The urinary and reproductive systems are closely associated and infections in one system easily spread to the other. The urinary tract has characteristics that aid in the prevention of infection. Where the ureters enter the urinary bladder, there are valves that normally prevent the backflow of urine to the kidneys. This helps to shield the kidneys from lower urinary tract infections. The acidity of urine has some antimicrobial properties and the flushing action of urine to the exterior also aids in preventing microorganisms from causing infection. The female urethra does contain a small resident microbiota. Many infections of the urinary system are opportunistic. Because the anus is fairly close to the urethra in females, it is not uncommon for the urinary tract to be contaminated with intestinal bacteria, especially Escherichia coli, Proteus spp., and other gram negative bacteria. Streptococci, Staphylococci, and Pseudomonas species are also common causes of infection. The fungus Candida albicans is also an opportunistic agent of urinary tract infection. Many infections of the urinary tract are nosocomial. Operations on the urinary bladder and prostate gland and catheterization for draining the urinary bladder can introduce bacteria into the urinary bladder and ureters. E. coli accounts for 50% of the nosocomial infections of the urinary tract. Fecal Streptococci, Proteus, Klebsiella, and Pseudomonas are also common causes of nosocomial infections.

Symptoms of urinary tract infections include:

a. **urethritis** - inflammation or infection of the urethra.

b. **cystitis** - inflammation or infection of the urinary bladder.

c. **urethrocystitis** - infections that easily spread from the urethra to the urinary bladder.

d. **ureteritis** - inflammation or infection of the ureters.

e. **pyelonephritis** - inflammation or infection of the kidneys.
The reproductive system is relatively free of microorganisms except for the female vagina. The normal microbiota of the vagina is greatly affected by sex hormones. Lactobacilli are found in the female vagina shortly after birth because estrogens are transferred from the maternal to the fetal blood. Estrogens cause glycogen to accumulate in the cells lining the vagina. Lactobacilli convert the glycogen to lactic acid and the pH of vagina becomes acidic. The physiological effects of the estrogens diminishes several weeks after birth, and other bacteria, such as Corynebacterium and various cocci and bacilli become established. The pH of the vagina becomes more neutral until puberty. At puberty, estrogen levels increase, lactobacilli again dominate and the vagina becomes acidic. During the reproductive years, small numbers of other bacteria and fungi become part of the microbiota. During menopause, estrogen levels decrease, the vagina becomes neutral and the microbiota is similar to that during childhood.

Symptoms of reproductive tract infections include:

a. vaginitis - inflammation or infection of the vagina.

b. endometriosis - inflammation or infection of the vaginal linings.

c. salpingitis - inflammation or infection of the fallopian tubes.

d. oophoritis - inflammation or infection of the ovaries.

e. prostatitis - inflammation or infection of the prostate gland.

Bacterial Diseases of the Urinary Tract

1. Cystitis

   a. causative agent: Escherichia coli or Staphylococcus saprophyticus

   b. method of transmission: Sexual intercourse or careless personal hygiene transfers fecal matter to the urethra. In the female it may also be transmitted by gastrointestinal system infections and preexisting infections of the vagina, uterus, or urethra. In the male it may be transmitted by infections of the gastrointestinal system, kidneys, or urethra.
c. symptoms: inflammation of the urinary bladder, dysuria (difficult or painful urination), and pyuria (the presence of leukocytes in the urine).

d. prevention: Good hygiene.

e. treatment: Trimethoprim-sulfamethoxadole. Quinolone antibiotics or ampicillin if resistance is encountered.

2. Pyelonephritis

a. causative agent: Escherichia coli

b. method of transmission: Generally a complication of infection elsewhere in the body. Untreated cystitis may progress to pyelonephritis. In females, it is often a complication of lower urinary tract infections. Urine backs up into the kidneys due to lower urinary tract blockage or anatomical defects.

c. symptoms: It can be asymptomatic or indistinguishable from cystitis, except sometimes chills and fever occur. Dilute urine leading to frequent urination and nocturia (nighttime urination) is common. Inflammation of one or both kidneys occurs and if it becomes chronic, scar tissue forms in the kidneys and severely impairs their function.

d. prevention: Treatment of cystitis and other infections that may lead to pyelonephritis.

e. treatment: Removal of blockage or defects. Since it is potentially life-threatening, treatment begins with intravenous administration of a broad-spectrum antibiotic such as second- or third-generation cephalosporin and is usually extended for 14 days.

3. Prostatitis

a. causative agent: Escherichia coli

b. method of transmission: Ascent through the urethra, backflow of contaminated urine, passage of fecal organisms from the rectum through the lymphatics and to the prostate, or descent of bloodborne organisms.

c. symptoms: Urgent and frequent urination, dysuria, low fever, back pain, and sometimes muscle and joint pain. Chronic prostatitis, although uncommon, is a major cause of persistent urinary tract infections (UTIs) in males, and it can cause infertility.
d. prevention: Good hygiene and treatment of other infections.

e. treatment: trimethoprim-sulfamethoxadole, ampicillin, or cephalosporin.

4. Leptospirosis

a. causative agent: Leptospira interrogans - a spirochete that has a hooked end and resembles a question mark.

b. method of transmission: Dogs, cats, cattle, rodents, and wild animals, and water or soil contaminated with their urine are reservoirs. It is transmitted directly by urine from infected animals entering through a break in the skin, or indirectly in contaminated water and soil. They enter the bloodstream and are distributed to tissues throughout the body. In the kidney they multiply and are excreted in urine.

c. symptoms: Usually asymptomatic, and most who become ill have flu-like symptoms of fever, headache, muscle pain, and reddened eyes that is usually misdiagnosed as a viral infection. Usually recovery is in a week. Some may progress to kidney damage, which may result in renal failure, and liver damage, resulting in jaundice.

d. prevention: Disinfection of drinking water, closing contaminated water to swimmers, vaccination of dogs, cats and livestock, elimination of rodents.

e. treatment: penicillin or tetracycline

5. Nongonococcal Urethritis (NGU)

a. causative agent: Chlamydia trachomatis

b. method of transmission: Trauma (catheterization), but at least 40% are transmitted sexually. A substantial number of people with gonorrhea are coinfected with Chlamydia. Infected women transmit it to infants at birth, causing neonatal eye infections and pneumonia.

c. symptoms: In males, symptoms are often mild and in females it is asymptomatic. Males may develop inflammation of the epididymis and in females inflammation of the fallopian tubes may cause sterility by scarring the tubes or ectopic pregnancy. Pelvic inflammatory disease (PID) when bacteria infect the vagina, uterus, and fallopian tubes may occur in females.
d. **prevention:** Everyone who is sexually active should be regularly screened especially in high risk groups and pregnant women. Use of condoms is effective.

e. **treatment:** doxycycline, tetracycline, erythromycin, or azithromycin

*Mycoplasma hominis* is a normal flora that also causes NGU. They have no cell walls and fuse their cell membranes with those of the host cell membranes. It sometimes causes PID in females and opportunistic urethritis in males. *Mycoplasmas* on the cervix during pregnancy cause spontaneous abortions, premature births, and ectopic pregnancies.

*Ureaplasma urealyticum* also causes NGU and is one of the smallest bacteria known to cause human disease and between 1 and 2.5 million people in the U.S. are infected. The organism accounts for more than half of all infections that make couples infertile. Low sperm counts and poor sperm motility occurs in males. It is a major cause of fetal death, recurrent miscarriage, prematurity, and low birth weight.

### Bacterial Diseases of the Reproductive Tract

Most diseases of the reproductive tract are **sexually transmitted diseases (STDs)**

1. **Gonorrhea**

   It is the most common reportable communicable disease in the U.S.

   a. **causative agent:** *Neisseria gonorrhoea* - a gram negative diplococci

   b. **method of transmission:** Attachment pili (fimbriae) enable it to attach to the epithelial cells that line the urinary tract and they are not swept out with the passage of urine, and the release of endotoxin damages the mucosa. They also use the pili to attach to sperm as they are traveling into the upper part of the reproductive tract. Gonorrhea is transmitted by carriers who either have no symptoms or have ignored them. As many as 40% of males and 60-80% of females remain asymptomatic after they are infected and can act as carriers. Transfer of bacteria by contaminated hands, or fomites such as towels, can result in eye infections. If untreated, severe scarring of the cornea and blindness can result. Newborns can acquire ophthalmia neonatorum (conjunctivitis) during passage through the birth canal. The use
of oral contraceptives favors the growth of Neisseria in the vagina because their pili alter the conditions, and IUDs promote their growth in the endometrial cavity and fallopian tubes.

c. symptoms: The incubation period is usually 2 to 7 days and males develop symptoms of painful urination and pus drips from the urethra. If left untreated the urethra may become scarred and partially blocked, and sterility can occur when the testes become infected or the vas deferens become blocked. In females it is asymptomatic and in later stages there may be abdominal pain due to PID. Complications may include gonorrheal meningitis, gonorrheal endocarditis, and gonorrheal arthritis. The symptoms of pharyngeal gonorrhea resemble those of septic sore throat and anal gonorrhea symptoms are itching, pain, and sometimes a discharge of pus.

d. prevention: Use of spermacides and condoms and avoid sexual contact with infected individuals.

e. treatment: doxycycline or third-generation cephalosporins such as ceftriaxone.

2. Syphilis

a. causative agent: Treponema pallidum - a thin, tightly coiled spirochete

b. method of transmission: It is transmitted by sexual contact of all kinds, by way of the genitals and other body parts. It can be transmitted by saliva during kissing, and creates a hazard for dentists and dental hygienists.

c. symptoms: The incubation period is from 2 weeks to several months, but averages 3 weeks. The bacteria multiplies and spreads throughout the body.

The disease progresses through several recognized stages:

Primary stage - the initial sign is a small, hard-based chancre, or sore, which usually appears at the sight of infection. The chancre is painless, and a serous exudate is formed in the center. The fluid is highly infectious. In a few weeks the lesion disappears. Many women are entirely unaware of the chancre, which is often on the cervix. In males, the chancre sometimes forms in the urethra, and is not visible. During this stage, bacteria enter the bloodstream, which distributes them widely in the body.

Secondary stage - several weeks after the primary stage, skin rashes. The rash is widely distributed on the skin and is also found in the mucous membranes of the mouth, throat, and cervix. The lesions of the rash contain many spirochetes and are very infectious. Symptoms of loss of patches of hair, malaise, and a mild fever may also occur. The symptoms usually subside after a few weeks, disappear, and reappear over a period of five years.
Latent period - during this period there are no symptoms. After two to four years of latency, the disease is not normally infectious, except for transmission from mother to fetus.

Tertiary stage - without medical attention, half of the cases in the latent period may progress after ten years to a tertiary stage. Inflammatory responses by phagocytic cells such as macrophages and neutrophils, and cell-mediated immune responses of the body cause the production of gummatus (rubbery masses of tissue that appear in many organs and sometimes on external skin). Many of the lesions are not harmful or infectious, but some may cause extensive tissue damage, such as perforation of the palate (roof of the mouth), which interferes with speech. The cardiovascular system may be affected by weakening of the aorta, and damage to blood vessels and heart valves. If the central nervous system is damaged, a loss of motor control occurs; the brain may be affected, with personality changes, blindness, and seizures.

Congenital syphilis transmitted across the placenta to the unborn fetus damages mental development and other neurological symptoms during the latent period. During the primary or secondary stage stillbirth occurs.

d. prevention: Avoid contact with infected individuals. Use spermicides and condoms.

e. treatment: Benzathine penicillin is long-acting and remains effective in the body for about two weeks. For penicillin-sensitive people, erythromycin or tetracycline is effective.

3. Gardnerella vaginitis

a. causative agent: Gardnerella vaginalis

b. method of transmission: It is present in the vagina of 20-40% of healthy women. When the pH of the vagina reaches 5 to 6 it interacts with anaerobic Bacteroides and Peptostreptococcus to produce vaginitis. None of these organisms alone produces vaginitis. It can be transmitted to males by sexual contact.

c. symptoms: A frothy, fishy-smelling discharge in females, and an infection of the penis in males. Lesions appear on the penis after contact with a woman who has vaginitis.

d. prevention: Avoid sexual contact with infected individuals.

e. treatment: Metronidazole (Flagyl) eradicates the anaerobes necessary for the continuance of the disease and allows normal lactobacilli to repopulate the vagina. Ampicillin or tetracycline are also used.
Viral Diseases of the Reproductive Tract

Viral diseases of the reproductive system are difficult to treat effectively and they represent an increasing health problem.

1. Genital Herpes

It is the most common and most severe of the herpes simplex viral infections.

a. causative agent: herpes simplex virus type 2 (HSV-2)

b. method of transmission: It is transmitted by sexual contact, but it can survive for short periods of time in moist areas such as hot tubs.

c. symptoms: Some individuals are asymptomatic and shed the viruses. In females vesicles appear on the mucous membranes of the labia, vagina, and cervix. Ulcerations sometimes spread over the vulva and can even appear on the thighs. In males tiny vesicles appear on the penis and foreskin and are accompanied by urethritis and a watery discharge. The prostate gland and seminal vesicles also can be affected. Both sexes experience intense pain and itching at the sites of lesions and swelling of lymph nodes. A person is contagious any time viruses are being shed. Shedding always occurs when active lesions are present and usually starts a few days before lesions appear. Women have a higher incidence of miscarriages, an increased risk of developing cervical carcinoma, and babies must be delivered by Caesarian section. Latency is a hallmark of herpes infections. Within two weeks of infection, the viruses travel by way of sensory neurons to ganglia. Within the ganglia they replicate slowly or not at all. They can reactivate spontaneously or be activated by ultraviolet radiation, fever, stress, hormone imbalance, menstrual bleeding, a change in the immune system, or trauma. The infection can spread to and kill cells in the adrenal glands, liver, spleen, and lungs. After reactivation the virus moves along the nerve axon to the epithelial cells. There it replicates, causing recurrent lesions at the site of the original infection. The lesions are smaller, shed fewer viruses, contain more inflammatory cells, and heal more rapidly than primary lesions. Each recurrence becomes milder.

Neonatal herpes can be acquired when the baby passes through the birth canal and can appear at birth or up to 3 weeks after birth. Most have skin vesicles and others already have disseminated infection with neural or visceral lesions. Those with disseminated infections have a poor appetite, vomiting, diarrhea, respiratory difficulties, and hypoactivity. Some also have neurological disorders, jaundice, and eye disorders. They usually die within 10 days, but the few that survive have central nervous system and eye damage.
d. prevention: Avoid sexual contact with infected persons even when lesions are absent. Use condoms.

e. treatment: Acyclovir alleviates symptoms of a primary outbreak.

2. Genital Warts or Condylomas

The incidence of genital warts has increased rapidly in recent years to the extent that they are now among the most prevalent STDs.

a. causative agent: human papillomavirus

b. method of transmission: Sexual contact. Infants can be infected during birth.

c. symptoms: The warts can be papillary or flat. In males they appear on the penis, anus, and perineum. In females they are on the vagina, cervix, perineum, and anus. They cause irritation and sometime itching and they can persist or regress spontaneously. They often become infected with bacteria and those that persist can transform into malignant growths such as cervical cancer in females and cancer of the penis and rectum in males.

d. prevention: Avoid sexual contact with infected individuals and use condoms.

e. treatment: Application of extremely cold liquid nitrogen (cryotherapy), drying them with an electric current, burning them with acids, lasers, or injection with interferon have not been completely effective.

Fungal Disease of the Reproductive Tract

Candidiasis

It is one of the most common causes of vaginitis.

a. causative agent: *Candida albicans* - a yeastlike fungus

b. method of transmission: It is the result of an opportunistic overgrowth when the competing microbiota is suppressed by antibiotics, hormonal changes during pregnancy, or oral contraceptives.

c. symptoms: Thick white vaginal discharge and severe vaginal itching.
d. prevention: Consumption of dairy products containing lactobacillus, such as yogurt.

e. treatment: nystatin, terconazole, clotrimazole, or miconazole

Protozoal Disease of the Reproductive Tract

Trichomoniasis

a. causative agent: Trichomonas vaginalis - a flagellated protozoan

b. method of transmission: Sexual contact. It is a normal inhabitant of the female vagina and the male urethra. If the normal acidity of the vagina is disturbed, it may overgrow the normal microbiota.

c. symptoms: A painful vaginitis with a copious, frothy vaginal discharge. In males, it infects the urethra and is asymptomatic unless it is accompanied by a bacterial infection.

d. prevention: Avoid sexual contact with infected individuals. Asymptomatic males must be treated.

e. treatment: metronidazole