?



Facultative anaerobe
Opaque
Creamy white



Name of the test: Novobiocin sensitivity
Example A: Staph epidermidis (Sensitive)
Example B: Staph saprophyticus (Resistant)

Specific pathogens involve

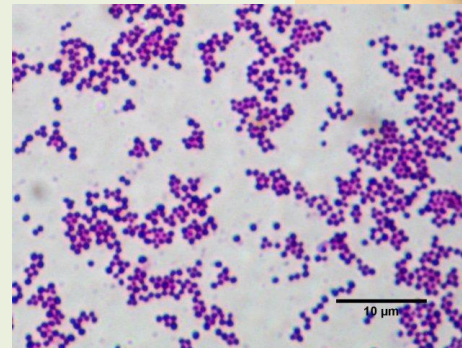
Staphylococcus aureus

- Urinary tract infections due to *S. aureus* typically occur secondary to blood-borne infections resulting in intrarenal or perinephric abscesses.
- *S. aureus* uncommonly causes cystitis and ascending pyelonephritis

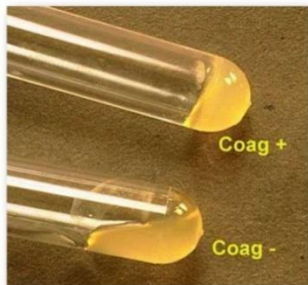
Specific pathogens involve

Staphylococcus aureus

- How to identify?

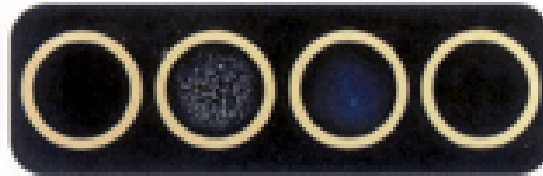


Coagulase Test



Staphylococcus aureus

Coagulase negative
staphylococci,
e.g. *S. epidermidis*



Specific pathogens involve

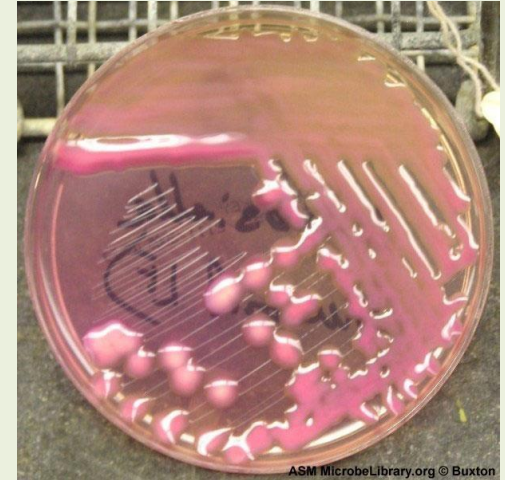
Klebsiella spp

- Important cause for nosocomial UTI (Sp Catheter related)
- *Klebsiella* organisms are often resistant to multiple antibiotics (ESBL, CRE)

Specific pathogens involve

Klebsiella spp

- How to identify?



Specific pathogens involve

Enterococcus faecalis

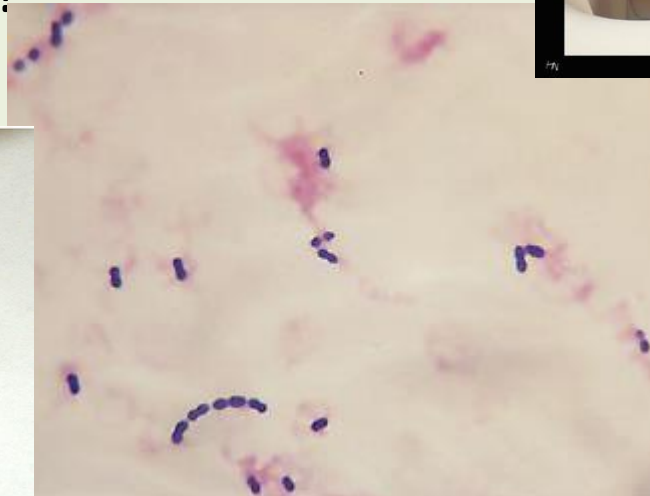
- Enterococci - commensal bacteria
- Entry – ascending
- Enterococci - significant agents of UTI in the hospital setting
- Troublesome to treat because of frequent resistance to multiple antibiotics, including vancomycin

Specific pathogens involve

- **Enterococcus**

Enterococcus faecalis

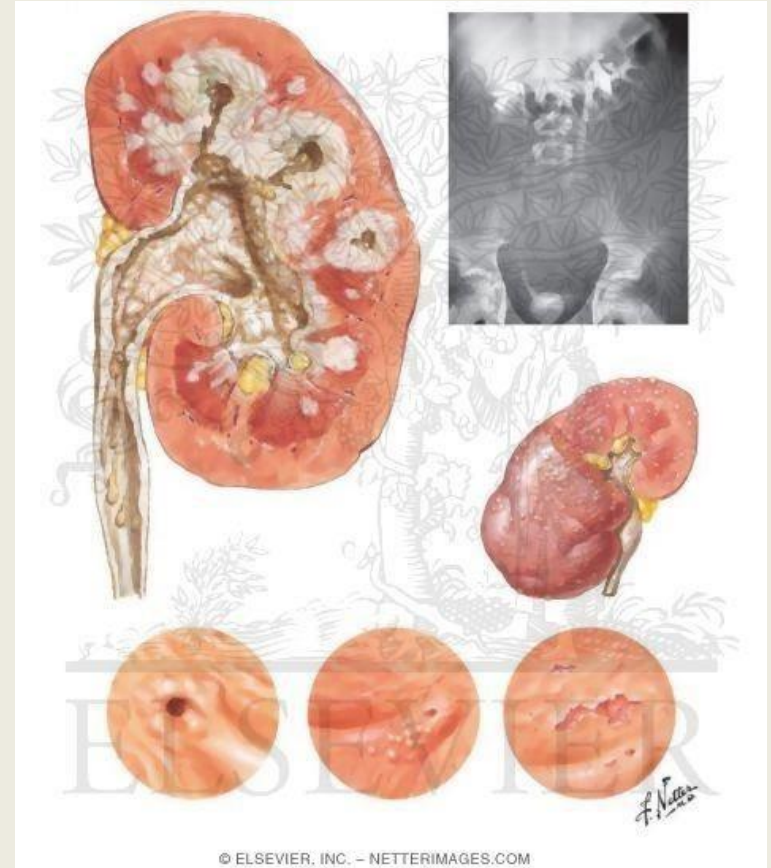
How to identify?



Specific pathogens involve

Mycobacterium tuberculosis

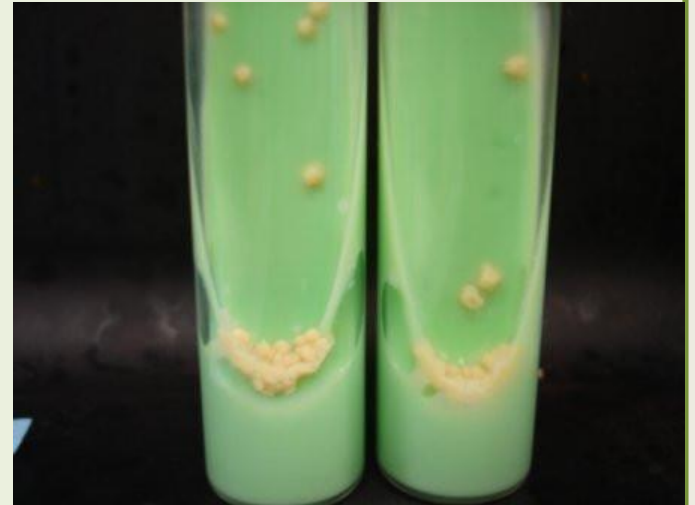
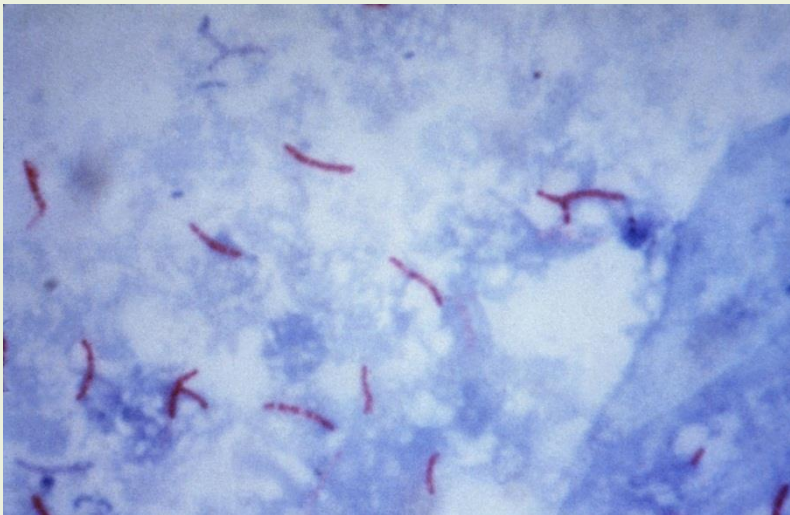
- The GUT is a **primary target** of **hematogenous** infections
- The most common site of extra-pulmonary TB
- The **kidney** is the most common site of GUTB.
- An increased incidence noted in **AIDS patients**



Specific pathogens involve

Mycobacterium tuberculosis

- How to identify?



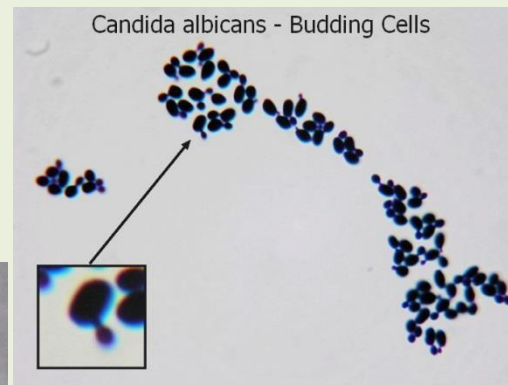
Specific pathogens involve

- Fungi (particularly *Candida* spp.) occur in hospitalized patients with indwelling catheters who are receiving antimicrobial therapy and particularly if diabetes is present

Specific pathogens involve

Candida

- How to identify?

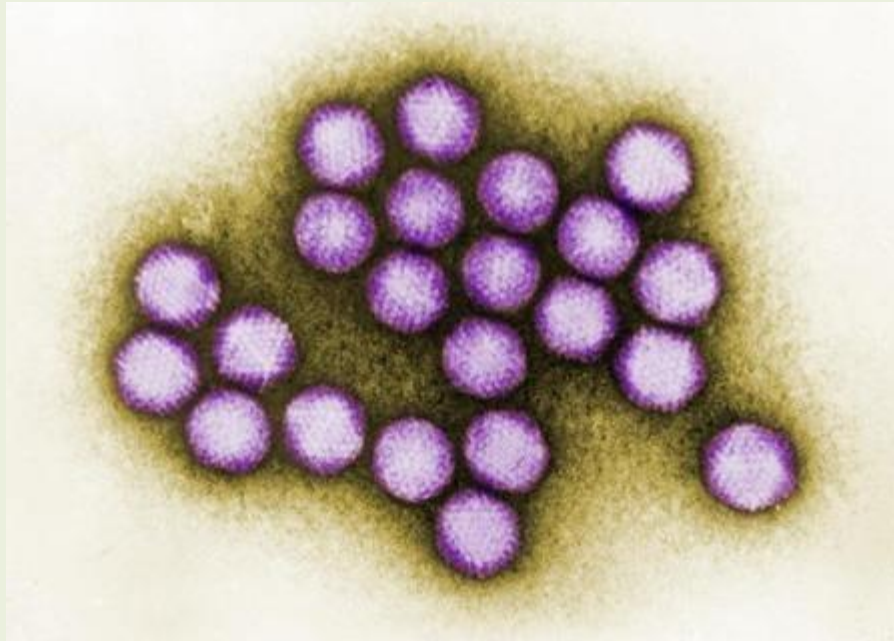


Specific pathogens involve

- Anaerobic organisms are rarely pathogens in the urinary tract.
- Anaerobic microorganisms are frequently encountered in suppurative infections of the genitourinary tract (e.g., periurethral abscess and Fournier gangrene)
- *Gardnerella vaginalis* is frequently isolated from the urine of women with and without urinary tract symptoms, but its pathogenic role is unclear.

Specific pathogens involve

- **Adenoviruses** (particularly type 11) have been strongly implicated as causative agents in **hemorrhagic cystitis** in **pediatric** patients, especially boys

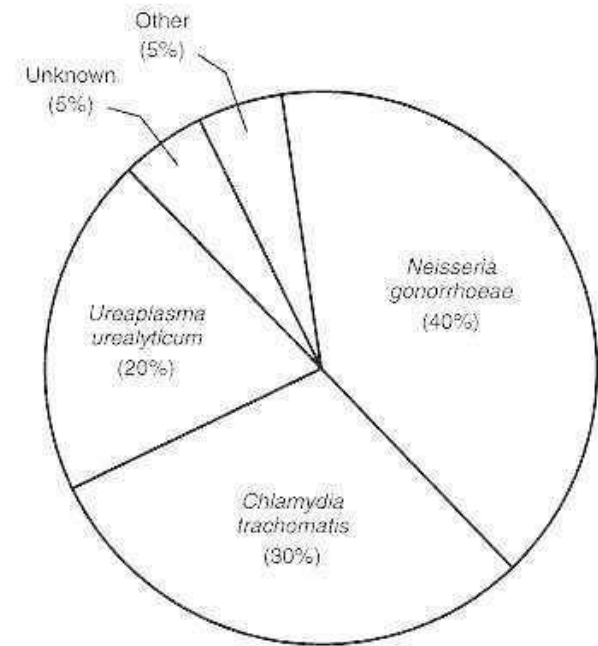


Organisms Associated with Urinary Tract Infections.

Pyelonephritis	Gram-positive Bacteria <i>Staphylococcus aureus</i> <i>Staphylococcus saprophyticus</i> Gram-negative Bacteria <i>Escherichia coli</i> <i>Klebsiella species</i> <i>Proteus species</i> <i>Pseudomonas aeruginosa</i> <i>Enterobacter species</i>
Cystitis	Gram-negative Bacteria <i>Escherichia coli</i> <i>Klebsiella species</i> <i>Proteus species</i> Gram-positive Bacteria <i>Staphylococcus saprophyticus</i> <i>Enterococcus species</i> <i>Staphylococcus aureus</i>
Urethritis	<i>Chlamydia trachomatis</i> <i>Neisseria gonorrhoeae</i> <i>Ureaplasma urealyticum</i>

Major causes of urethritis

- ***Neisseria gonorrhoeae*** attaches to mucosal cells via **pili** and other surface proteins.
- Proliferation occurs with subsequent **influx of polymorphonuclear neutrophils (PMN)**, which produce the exudate that is the hallmark of gonorrhea.
- ***Chlamydia trachomatis*** is an obligate intracellular parasite with a dimorphic life cycle

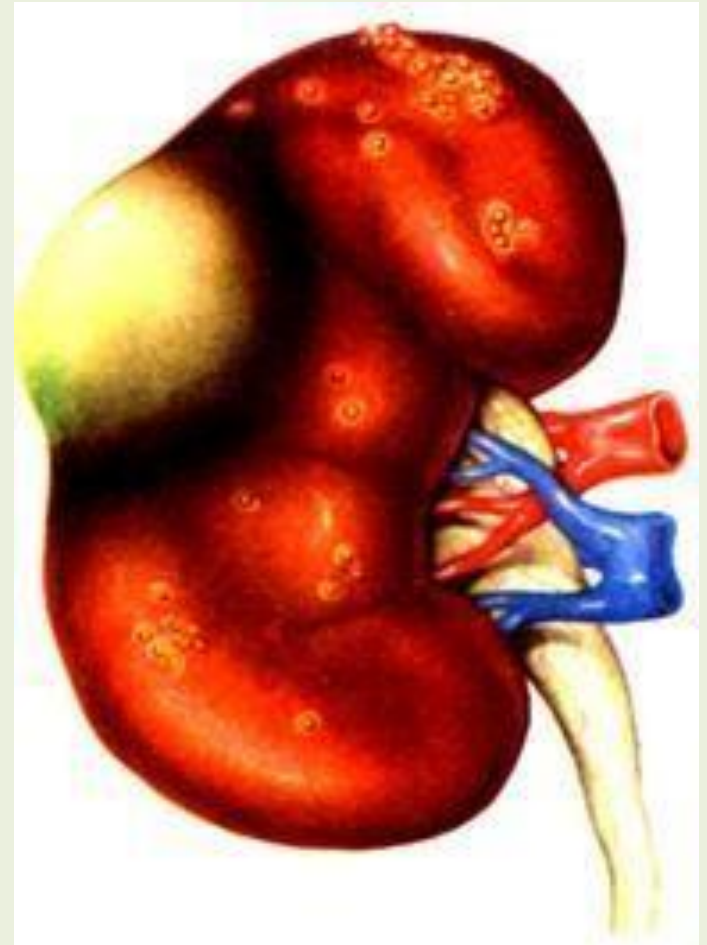


Pyelonephritis

- The kidney itself is not uniformly susceptible to infection, because very few organisms are needed to infect the medulla, whereas 10,000 times as many are needed to infect the cortex.
- The greater susceptibility of the medulla may be caused by the high concentration of ammonia, which may inactivate complement, and by poor chemotaxis of polymorphonuclear neutrophils (PMNs) into an area of high osmolality, low pH, and low blood flow.

Perinephric abscess

- Perinephric abscess occurs when **microorganisms** from the renal parenchyma or blood are **deposited** in the **soft tissues** surrounding the kidneys.



Perinephric abscess

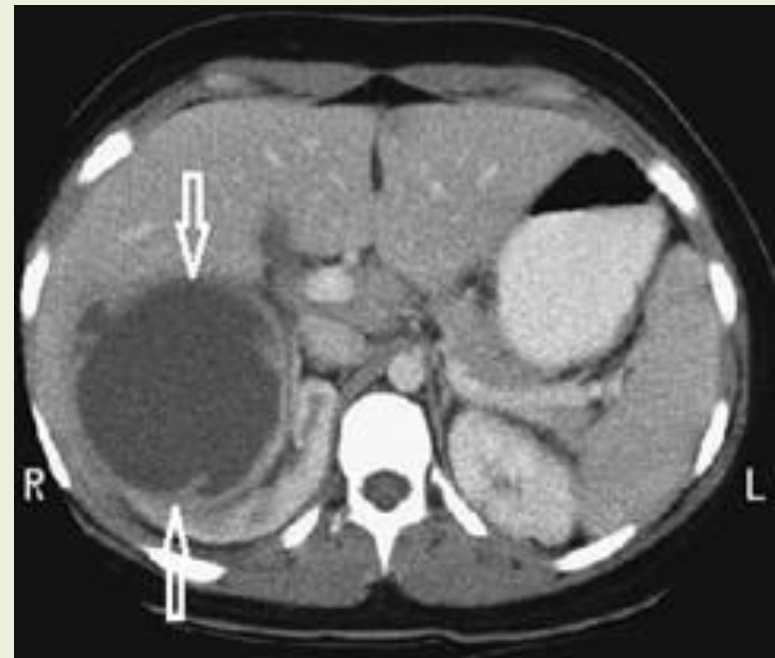
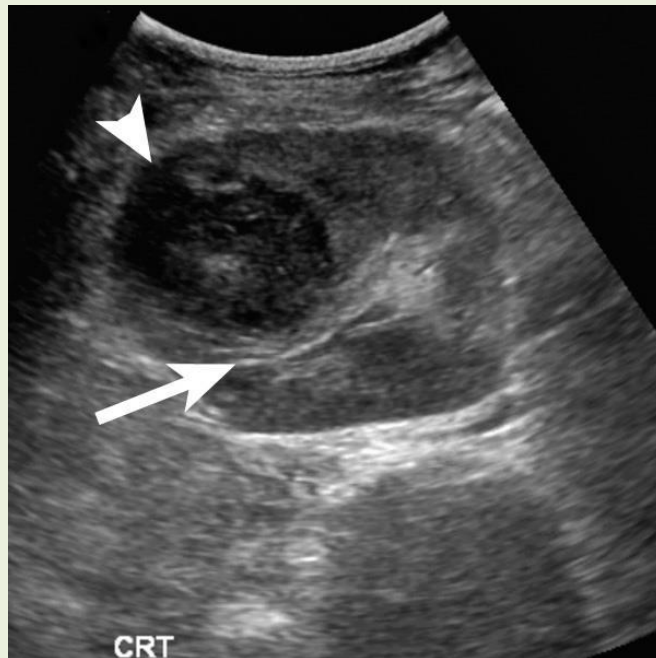
- An uncommon complication of UTI
- The most common predisposing factors are urinary tract calculi and diabetes mellitus
- The infecting bacteria are usually Gram-negative enteric bacilli and occasionally Gram-positive cocci when the infection is of hematogenous origin

Perinephric abscess

- Urinalysis is abnormal in 70% of patients with a corticomedullary abscess, whereas it is usually normal in the patient with a hematogenous cortical or perinephric abscess.
- Confirmation of the diagnosis requires imaging techniques

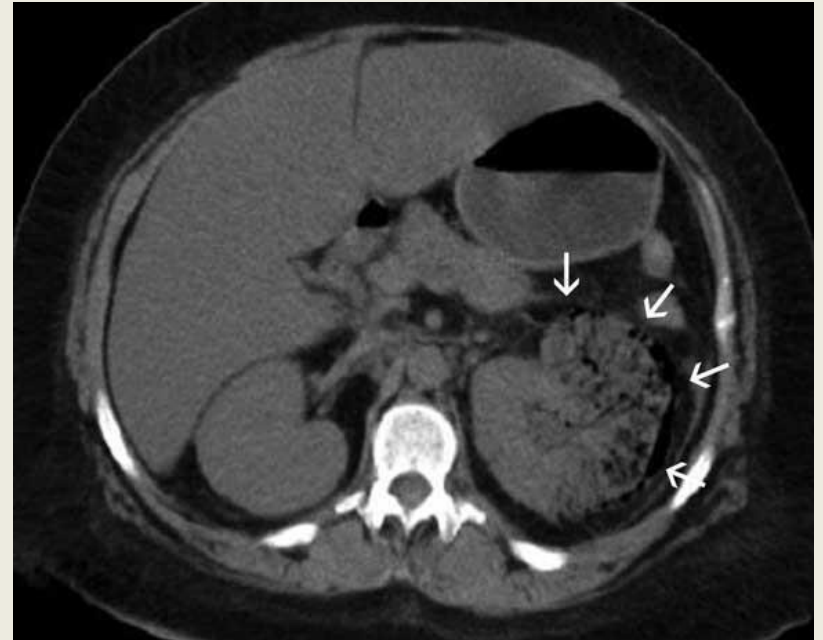
Intrarenal Abscess

- Occur as a consequence of bacteremia /severe pyelonephritis
- Often caused by coagulase-positive staphylococci.



Emphysematous pyelonephritis

- Severe, necrotizing form of acute multifocal bacterial nephritis
- retroperitoneal, extraluminal **gas** is seen in the renal **parenchyma** and **perirenal space**
- ***E. coli*** is the **most common** organism associated with, but ***Klebsiella spp.***, ***P. mirabilis***, and ***Citrobacter* spp.** / ***Candida* spp** may be involved.
- Occurs most commonly in **diabetic patients**



Diagnosis - UTI

Dipstick leukocyte esterase test

- **Rapid screening test** for detecting pyuria
- Positive test by no means indicates UTI
- Patients with a negative leukocyte esterase test and UTI symptoms should have a urine microscopic examination for pyuria or a urine culture



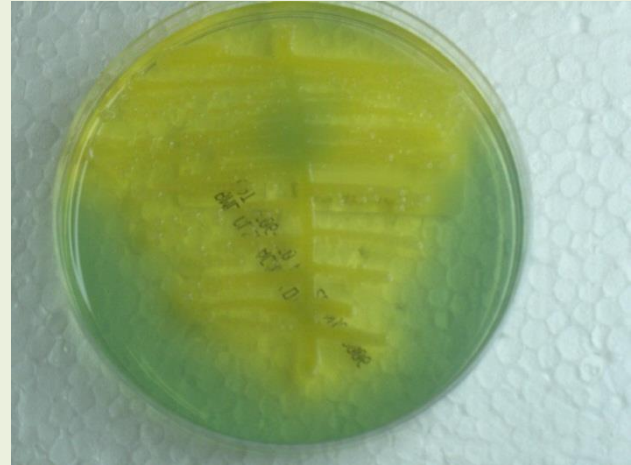
microscopic examination of a specimen for bacteria



Diagnosis of urinary tract infection by culture

Significant bacteriuria

- Numbers of bacteria in voided urine that usually exceed the numbers caused by contamination from the anterior urethra (i.e., $\geq 10^5$ bacteria/mL)



More than 95% of UTIs are caused by a single bacterial species

Pyuria

- At least 10 leukocytes/mm³ of midstream urine by counting chamber
- The vast majority of patients with symptomatic or asymptomatic bacteriuria have pyuria

Sterile pyuria

- **Sterile pyuria** is the presence of **elevated numbers of white cells** (>10 white cells/mm³) in urine which appears **sterile** using standard culture techniques.
- Sterile pyuria is often found in female patients with symptoms of urinary tract infection

Causes of Sterile pyuria

Causes related to infection

Current use of antibiotics

Recently treated urinary tract infection (within past 2 wk)

Gynecologic infection

Urethritis due to chlamydia, *Neisseria gonorrhoeae*, mycoplasma, or ureaplasma

Prostatitis

Balanitis

Appendicitis (if the appendix lies close to a ureter or the bladder)

Viral infection of the lower genitourinary tract

Genitourinary tuberculosis

Fungal infection

Parasitic disease such as trichomoniasis or schistosomiasis

Causes not related to infection

Presence or recent use of a urinary catheter

Recent cystoscopy or urologic endoscopy

Urinary tract stones

Foreign body such as surgical mesh in the urethra or a retained stent

Urinary tract neoplasm

Asymptomatic bacteriuria

- Presence of more than 10^5 bacteria/mL in the urine of a patient without urinary tract and/or constitutional symptoms.
- Antibiotic treatment for asymptomatic bacteriuria is not indicated unless the woman is pregnant or the patient is about to undergo a urologic procedure, e.g. cystoscopy or or in immunocompromised patients

Recurrences of urinary tract infection

- In recurrent UTIs,
 - Especially in the presence of structural abnormalities of the urinary tract
 - Recur same organism
 - frequency of infection caused by *Proteus*, *Pseudomonas*, *Klebsiella*, and *Enterobacter* spp. and by enterococci and staphylococci increases greatly

Reinfection

- Reinfection is a recurrence of bacteriuria with a microorganism **different** from the **original** infecting **bacterium**.
- It is a **new** infection

Treatment

Refer the guideline

