Urinary System

A. Functions

 1. Maintain

 2. Elimination of

B. Structures

 1. Kidneys

 A) reddish-brown in color & bean-shaped

 B) Lie in superior lumbar region of the posterior abdominal wall (T12 to L3)

 C) External Anatomy

 1) Renal – indentation located on the medial aspect of the

 kidney

 2) Renal – connective tissue covering surrounding each kidney;

 several layers thick

 D) Internal Anatomy

 1) Renal – outer region of the internal kidney; lies beneath the capsule

 2) Renal – inner region of the internal kidney; lies deep to the

 cortex

 a) Renal – cone-shaped masses in the medulla; contain bundles

 of the urine-collecting tubules resulting in a striated appearance; base of each

 pyramid faces the cortex; 5-11 per kidney

 i) of the pyramid – the “point” of each pyramid

 b) Renal – inward extensions of the renal cortex that separate

 the pyramids

 3) (calyx) – cup-shaped tubes that enclose the papilla of

 each pyramid and collect urine from the tubules; 5-11 per kidney

 4) (calyx) – branching extensions of the renal pelvis; minor

 calyces pass urine into them; 2-3 per kidney

 5) Renal – flat, funnel-shaped tube on superior aspect of ureter; major

 calyces pass urine into pelvis; 1 per kidney

 E) Microscopic Anatomy

 1) – functional unit of the kidney; over 1 million/kidney;

 produces urine through the processes of filtration, reabsorption, & secretion

 a) – web of capillaries where filtration occurs; filtrate is

 the result

 i) arteriole – takes blood to the glomerulus

 ii) arteriole – takes blood from the glomerulus

 b) Peritubular capillaries – surround the tubular portion of the nephron

 c) – cup-shaped, hollow covering that surrounds

 glomerulus; collects filtrate from the glomerulus

 i) – cells in the Bowman’s capsule that wrap around the

 glomerulus.

 d) (PCT) – tubular structure leading

 from the Bowman’s capsule; site of most reabsorption

 e) – narrow hairpin loop that connects the

 PCT & DCT

 i) Has 2 portions

 (a) portion – continuous with PCT

 (b) portion – continuous with DCT

 f) (DCT) – tubular structure that empties

 into collecting duct

 g) (tubules) – receive urine from the DCT

 i) Receives input from many nephrons (DCTs)

 ii) Extends deep into the renal medulla (pyramids)

 h) – created by the junction of adjacent collecting

 ducts (tubules)

 i) Empty into minor calyces

 i) Juxtaglomerular apparatus (JGA)

 i)

 (a) Monitor BP in the afferent arteriole

 (b) Secrete

 ii)

 (a) Monitor the Na+ content of the filtrate in the DCT

 2) Related terms

 a) Vascular nephron – refers collectively to the afferent arteriole, glomerulus,

 efferent arteriole, and peritubular capillaries

 b) Tubular nephron – refers collectively to the Bowman’s capsule, PCT, loop of

 Henle, DCT, and collecting ducts

 c) Renal – refers collectively to the glomerulus &

 Bowman’s capsule

 2.

 A) Slender tubes that transport urine from the kidneys (renal pelvis) to the urinary

 bladder

 B) Transport urine via

 3.

 A) Collapsible, muscular sac that stores and expels urine; lined with

 1) In males – it lies superior to the prostate gland

 2) In females – it lies inferior and slightly anterior to the uterus

 B) muscle – smooth muscle surrounding the bladder squeezes urine

 from the bladder

 C) holds max of

 D) – smooth, triangular portion outlined by the openings of the

 ureters & urethra

 1) Common site of infections

 4.

 A) Thin-walled tube that carries urine from the bladder to the outside of the body

 1) Internal urethral sphincter

 a)

 b) Located at the junction of the bladder and the urethra

 2) External urethral sphincter

 a)

 b) Surrounds the urethra at the urogenital diaphragm

 B) Females

 1) External urethral orifice – opening of the urethra; located between the vagina

 and the clitoris

 C) Males – multiple segments

 1) urethra – portion running within the prostate gland

 2) urethra – portion running through the urogenital

 diaphragm

 3) urethra – portion running through the penis (corpus spongiosum)

 4) External urethral orifice – opening of the urethra at the end of the penis

 5) The male urethra is also the passageway for reproductive secretions

C. Filtering of Blood

 1. Blood Pathway

 A) Renal artery 🡪 segmental artery 🡪 lobar artery 🡪 interlobar artery 🡪 arcuate

 artery 🡪 cortical radiate artery 🡪 afferent arteriole 🡪 glomerulus 🡪 efferent

 arteriole 🡪 peritubular capillaries 🡪 cortical radiate vein 🡪 arcuate vein🡪

 interlobar vein 🡪 lobar vein 🡪 renal vein

 2. Filtration – movement of fluid/substances from the into the

 A) Glomerulus

 1)

 2) Composed of

 3) NFP = GBHP - (CHP+GBOP)

 B) Bowman’s capsule

 1) – gaps between the podocytes that allow fluid to pass

 through

 2) Fluid is referred to as (glomerular) filtrate

 3) Glomerular filtration rate (GFR) = volume/time (~180L/day or ~48 gal/day)

 3. Reabsorption – movement of fluid/substances from the kidney tubules into the

 peritubular capillaries

 A) Proximal convoluted tubule – site of the greatest amount of reabsorption

 1) – occurs via both primary active transport & facilitated diffusion

 a) The active transport of Na+ sets up the conditions that allow almost all

 other types of reabsorption in the PCT

 2) – secondary active transport

 (cotransport) with Na+

 3) (Ca++, K+, Mg++) via paracellular movement

 4) (Cl-, HCO3-) – Cl- via paracellular transport and HCO3- via

 cotransport with Na+

 5) via osmosis

 6) & lipid-soluble substances via simple diffusion

 B) Loop of Henle

 1) Descending portion

 a) Water via

 2) Ascending portion

 a) Na+, K+ & Cl-  via

 b) Ca++ and Mg++ via

 c)

 C) Distal convoluted tubule

 1) Na+ via primary active transport in the presence of

 2) Ca++ via primary active transport in the presence of

 3) Cl- via simple diffusion & secondary active transport (cotransport w/ Na+)

 4) Water via osmosis in the presence of

 D) Collecting ducts

 1) Na+ via primary active transport in the presence of

 2) H+, K+, HCO3-, & Cl- via passive processes dependent on the movement

 of

 3) Water via osmosis in the presence of antidiuretic hormone (ADH)

 4. Secretion – movement of fluid/substances from the peritubular capillaries into the

 kidney tubules

 A) Occurs in all portions of tubule system

 B) Important for:

 1) Eliminating substances that weren’t filtered

 2) Eliminating undesirable substances that were passively reabsorbed

 3) Eliminating excess

 4) Maintaining

 5. Urine

 A) Urine Composition

 1)

 2) Nitrogenous wastes

 3)

 4) Toxins

 5) Pigments (from the breakdown of hemoglobin and bile pigments)

 6)

 7) If blood, protein, or glucose are detected this is usually an indication of kidney

 troubles

 8) Pus, mucus, or cloudiness can indicate an infection somewhere in the urinary

 tract

 B) Urine characteristics

 1) Color – in color

 2) Odor – slightly aromatic when fresh but tends to develop an odor due

 to bacterial metabolism

 3) pH – urine is (about pH 6)

 4) Specific gravity –

 5) Volume –

 6. Pathway of Urine from Bowman’s capsule

 A) Bowman’s capsule 🡪 proximal convoluted tubule 🡪 descending loop of Henle 🡪

 ascending loop of Henle 🡪 distal convoluted tubule 🡪 collecting ducts 🡪 papillary

 ducts 🡪 minor calyces 🡪 major calyces 🡪renal pelvis 🡪 ureters 🡪 urinary bladder

 🡪 urethra 🡪 outside the body

 7. Urination (Micturition)

 A) Visceral reflex

 1) When bladder fills to stretch receptors in wall fire

 2) Impulses travel to center in sacral region of spinal cord

 3) Impulses travel back to detrusor muscle and internal urethral sphincter, as well

 as to the cerebral cortex

 a) The detrusor & the internal urethral sphincter

 allowing urine to travel down the urethra until it reaches the external urethral

 sphincter

 b) The gives us a conscious awareness of the need to urinate

 i) Initially we can choose to ignore this and the urge will subside temporarily

 4) Under conscious control cerebral cortex fires causing external urethral sphincter

 to relax

 a) Pressure created by the detrusor muscle and other muscles in the urogenital

 region force urine from the body

 8. Glomerular Filtration Rate (GFR)

 A) Total glomerular filtrate of both kidneys/time

 B) Directly proportional to

 C) Directly proportional to the

 D) Regulation of GFR

 1) Autoregulation

 a) mechanism

 i) Triggered by smooth muscle in afferent arteriole

 (a) In response to systemic BP (stretch)

 (i) Causes vasoconstriction of the afferent arteriole to reduce pressure

 and protect the glomerulus

 (b) In response to systemic BP (stretch)

 (i) Causes vasodilation of the afferent arteriole to increase pressure

 and maintain a minimal GFR

 b) feedback mechanism

 i) Triggered by the macula densa cells

 (a) In response to flow rate and/or osmolarity of the filtrate

 (i) Causes vasoconstriction of afferent arteriole to decrease pressure

 and protect the glomerulus

 (b) In response to flow rate and/or osmolarity of the filtrate

 (i) Causes vasodilation of afferent arteriole to increase pressure and

 maintain a minimal GFR

 2) Hormonal Regulation

 a) Renin-angiotensin mechanism

 i) JG cells are stimulated to release renin in response to:

 (a)

 (b) Input from

 (c)

 ii) Renin converts angiotensinogen to angiotensin I

 iii) Angiotensin I is converted to angiotensin II by ACE

 iv) Angiotensin II causes:

 (a) Vasoconstriction of

 (b) Stimulation of

 (c) The release of

 (i) ADH promotes the reabsorption of water in the DCT & CD

 (ii) Aldosterone promotes the reabsorption of Na+ in the DCT & CD

 b) Atrial natriuretic peptide (ANP)

 i) Released from cells in the ventricles

 ii) Inhibits release of renin, aldosterone, and ADH

 iii) Promotes excretion of Na+ & water from the DCT & CD

 3) Neural Regulation (ANS)

 a) Sympathetic nervous system

 i) No input

 ii) Moderate input

 iii) Large input – “fight-or-flight”

D. Disorders

 1. Pyelitis – infection of the renal pelvis and calyces

 2. Pyelonephritis – infection or inflammation of the entire kidney

 3. Glomerulonephritis – infection or inflammation of the glomerulus

 4. Anuria – low urinary output as a result of injury, transfusion reactions, low blood

 pressure, etc

 5. Renal calculi – kidney stones

 6. Urethritis – inflammation of the urethra

 7. Cystitis – inflammation of the bladder

 A) Urinary Tract Infection (UTI) – generic term used to refer to urethritis, cystitis, or

 both

 8. Incontinence – inability to control micturition

 9. Vesicoureteral reflux (Kidney reflux) – urine moves backwards up the ureter and into

 the kidney; sometimes seen with severe UTI’s

 10. Renal Failure – can be caused by:

 A) Repeated disorders/infections

 B) Physical trauma

 C) Chemical poisoning

 D) Atherosclerosis