Chapter 23

The Genitourinary tract

- Genitourinary system
- Normal Flora (Resident Biota)
- Barriers (Protection)
- Diseases

Genitourinary system

- Urinary system
- Reproductive system

The urinary tract includes the kidneys, ureters, bladder and the urethra.

Urinary system

- Removes substances from the blood
- Regulates body processes
- Forms urine and transports out of the body

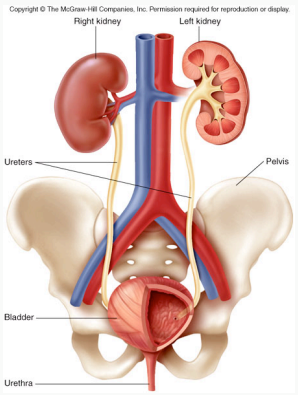

Fig. 23.1 The urinary system.

The major parts of the female reproductive system.

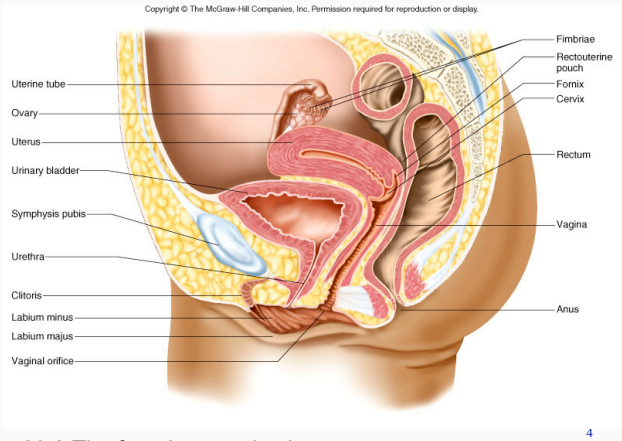

Fig. 23.3 The female reproductive system.

The major parts of the male reproductive system.

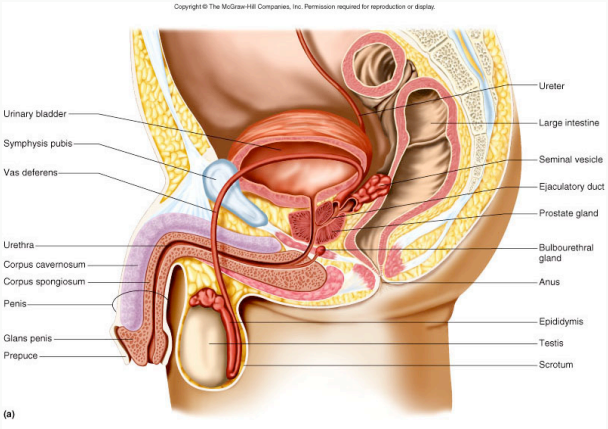

Fig. 23.2 The male reproductive system.

Normal flora

- Urinary Tract (both male and female)
  - Location: outer regions of the urethra
  - Flora: non-hemolytic streptococci, staphylococci, corynebacteria, some lactobacilli
- Reproductive system (female only)
  - Location: Vagina
  - Flora: Lactobacilli and some fungi (*Candida*)

Barriers (Protection)

- Flushing action (desquamation)
- Acidic pH (fermentation)
- In urine: Antibacterial proteins including lysozyme, lacto(trans)ferr(it)in & some IgA
- In vaginal mucous membrane: IgA

Diseases

- Urinary tract infections (UTI)
- Reproductive tract infections
- Genital ulcer
- Warts
- Group B *Streptococcus* (GBS) infections

Urinary tract infections (UTI)

- Common bacterial infections
  - Cystitis
  - Pyelonephritis
  - Urethritis
- Leptospirosis
- Urinary schistosomiasis

Bacterial infections

- General observation:
  - More common in women
  - Most common nosocomial infection
- *Escherichia coli*
  - Acquired from GI tract
- *Staphylococcus saprophyticus*
- *Proteus mirabilis*

Features of urinary tract infections.

CHECKPOINT 23.1 Urinary Tract Infections (Cystitis, Pyelonephritis)

Causative Organism(s)	*Escherichia coli*	*Staphylococcus saprophyticus*	*Proteus mirabilis*
Most Common Modes of Transmission	Endogenous transfer from GI tract (opportunism)	Opportunism	Opportunism
Virulence Factors	Adhesins, motility	–	Urease enzyme, leads to kidney stone formation
Culture/Diagnosis	Often "bacterial infection" diagnosed on basis of increased white cells in urinalysis; if culture performed, bacteria may or may not be identified to species level	Often "bacterial infection" diagnosed on basis of increased white cells in urinalysis; if culture performed, bacteria may or may not be identified to species level	Often "bacterial infection" diagnosed on basis of increased white cells in urinalysis; if culture performed, bacteria may or may not be identified to species level
Prevention	Vaccine may be available soon; hygiene practices	Hygiene practices	Hygiene practices
Treatment	Nitrofurantoin, lexofloxacin, or trimethoprim-sulfamethoxazole	Nitrofurantoin, lexofloxacin, or trimethoprim-sulfamethoxazole	Nitrofurantoin, lexofloxacin, or trimethoprim-sulfamethoxazole
Distinctive Features	–	–	Kidney stones and severe pain may ensue

Checkpoint 23.1 Urinary tract infections (cystitis, pyelonephritis)

Leptospira interrogans, is a spirochete bacterium.

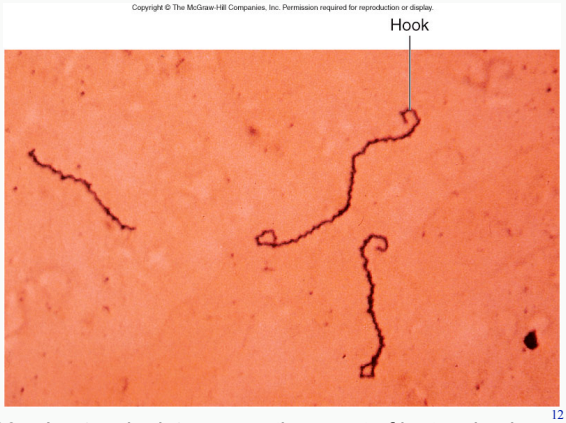

Fig. 23.4 *Leptospira interogans*, the agent of leptospirosis.

Leptospirosis

- Complex bacterial infection, because:
  - Approximately 200 different serotypes
  - Leads often to kidney infection
  - Zoonotic Disease
    - Present in animal urine (often cause of death due to kidney failure in pet dogs)

Features of leptospirosis.

CHECKPOINT 23.2	Leptospirosis
Causative Organism(s)	*Leptospira interrogans*
Most Common Modes of Transmission	Vehicle—contaminated soil or water
Virulence Factors	Adhesins? Invasion proteins?
Culture/Diagnosis	Slide agglutination test of patient's blood for antibodies
Prevention	Strain-specific vaccine available to limited populations; avoiding contaminated vehicles
Treatment	Early penicillin or tetracycline

Checkpoint 23.2 Leptospirosis

Features of helminth-caused urinary schistosomiasis.

CHECKPOINT 23.3	Urinary Schistosomiasis
Causative Organism(s)	*Schistosoma haematobium*
Most Common Modes of Transmission	Vehicle (contaminated water)
Virulence Factors	Antigenic "cloaking," induction of granulomatous response
Culture/Diagnosis	Identification of eggs in urine
Prevention	Avoiding contaminated vehicles
Treatment	Praziquantel

Checkpoint 23.3 Urinary schistomiasis.

Reproductive Tract Diseases

- Vaginitis and vaginosis
- Discharge diseases
- Genital ulcer diseases
- Warts
- Group B *Streptococcus* infections

Vaginitis and vaginosis

- Infectious vaginitis
  - Candidiasis - caused by *Candida albicans* (a yeast)
- Infectious bacterial vaginosis:
  - Vaginitis - caused by *Gardnerella* (and a mixture of bacteria)
    => "fishy" smell
- Infectious *Trichomonas vaginalis* vaginosis (STD)
  => profuse discharge with a fish-like odor
- non-inflammatory, atrophic vaginitis ("Senile Vaginitis" or "dry vagina") => scant odorless vaginal discharge

Gram stain of *Candida albicans,* the causative agent of vaginitis.

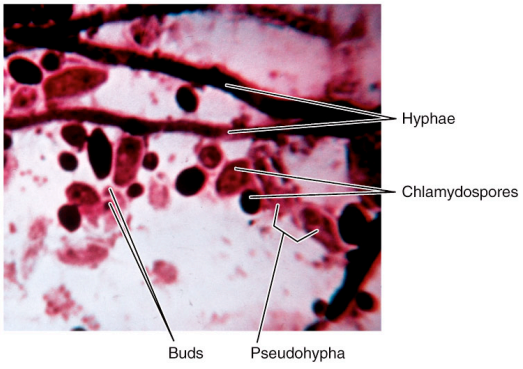

Fig. 23.5 Gram stain of *Candida albicans* in a vaginal smear.

Features of vaginitis and vaginosis.

CHECKPOINT 23.4	Vaginitis/Vaginosis		
Causative Organism(s)	*Candida albicans*	Mixed infection, usually including *Gardnerella*	*Trichomonas vaginalis*
Most Common Modes of Transmission	Opportunism	Opportunism?	Direct contact (STD)
Virulence Factors	–	–	–
Culture/Diagnosis	Wet prep or Gram stain	Visual exam of vagina, or clue cells seen in Pap smear or other smear	Protozoa seen on Pap smear or Gram stain
Prevention	–	–	Barrier use during intercourse
Treatment	Topical or oral azole drugs, some over-the-counter drugs	Metronidazole or clindamycin	Metronidazole
Distinctive Features	White curdlike discharge	Discharge may have fishy smell	Discharge may be greenish

Checkpoint 23.4 Vaginitis/vaginosis

Discharge diseases

Increase in fluid discharge in male & female:

- Gonorrhea
- Chlamydiasis

Gonorrhea

- Bacterial infection with *Neisseria gonorrhoeae*
- Strictly a human STD
- Phase variation – fimbrial proteins
- IgA protease
- Male - urethritis (infection and inflammation of the urethra)
- Female
  - Salpingitis (infection and inflammation in the fallopian tubes)
  - Pelvic inflammatory disease (PID)
- Disseminated
  - other organs (skin, eye)
  - Infants: eye infections

Neisseria gonorrhoeae, the causative agent of gonorrhea, can cause peritonitis and PID, which can result in ectopic pregnancies.

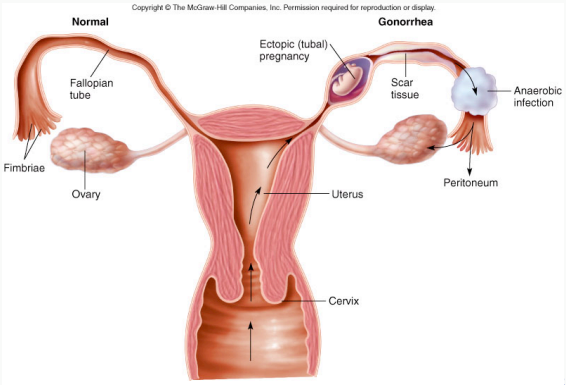

Fig. 23.8 Invasive gonorrhea in women.

N. gonorrhoeae can cause eye infections in newborns.

Fig. 23.9 Gonococcal ophthalmia neonatorum in a week-old infant.

N. gonorrhoeae, from a male patient with gonorrhea, are the diplococci inside neutrophils.

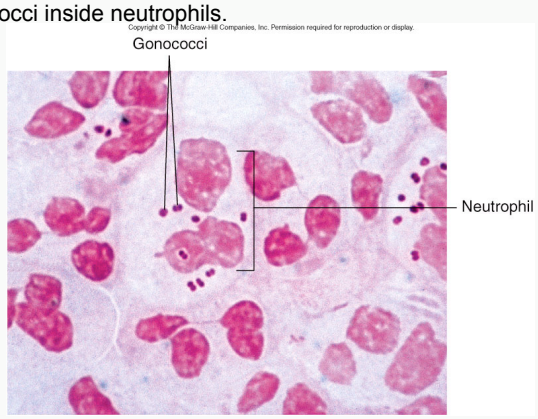

Fig. 23.10 Gram stain of urethral pus from a male patient with gonorrhea.

Incidence rates of gonorrhea and syphilis from 1964 to 2003.

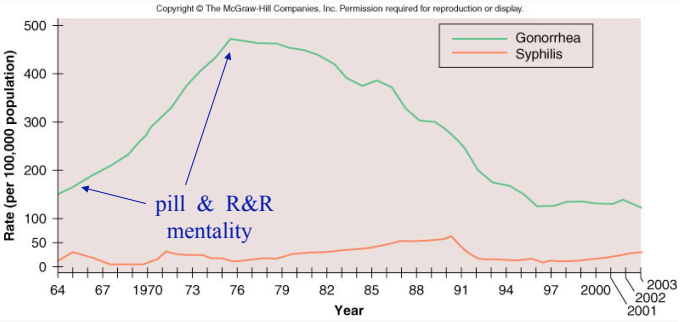

Fig. 23.11 Gonorrhea and syphilis-reported rates.

Chlamydia-infections

- Bacterial infection
  - Elementary body
  - Reticulate body
  - Intracellular
  - Asymptomatic
- Male - non-gonococcal urethritis
- Female - Pelvic inflammatory disease (PID)
- Infant conjunctivitis
- Rare - lymphogranuloma venereum

Chlamydia trachomatis, the causative agent of chlamydiasis, adheres to the mucosa of the fallopian tube.

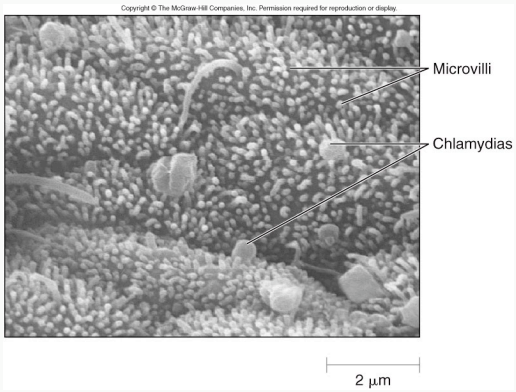

Fig. 23.12 *Chlamydia trachomatis* adhering to mucosa of the fallopian tube.

Chlamydia is an intracellular pathogen, and the life cycle involves an infectious elementary body stage and a reticular body or multiplying stage.

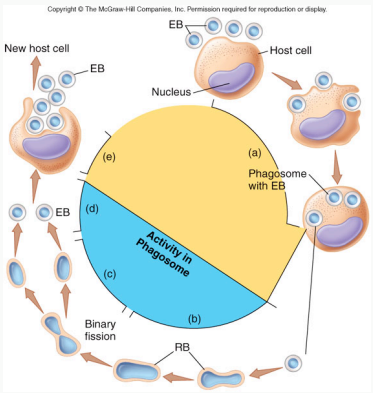

Fig. 23.13 The life cycle of Chlamydia.

Features of discharge diseases.

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CHECKPOINT 23.5 Genital "Discharge" Diseases (in Addition to Vaginitis/Vaginosis)

	Gonorrhea	Chlamydia
Causative Organism(s)	*Neisseria gonorrhoeae*	*Chlamydia trachomatis*
Most Common Modes of Transmission	Direct contact (STD), also vertical	Direct contact (STD), vertical
Virulence Factors	Fimbrial adhesions, antigenic variation, IgA protease, membrane blebs/endotoxin	Intracellular growth resulting in avoiding immune system and cytokine release, unusual cell wall preventing phago-lysosome fusion
Culture/Diagnosis	Gram stain in males, rapid tests (PCR, ELISA) for females, culture on Thayer-Martin agar	PCR or ELISA, can be followed by cell culture
Prevention	Avoid contact; condom use	Avoid contact; condom use
Treatment	Many strains resistant to various antibiotics; local and current guidelines must be consulted	Azithromycin and follow-up to check for reinfection
Distinctive Features	Rare complications include arthritis, meningitis, endocarditis	More commonly asymptomatic than gonnorhea
Effects on Fetus	Eye infections, blindness	Eye infections, pneumonia

Checkpoint 23.5 Genital "discharge" diseases

Genital ulcer diseases

- Lesions on the genitals
- Syphilis
- Chancroid
- Genital herpes

Syphilis

- Infection by *Treponema pallidum*
- Stages
  - Primary - chancre
  - Secondary
  - Tertiary
- Congenital

Treponema pallidum, the causative agent of syphilis, is a spirochete bacterium.

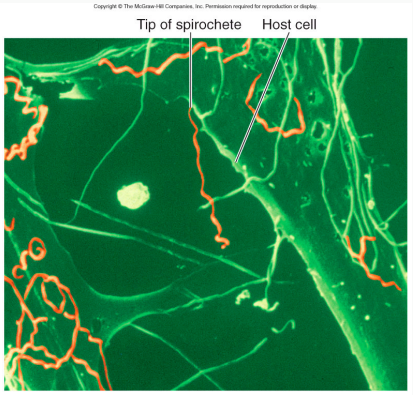


Fig. 23.17 Electron micrograph of the syphilis spirochete attached to cells.

After the chancre has healed, secondary syphilis develops, in which a skin rash forms on the trunk, arms, palms, and soles.

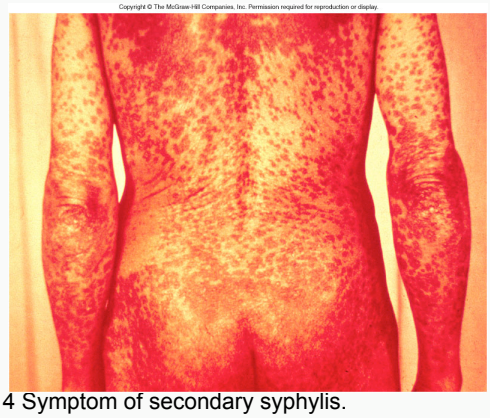


Fig. 23.14 Symptom of secondary syphylis.

After resolution of secondary syphilis, latency occurs which can last up to 20 years, and in time destruction of tissues (gummas) can result in cardiovasculer, hepatic, bone, cartilage, and nerve damage.

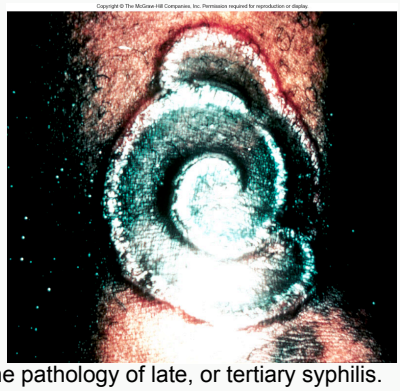


Fig. 23.15 The pathology of late, or tertiary syphilis.

Congenital syphilis begins as an early profuse nasal discharge and later develops into a condition called Hutchinson's teeth.

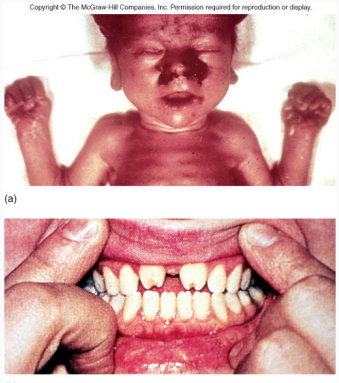


Fig. 23.16 Congenital syphilis.

Chancroid

- *Haemophilus ducreyi* infection
- Pleomorphic
- Most prevalent in tropic and subtropic environments
- STD

Genital herpes

- HSV infection
- Chronic – viral latency
- Asymptomatic
- Recurrent symptoms
- Serious in newborns

Herpes simplex virus -1 and –2 are responsible for genital herpes, and can be transmitted to the fetus, which then can infect the skin, mouth, eyes, and the CNS.

Fig. 23.19 Prenatal herpes simplex.

HSV-1 is believed to be responsible for oral herpes or cold sores.

Fig. 23.20 Oral herpes infection.

HSV-1 and –2 have an icosahedral capsid and envelope structure, as evident by the transmission electron micrograph.

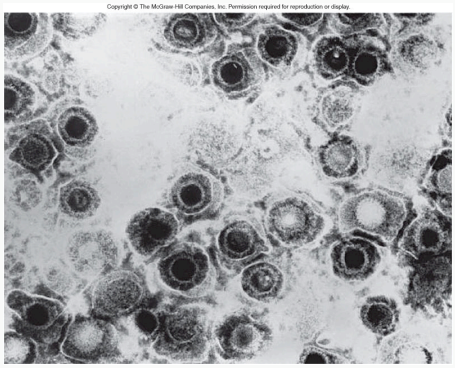


Fig. 23.21 Transmission electron micrograph of herpes simplex virus.

Reactivation of HSV-2 causes the virus to travel down the neuron to the body's surface, forming visible lesions.

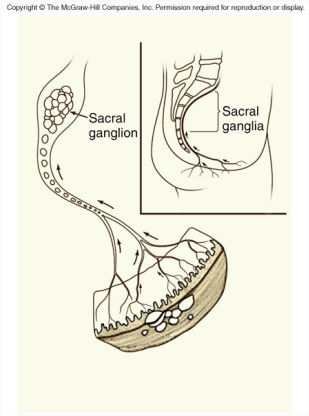


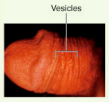
Fig. 23.22 HSV-2 latent in lumbosacral ganglion.

Because herpes can be shed without visible lesions, preventative methods include condom use by women.

Fig. 23.23 The female condom.

Features of genital ulcer diseases.

CHECKPOINT 23.6 Genital Ulcer Diseases

	Syphilis	Chancroid	Herpes
Causative Organism(s)	*Treponema pallidum*	*Haemophilus ducreyi*	Herpes simplex 1 and 2
Most Common Modes of Transmission	Direct contact and vertical	Direct contact (vertical transmission *not* documented)	Direct contact, vertical
Virulence Factors	Lipoproteins	Hemolysin (exotoxin)	Latency
Culture/Diagnosis	Direct tests (immunofluorescence, dark-field microscopy), blood tests for treponemal and nontreponemal antibodies, PCR	Culture from lesion	Clinical presentation, PCR, Ab tests, growth of virus in cell culture
Prevention	Antibiotic treatment of all possible contacts, avoiding contact	Avoiding contact	Avoiding contact, antivirals can reduce recurrences
Treatment	Penicillin G	Azithromycin, ceftriaxone	Acyclovir and derivatives
Distinctive Features	Three stages of disease plus latent period, possibly fatal	No systemic effects	Ranges from asymptomatic to frequent recurrences
Effects on Fetus	Congenital syphilis	None	Blindness, disseminated herpes infection
Appearance of Lesions			

Checkpoint 23.6 Genital ulcer diseases

Warts

- Human papillomavirus (HPV)
  - Mild
  - Serious (cervical cancer- oncogenes)
- Molluscum contagiosum
  - Virus infection
  - Less severe than HPV

Features of wart diseases.

CHECKPOINT 23.7 Wart Diseases

	HPV	Molluscum Contagiosum
Causative Organism(s)	Human papillomaviruses	Poxvirus, sometimes called the molluscum contagiosum virus (MCV)
Most Common Modes of Transmission	Direct contact (STD)—also autoinoculation, indirect contact	Direct contact (STD), also indirect and autoinoculation
Virulence Factors	Oncogenes (in the case of malignant types of HPV)	–
Culture/Diagnosis	PCR tests for certain HPV types, clinical diagnosis	Clinical diagnosis, also histology, PCR
Prevention	Vaccine available soon? avoid direct contact; prevent cancer by screening cervix	Avoid direct contact
Treatment	Warts or precancerous tissue can be removed; virus not treatable	Warts can be removed; virus not treatable
Distinguishing Features	Infection may or may not result in warts; infection may result in malignancy	Wartlike growths are only known consequence of infection
Effects on Fetus	May cause laryngeal warts	–
Appearance of Growths		

Checkpoint 23.7 Wart diseases

Group B *Streptococcus*

- Bacterial infection
- Infants contract it from the mother during birth
- Pregnant women are routinely screened

Features of Group B *Streptococcus* colonization.

CHECKPOINT 23.8 Group B Streptococcus Colonization

Causative Organism(s)	Group B *Streptococcus*
Most Common Modes of Transmission	Vertical
Virulence Factors	–
Culture/Diagnosis	Culture of mother's genital tract
Prevention/Treatment	Treat mother with penicillin/ampicillin

Checkpoint 23.8 Group B *Streptococcus* colonization

Summary of diseases in the genitourinary tract.

Taxonomic Organization of Microorganisms Causing Disease in the Genitourinary Tract

Microorganism	Disease	Chapter Location
Gram-Positive Bacteria		
Staphylococcus saprophyticus	Urinary tract infection	UTI, p. 739
Gardnerella (note: stains gram negative)	Vaginosis	Vaginitis or vaginosis, p. 743
Group B *Streptococcus*	Neonatal disease	Group B strep neonatal disease, p. 761
Gram-Negative Bacteria		
Escherichia coli	Urinary tract infection	UTI, p. 739
Leptospira interrogans (spirochete)	Leptospirosis	Leptospirosis, p. 740
Proteus mirabilis	Urinary tract infection plus kidney stones	UTI, p. 739
Neisseria gonorrhoeae	Gonorrhea	Discharge diseases, p. 746
Chlamydia trachomatis	"Chlamydia"	Discharge diseases, p. 748
Treponema pallidum (spirochete)	Syphilis	Genital ulcer diseases, p. 750
Haemophilus ducreyi	Chancroid	Genital ulcer diseases, p. 754
DNA Viruses		
Herpes simplex viruses 1 and 2	Genital herpes	Genital ulcer diseases, p. 755
Human papillomaviruses	Genital warts, cervical carcinoma	Wart diseases, p. 758
Poxviruses	Molluscum contagiosum	Wart diseases, p. 760
Fungi		
Candida albicans	Vaginitis	Vaginitis or vaginosis, p. 742
Protozoa		
Trichomonas vaginalis	Trichomoniasis (vaginitis)	Vaginitis or vaginosis, p. 744
Helminth—Trematode		
Schistosoma haematobium	Urinary schistosomiasis	Urinary schistosomiasis, p. 741

Microorganisms that cause disease in the genitourinary tract.