Biology 112
Study Notes Exam 6

Chapter 17: Urinary System

Introduction: the **urinary system** consists of a pair of **kidneys**, which remove excess salts and nitrogenous wastes from blood, form urine and help regulate metabolism; a pair of **ureters**, which transport urine from the kidneys to the bladder; the **urinary bladder**, which stores urine; and a **urethra**, which conveys urine to the outside.

Kidneys: reddish-brown bean-shaped organs located on either side of the abdominal cavity from the level of the 12th thoracic to 3rd lumbar vertebrae
- kidneys are ***retroperitoneal***; they lie behind the peritoneum
- renal ***capsule***: tough fibrous CT and adipose tissue surrounding kidney

Kidney Structure:
- ***renal sinus***: hollow chamber at medial depression; *hilum* is entrance to sinus through which blood vessels, lymphatics, nerves & ureter pass
- **renal pelvis**: funnel-shaped sac inside sinus just lateral to ureter
- *minor calyces* & *major calyces* route urine to pelvis & then ureter
- **renal medulla**: inner region of kidney composed or renal pyramids that collect urine
- ***renal papillae***: small elevations at end of pyramids that lead into minor calyces
- **renal cortex**: outer region of kidney which houses nephrons, the functional units of kidney; renal columns are projections of cortex into medulla between pyramids

Kidney Functions:
- maintain *homeostasis* by removing metabolic wastes from blood & excreting them
- produce the hormone ***erythropoietin***, which regulates red blood cell production
- regulate blood volume & blood pressure (renin-angiotensin mechanism)
- regulate volume, composition & pH of body fluids
- **pathway of blood through kidney**: aorta→renal artery→segmental artery→interlobar artery→arcuate artery→interlobular artery→afferent arteriole→glomerular capillaries→efferent arteriole→peritubular capillaries→interlobular vein→arcuate vein→interlobar vein→renal vein→inferior vena cava
- **nephron**: functional unit of kidney consisting of a renal corpuscle & renal tubule
  - **renal corpuscle:** glomerulus (capillaries) & glomerular capsule
  - **renal tubule**: proximal convoluted tubule, nephron loop (ascending & descending limbs), distal convoluted tubule
- ***collecting ducts***: collect urine from nephrons; in renal pyramids
- collecting ducts empty into minor calyces
- glomerular capillaries receive blood from ***afferent arterioles*** & pass remaining blood to efferent arterioles
- ***efferent arterioles*** give rise to ***peritubular capillaries***, which surround renal tubules
- ***juxtaglomerular apparatus:*** at junction of distal convoluted tubule with afferent & efferent arterioles; consists of ***macula densa & juxtaglomerular cells***

Urine Formation: ***nephrons*** remove wastes from blood and regulate water & electrolyte concentrations; **urine** is end product

- **glomerular filtration**: water & dissolved materials filter (diffuse) out of glomerular capillaries
  - glomerular capillaries are much more permeable than typical tissue capillaries
  - composition of ***filtrate*** is similar to that of tissue fluid
- **filtration pressure**: net force moving material out of glomerulus & into glomerular capsule
  - filtration is mainly due to ***hydrostatic pressure*** inside glomerular capillaries
  - ***osmotic pressure*** of *plasma & hydrostatic pressure in capsule* also contribute
- **filtration rate**: varies with filtration pressure
  - filtration pressure changes with diameters of afferent & efferent arterioles
  - filtration rate decreases with increasing ***colloid osmotic pressure*** (pressure due to large proteins in plasma)
  - filtration rate decreases with increasing ***capsule hydrostatic pressure***
  - kidneys normally produce ~ 125 ml of filtrate per minute; most is *reabsorbed*
- **regulation of filtration rate**:
  - increased *sympathetic nerve* activity can decrease glomerular filtration rate
  - ***macula densa***: senses decreased amounts *of chloride, potassium & sodium ions* in distal tubule & causes juxtaglomerular cells to release ***renin***
  - **renin** triggers a series of changes leading to ***vasoconstriction*** of afferent & efferent arterioles (which may affect filtration rate) and ***aldosterone*** secretion, which stimulates tubular sodium reabsorption
- **tubular reabsorption**: returns some substances in filtrate to blood (peritubular capillaries)
  - permeability of peritubular capillaries adapted for reabsorption
  - most reabsorption occurs at ***proximal tubule***; epithelial cells have microvilli
  - different modes of transport reabsorb different substances in particular segments of renal tubule
    - active transport reabsorbs glucose, amino acids & some sodium
    - osmosis reabsorbs water
  - active transport mechanisms have limited capacities
- **sodium & water retention**:
  - substances that remain in filtrate are concentrated as water is reabsorbed
  - active transport reabsorbs **sodium** ions
  - as positive sodium ions move out of tubules, negative ions & water follow
  - **water** is passively reabsorbed by ***osmosis***
- **tubular secretion**: transports substances from plasma to tubular filtrate
  - various organic compounds (creatinine, histamine, penicillin) are actively secreted
  - ***potassium & hydrogen ions*** are secreted both actively & passively
- **regulation of urine concentration & volume**:
  - most sodium is actively reabsorbed before urine is excreted
  - **antidiuretic hormone (ADH)** increases permeability of distal tubule & collecting duct, promoting water reabsorption
- **urea & uric acid excretion**:
  - diffusion passively reabsorbs urea; ~ 50% of urea excreted in urine

    - active transport reabsorbs uric acid; some uric acid is secreted
- **urine composition**: urine is ~ 95% water, & usually contains urea & uric acid
    - urine volume normally between 0.6 & 2.5 liters per day
    - urine contains varying amounts of electrolytes & may contain traces of amino acids
    - urine volume varies with fluid intake & certain environmental factors (temperature, humidity, emotion, respiratory rate, body temperature)

Urine Elimination
- **ureters**: extend from kidneys to urinary bladder
    - peristaltic waves in ureter force urine into urinary bladder
- **urinary bladder**: stores urine & forces it through ***urethra*** during ***micturition***
    - **trigone:** triagonal region formed by openings of ureters into bladder superiorly & opening into urethra inferiorly
    - **internal urethral sphincter:** smooth muscle formed by portion of ***detrusor muscle;*** involuntary
    - **external urethral sphincter:** skeletal muscle; voluntary control of urination
- **micturition**: expels urine
    - contraction of detrusor muscle & relaxation of external urethral sphincter
    - ***micturition reflex***: distension stimulates stretch receptors in bladder wall; ***parasympathetic*** motor impulses sent to detrusor muscle by micturition reflex center in spinal cord
        - as bladder fills, internal pressure increases, forcing internal urethral sphincter open
        - second reflex relaxes external urethral sphincter unless voluntarily controlled
        - nerve centers in cerebral cortex & brainstem aid control of urination
- **urethra**: conveys urine from urinary bladder to outside

Chapter 18: Water, Electrolyte & Acid-Base Balance

Introduction: maintenance of water & electrolyte balance requires that equal quantities of each enter & leave the body; altering water balance affects electrolyte balance

Distribution of Body Fluids

- **fluid compartments**: intracellular & extracellular fluid
  - **intracellular fluid:** fluids & electrolytes enclosed by cell membrane (inside cell)
  - **extracellular** fluid: all fluids & electrolytes outside cell membrane; fluid in spaces in between tissue cells (*interstitial fluid*), in blood vessels (*plasma*), in lymphatic vessels (*lymph*), ***transcellular fluid*** (cerebrospinal fluid, synovial fluid, serous fluid, aqueous & vitreous humors of eyes)
- **body fluid composition**:
  - ***extracellular fluid***: high concentrations of ***sodium, chloride & bicarbonate ions***
    - ***plasma*** contains more ***protein*** than interstitial fluid or lymph
  - ***intracellular fluid***: high concentrations of ***potassium, magnesium & phosphate ions***
  - *sulfate ions* are slightly more concentrated in intracellular fluid; *calcium ions* are slightly more concentrated in extracellular fluid
- **movement of fluid between compartments**:
  - *hydrostatic pressure & osmotic pressure* regulate fluid movements
    - ***hydrostatic pressure*** forces fluid out of plasma; ***colloid osmotic pressure*** returns fluid to plasma
    - ***hydrostatic pressure*** moves fluid into lymphatic vessels
    - ***osmotic pressure*** regulates fluid movement into & out of cells
  - ***sodium ion concentrations assist fluid movement***
    - if sodium ion concentration in interstitial fluid decreases, water moves into cells by osmosis (cells swell); if sodium ion concentration in interstitial fluid increases, water moves out of cells by osmosis (cells shrink)

Water Balance

- **water intake**: most water comes from consuming liquids or foods
  - *oxidative metabolism* produces some water
- **regulation of water intake**: ***thirst*** is primary regulator of water intake
  - drinking & stomach distention by fluid inhibit thirst
  - increase in osmotic pressure in extracellular fluids activates *osmoreceptors* in the ***thirst center*** in the *hypothalamus* of the brain
- water output: water is lost in urine, feces, sweat & evaporation from skin & lungs
- **regulation of water output**: *distal convoluted tubules & collecting ducts* of nephrons regulate water output in urine through effects of ***ADH***
  - if ADH is present, more water is reabsorbed & less urine is produced

Electrolyte Balance

- **electrolyte intake**: most important ions from electrolytes are sodium, potassium, calcium, magnesium, chloride, sulfate, phosphate, bicarbonate & hydrogen ions; these are obtained in foods and beverages or as by-products of metabolism

- **regulation of electrolyte intake**: food & drink usually provide adequate electrolytes
  - severe electrolyte deficit may produce salt craving
- **electrolyte output:** electrolytes lost in perspiration, feces & urine
- **regulation of electrolyte output**: concentrations of sodium, potassium & calcium ions need to be carefully regulated
  - ***aldosterone*** from adrenal cortex regulates sodium & potassium ions
  - ***parathyroid hormone & calcitonin*** regulate calcium ions
  - negative ions are secondarily regulated by positive ion movement

Acid-Base Balance
- body fluid pH must be maintained within a certain range
- ***acids*** are electrolytes that release hydrogen ions; ***bases*** combine with hydrogen ions
- sources of hydrogen ions:
  - ***aerobic respiration of glucose*** produces *carbonic acid* (carbon dioxide combined with water)
  - ***anaerobic respiration of glucose*** produces *lactic acid*
  - ***oxidation of sulfur-containing amino acids*** produces *sulfuric acid*
  - ***incomplete oxidation of fatty acids*** produces *acidic ketone bodies*
  - ***hydrolysis of phosphoproteins & nucleic acids*** produces *phosphoric acid*
- **strengths of acids & bases**: acids & bases vary in ionization extent (strength)
  - strong acids (hydrochloric acid) ionize more completely
  - weak acids (carbonic acid) ionize less completely
- **regulation of hydrogen ion concentration**:
  - **acid-base buffer systems**: buffer systems convert strong acids into weaker acids or strong bases into weaker bases
    - **bicarbonate buffer system**: uses bicarbonate ions (HCO_3^-) as weak base & carbonic acid (H_2CO_3) as weak acid
      - reactions: $CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow H^+ + HCO_3^-$
    - ***phosphate buffer system***: mixture of dihydrogen phosphate (weak acid) & monohydrogen phosphate (weak base); helps regulate hydrogen ions
    - ***protein buffer system***: proteins in plasma & within cells can act as weak acids or weak bases
  - ***respiratory center of brain*** controls rate & depth of breathing to regulate pH
  - kidney nephrons secrete hydrogen ions to regulate pH
  - acid-base buffers act more rapidly; physiological buffers (respiratory center, kidneys) act more slowly

Acid-Base imbalances
- **acidosis**: blood pH < 7.35
  - ***respiratory acidosis*** results from increases in concentrations of carbon dioxide & carbonic acid
  - ***metabolic acidosis*** results from accumulation of other acids or loss of bases
- **alkalosis**: blood pH > 7.45
  - ***respiratory alkalosis*** results from loss of concentrations of carbon dioxide & carbonic acid
  - ***metabolic acidosis*** results from loss of hydrogen ions or gain of bases

Chapter 19: Reproductive Systems

Introduction: reproductive organs produce sex cells (***sperm*** in males & ***oocytes*** in females) & sex hormones, sustain sex cells or transport them to sites of fertilization

Organs of the Male Reproductive System

- **testes**: primary male sex organs that produce sperm cells & male sex hormones
  - testes are composed of *lobules* separated by connective tissue & filled with ***seminiferous tubules***
  - **sperm cells** are produced by ***spermatocytes*** in epithelium lining seminiferous tubules
    - *supporting cells* (*Sertoli cells*) nourish & support spermatogenic cells
  - **interstitial cells** produce ***testosterone*** (male sex hormone)
  - **spermatogenesis:** process of sperm cell formation in seminiferous tubules
    - ***spermatogonia*** give rise to *primary spermatocytes* by mitosis
    - **meiosis: spermatocytes to spermatids**
      - **meiosis I** separates *homologous pairs* of chromosomes; cells begin ***diploid*** (46 chromosomes) & end up ***haploid*** (23 chromosomes)
      - **meiosis II** separates *chromatids* (duplicated chromosomes attached at centromere; like mitosis)
      - meiosis I: primary spermatocyte forms 2 *secondary spermatocytes*
      - meiosis II: each secondary spermatocyte forms 2 *spermatids*
    - **spermiogenesis: spermatids to sperm**
      - each spermatid undergoes changes to form sperm cell
      - at one end of nucleus, head region forms, including a tightly enclosed nucleus with an ***acrosome*** (contains hydrolytic enzymes for penetration of egg cell) at top
      - at other end, tail region forms, with a ***flagellum*** forming from *centrioles* & attached to the head region by a midpiece containing many mitochondria (supplying energy for moving flagellum)
- **male internal accessory organs**
  - **epididymis**: tightly coiled tube that leads into vas deferens
    - stores & nourishes immature sperm cells & promotes their maturation
  - **vas deferens** (ductus deferens): propels live sperm from epididymis to urethra
    - runs from epididymis upward anterior to pubic bone into pelvic cavity, loops over ureter & descends posteriorly along bladder, where it joins with seminal vesicle to form ***ejaculatory duct***
  - **seminal vesicles**: attached to vas deferens on posterior wall of bladder
    - secrete seminal fluid: a viscous alkaline fluid containing ***fructose*** (sugar), a coagulating enzyme & ***prostaglandins*** (stimulate muscular contractions of female reproductive organs to propel sperm to egg cell)
  - **prostate gland:** encircles urethra just inferior to bladder
    - secretes a milky, slightly alkaline fluid containing enzymes & prostate-specific antigen (PSA) that enters prostatic urethra during ejaculation
    - prostate gland hypertrophy affects nearly every elderly male
  - **bulbourethral glands** (Cowper's glands): small glands inferior to prostate gland

        - produce mucus prior to ejaculation that neutralizes acidic urine in urethra
    - **semen**: consists of sperm cells & secretions of seminal vesicles, prostate gland & bulbourethral glands
        - slightly alkaline & includes nutrients & prostaglandins
- **male external reproductive organs**:
    - **scrotum**: sac of skin & fascia that houses testes in left & right compartments
        - temperature of scrotum must be ~ 3°C lower than core body temperature for production of viable sperm
        - temperature maintained by contraction & relaxation of *dartos & cremaster muscles*… contraction pulls scrotum closer to body, increasing temperature, while relaxation allows scrotum to lower, decreasing temperature
    - **penis**: copulatory organ; releases sperm produced by testes
        - penis made up of attached root & free body or shaft ending in enlarged tip called *glans penis*
        - *prepuce* (foreskin): cuff of skin over penis; may be removed (circumcision)
        - ***erectile tissue*** *(corpus spongiosum & corpora cavernosum):* network of connective tissue & smooth muscle with vascular spaces that become filled with blood during sexual excitement

Hormonal Regulation of Male Reproductive Function
- *Gonadotropin-releasing hormone* ***(GnRH)*** release from hypothalamus controls release of *follicle-stimulating hormone (**FSH**)* & *luteinizing hormone (**LH**)* from anterior pituitary
- **FSH** stimulates sustentacular cells to release androgen-binding protein (ABP), which causes spermatogenic cells to bind ***testosterone*** & begin spermatogenesis
- **LH** binds to interstitial cells & stimulates them to secrete testosterone
- **testosterone** stimulates development of male reproductive organs and develops & maintains male secondary sex characteristics
- *testosterone* feeds back (negative feedback) to hypothalamus & anterior pituitary, inhibiting release of GnRH & tropic hormones

Organs of the Female Reproductive System
- **ovaries**: primary female sex organs that produce oocytes & female sex hormones
    - outer ***cortex*** houses follicles; inner ***medulla*** contains blood vessels & nerves
    - **primordial follicles**: contain ***primary oocyte*** encased by a layer of *follicular cells*
        - millions formed in cortex during prenatal development
        - begin meiosis during development, but stop midway through meiosis I & don't continue until puberty
        - number of primary oocytes steadily declines throughout female's life
    - **oogenesis:** ***ovum*** formation by *meiosis* in follicles of ovaries
        - starting at puberty, one follicle is chosen each month to complete *meiosis I*, resulting in a large *secondary oocyte* & a small ***polar body***
        - the *secondary oocyte* begins meiosis II, but <u>arrests</u> in metaphase II (awaiting fertilization in oviduct to complete meiosis II); the *polar body* may divide to form 2 smaller polar bodies

        - the secondary oocyte is ***ovulated*** & is picked up by uterine tube; if fertilization occurs, meiosis II is completed, forming the ***ovum*** and another *polar body*
        - *the end result of complete oogenesis is 3 small polar bodies & one very large ovum* (only the ovum is a functional female gamete); the ovum contains most of the cytosol, with ample nutrients for the 7 day journey to the uterus
    - **ovulation**: ejection of oocyte from follicle & ovary
        - ***corpus luteum***: structure formed from follicle cells following ovulation; eventually degenerates
- **female internal accessory organs**
    - **uterine tubes (*fallopian tubes or oviducts*)**: receive ovulated oocyte from ovary & provide site for fertilization
        - ovulated oocyte is cast into peritoneal cavity; *cilia* of fimbriae sweep oocyte into uterine tube
        - ciliated cells lining tube & peristaltic contractions of smooth muscle in wall of the tube help transport secondary oocyte down uterine tube
    - **uterus**: hollow, thick-walled organ in pelvis that receives, retains & nourishes a fertilized ovum
        - consists of fundus, body & cervix from superior to inferior; *cervix* (neck) projects into vagina
        - uterine wall composed of *perimetrium* (serous membrane), *myometrium* (smooth muscle) & *endometrium* (epithelial tissue) from outside to inside
        - contraction of muscles in myometrium expels baby during childbirth
        - inner lining of endometrium provides site for implantation of embryo; in absence of pregnancy it is shed during uterine cycle
    - **vagina**: thin-walled tube extending from cervix to body exterior
        - provides passageway for delivery of baby, for menstrual flow & for delivery of semen (& sperm) to uterine tube
        - ***urethra*** is embedded in anterior wall
        - wall consists of outer fibroelastic adventitia, smooth muscle muscularis & mucosa of stratified squamous epithelium with ridges (rugae)
- **female external reproductive organs**
    - ***labia majora***: elongated skin folds running posteriorly from mons pubis & enclosing labia minora
    - ***labia minora*** enclose recess called ***vestibule***, which contains the external opening of urethra (anteriorly) & vagina (posteriorly)
    - ***clitoris***: small protruding erectile tissue (corpora cavernosa) hooded by prepuce formed by junction of labia minora folds

Hormonal Regulation of Ovarian Cycle

- **GnRH** released from hypothalamus stimulates FSH & LH release from anterior pituitary
- **FSH & LH** stimulate follicle growth & **estrogen** secretion
- ***estrogen*** levels rise & feed back to anterior pituitary, *inhibiting* release (while stimulating production) of FSH & LH; in ovary, estrogen secretion is enhanced by maturation of follicles under the influence of FSH

- as estrogen levels peak (about midcycle), a burstlike release of accumulated LH (& FSH) from anterior pituitary stimulates secondary oocyte formation & ***ovulation***; LH also transforms the ruptured follicle into a corpus luteum
- release of ***progesterone, estrogen & inhibin*** from *corpus luteum* inhibits release of FSH & LH from anterior pituitary
- as LH blood levels decline, corpus luteum degenerates, & declining levels of progesterone & estrogen remove block to FSH & LH release; cycle begins again
- **ovarian cycle:** monthly series of events (~ 28 days) associated with egg maturation
- **uterine (menstrual) cycle**: cyclic changes in uterine endometrium in response to ovarian hormones in blood

Mammary Glands
- present in both sexes; normally only function in females
- produce milk & nourish newborn baby
- composed of modified sweat glands contained within a rounded skin-covered breast, anterior to pectoral muscles
- lobules within lobes contain ***alveoli*** that produce milk when a woman is lactating following childbirth
- ovarian hormones stimulate breast development; alveolar glands & ducts enlarge & fat is deposited within breasts

Sexually Transmitted Diseases (STDs or Venereal Diseases (VDs): infectious diseases spread through sexual contact
- ***Gonorrhea***: caused by bacterium *Neisseria gonorrhoeae*
- ***Syphilis***: caused by bacterium *Treponema pallidum*
- ***Chlamydia***: caused by parasitic bacterium *Chlamydia trachomatis*
- ***Genital Warts***: caused by human papillomavirus (HPV) (certain types also cause invasive cervical cancer)
- ***Genital Herpes***: caused by human herpesviruses (herpes simplex virus, Epstein-Barr virus)
- bacterial pathogens treated with antibiotics, while viral pathogens are generally treated with antiviral medications

Chapter 20: Pregnancy, Growth, Development & Genetics

Pregnancy: the presence of a developing offspring in the uterus
- consists of 3 ***trimesters***, each ~ 3 months long
- ***transport of sex cells***: sperm in semen moves from vagina through female reproductive tract, aided by *flagellum* and muscular contractions of uterus & uterine tube stimulated by *prostaglandins* in semen
- **fertilization**: union of egg cell & sperm cell to form a **zygote**
  - enzymes from sperm cell acrosome aid in penetration of ***zona pellucida*** surrounding egg cell membrane
  - only head region of one sperm cell with nucleus enters egg cell
  - changes in zona pellucida & plasma membrane prevent further sperm entry
  - fusion of egg cell nucleus & sperm cell nucleus produces *zygote* with 46 chromosomes

Prenatal period:
- **cleavage**: rapid cell division of zygote, producing successively smaller cells
- developing offspring moves down uterine tube & implants in ***endometrium*** of *uterus*
- **placenta** forms about third month from embryonic & maternal cells
- ***hormones during pregnancy***:
  - embryonic cells produce **hCG** (human chorionic gonadotropin), which maintains corpus luteum & hormone secretion
  - once formed, placenta releases high levels of ***estrogen*** & ***progesterone***
  - *estrogens* & *progesterone* maintain uterine wall & inhibit FSH & LH
  - progesterone & ***relaxin*** inhibit uterine contractions
  - estrogens enlarge vagina; relaxin relaxes ligaments of pelvic joints
  - *placental lactogen* stimulates breast & mammary gland development
  - increased *aldosterone* stimulates water retention; increased *PTH* maintains high blood calcium
- **embryonic stage**: from beginning of second week through eighth week
  - *inner cell mass* organizes into ***3 primary germ layers***
  - embryonic disc attaches to developing placenta
  - ***placental membrane*** forms from epithelium chorionic villi & capillary epithelium
    - transfers oxygen & nutrients to embryo; removes CO_2 & wastes
  - fluid-filled **amnion** surrounds embryo
  - ***umbilical cord*** forms as amnion wraps around tissue under embryo
  - **yolk sac** forms under embryonic disc; produces blood cells & primary germ cells
  - ***allantois*** extends from yolk sac into connecting stalk; forms blood cells & umbilical arteries & veins
- **fetal stage**: from ninth week of development through birth
  - mostly already existing structures grow & mature
  - fetus is full-term at end of 38 weeks
  - ***umbilical vein*** transports oxygenated blood from placenta to fetus
  - *ductus venosus* bypasses liver; *foramen ovale* & *ductus arteriosus* bypass lungs
  - umbilical arteries carry mostly deoxygenated blood to placenta through internal iliac arteries

    - fetal blood is enriched with oxygen; fetal hemoglobin has greater oxygen affinity
- **childbirth**
    - placental *progesterone* inhibits uterine contractions during pregnancy
    - decreasing progesterone near end of third trimester & release of prostaglandin initiate birth process
    - ***oxytocin*** from posterior pituitary stimulates uterine contractions & labor
    - following birth, placental tissues are expelled

Postnatal period
- following childbirth, placental hormones decline, releasing block to prolactin
- **prolactin** stimulates milk secretion
- suckling causes ***oxytocin*** release, which stimulates milk ejection
- **neonatal period**: from birth to end of first 4 weeks
    - newborn begins to breathe; first breath must be powerful to expand lungs
    - also begins to obtain nutrients, excrete waste & regulate body temperature
    - newborn depends largely on stored fat for energy (liver still immature)
    - homeostatic mechanisms also immature
    - liver & lung circulatory bypasses constrict & close

Genetics
- chromosomes & genes are in homologous pairs (one from sperm & one from egg)
- **karyotypes** show all 46 chromosomes in pairs
- 22 pairs of *autosomes* & one pair of sex chromosomes (XX in females; XY in males)
- ***homozygous***: 2 identical alleles for a trait
- ***heterozygous***: 2 different alleles for a trait
- ***genotype***: alleles present (genetic information) for a trait
- ***phenotype***: physical appearance for a trait
- ***dominant alleles*** mask expression of ***recessive alleles***
- ***polygenetic inheritance***: traits controlled by more than one gene
- Punnett squares & pedigrees depict gene transmission in families