Chapter 13

Drugs for Muscles and Joint Disease and Pain

Chapter 13 Topics

- Muscles and Joints
- Muscle Relaxants
- Inflammation and Swelling
- Arthritis and Related Disorders

Learning Objectives

- Define muscle relaxants.
- Identify muscle relaxants and their various mechanisms of action.
- Identify the nonnarcotic analgesics and describe their uses and mechanisms.
- Understand an autoimmune disease.

- Identify agents used to treat arthritis, rheumatoid arthritis, and gout, and discuss their usage and side effects.

Muscles and Joints

- Bones of the skeletal system provide framework of the body
  - Are connected at joints
- Joint: place of union or junction between 2 or more bones
- Skeletal muscles: contractile tissues that provide movement at joints

Anatomy of a Joint

- Diagram of a joint illustrating bone, joint cavity, articular cartilage, bone, synovial capsule, synovial fluid, and synovial membranes.
Joints and Ligaments

- Wide variety of joints in human body
- Ligaments: noncontractile connective tissue that ties one bone to another bone
  - Maintain bones in alignment
  - Form fibrous capsule that encloses moving parts

Classification of Joints By Structure

- Cartilaginous: articulating bone surfaces covered with cartilage
- Fibrous: articulating bone surfaces attached by fibrous connective tissue
- Synovial: articulating bone surfaces covered by a fluid-filled, fibrous sac

Classification of Joints By Movement

- Permit no movement
- Permit slight degree of movement
- Permit variety of movement

Examples of Joints and Their Functions

<table>
<thead>
<tr>
<th>Joint Type</th>
<th>Function</th>
</tr>
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<tbody>
<tr>
<td>Shoulder joint</td>
<td>Ball-and-socket</td>
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<tr>
<td>Humeroulnar joint</td>
<td>Hinge</td>
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<tr>
<td>Superior radioulnar joint</td>
<td>Pivot</td>
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<tr>
<td>Intervertebral joint</td>
<td>Gliding</td>
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Examples of Joints and Their Functions

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<th>Joint Type</th>
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<tbody>
<tr>
<td>Hip joint</td>
<td>Multiaxial ball-and-socket</td>
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<tr>
<td>Carpometacarpal joint of thumb</td>
<td>Saddle</td>
</tr>
<tr>
<td>Wrist joint</td>
<td>Condyloid</td>
</tr>
<tr>
<td>Knee joint</td>
<td>Uniaxial hinge</td>
</tr>
<tr>
<td>Ankle joint</td>
<td></td>
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</tbody>
</table>

Muscle

- An organ that produces movement by contracting (shortening itself)
- Connected to bones by tendons, tough cordlike tissue
Bones, Muscles, and Tendon for Movement at Elbow Joint

Three Muscle Groups
- **Skeletal**: voluntary contraction, locomotion and posture
- **Smooth**: involuntary contraction, lining of organs such as stomach, esophagus, uterus, bladder
- **Cardiac**: involuntary, heart muscle, striated texture

Three Types of Muscle

Muscle Relaxants
- **Skeletal** muscle contractions voluntarily controlled (CNS)
- Neurotransmitter acetylcholine (Ach) is released, binds with receptors on muscle cell membrane, calcium is released, causing a contraction
- Relaxation occurs when ACh is broken down by acetylcholinesterase

Muscle Relaxants
- Agent to reduce muscle tension, acts on motor neurons or at neuromuscular junction
- Block normal muscle function by
  - Blocking release of ACh
  - Preventing destruction of Ach
  - Preventing ACh from reaching receptors

Discussion
Most muscle relaxants are not controlled substances, so why are they highly abused?

They are abused due to the relaxing feeling that patients have from taking them.
Inflammation and Swelling
- Analgesics used to relieve pain
- Nonnarcotic analgesic used for mild-to-moderate pain, inflammation, and fever
- Two types of pain
  - Somatic: dull, throbbing pain from skin, muscle, or bone
  - Visceral: sharp, stabbing pain from organs

Fever
- Response to body’s temperature-regulating center (the hypothalamus) to endogenous pyrogens
  - Substance produced due to bacterial or viral infections
- Brain then releases prostaglandins (PGs) which cause the body thermostat to reset at higher temperature

Inflammation
- Pain pathway in tissue injury
- PGs can cause inflammation, tissue damage, and fever
- Nonnarcotic analgesics interrupt pathway, inhibiting enzyme to synthesize PGs
  - Relieves inflammation and pain
  - Reduces fever

Pain Pathway in Tissue Injury

Side Effects of Nonnarcotic Analgesics
- Increase risk of stomach ulcers
- Elevate serum concentrations of hepatic enzymes
- Promote water and electrolyte retention
- Can cause renal insufficiency

NSAIDs
- Properties of nonsteroidal anti-inflammatory drugs (NSAIDs)
  - Analgesic (pain relieving)
  - Anti-inflammatory
  - Antipyretic (fever reducing)
- Prototype NSAID is aspirin
Salicylates

- Analgesic, antipyretic and anti-inflammatory properties
- Primary analgesic actions are peripheral, not central
- Reduce fever by increasing blood flow to skin and inhibit prostaglandin synthesis
- Primary antipyretic action is central, probably in the hypothalamus

Aspirin Dosages

- More than 4 g per day can cause problems
- 10 g or more can cause death

Reye’s Syndrome

- Aspirin should not be given to children
- Effects of Reye’s Syndrome
  - Mental changes
  - Coma
  - Seizures
  - Relaxed muscles
  - Dilated pupils
  - Respiratory failure

Aspirin and Cardiovascular Disease

- Daily low-dose aspirin (81 mg to 325 mg) reduces risk of heart attack and stroke
- Alters platelet aggregation for clotting
- Enteric coated daily aspirin to protect stomach lining
- Plain aspirin for MI to quickly enter bloodstream to prevent clot formation

Mixed Analgesics

- Contains a narcotic and NSAID or acetaminophen
- Chronic use can lead to kidney failure
- Alcohol can cause a problem with OTC analgesics
  - Acetaminophen: risk of liver toxicity
  - Ibuprofen: risk of GI bleeding

Arthritis and Related Disorders

- Arthritis: joint inflammation
- Persistent pain most common complaint
- Pain originates from surrounding joint structures: bone, tendon, ligament, muscle
- Pain is caused by functional problems of the joints.
Osteoarthritis
- Degenerative joint disease
- Results in loss of thickness and cartilage elasticity
- Bones wear and become deformed
- Commonly affected joints
  - Sternoclavicular joint, spine, hips, knees, fingers, and great toes
  - Knees and fingers especially affected
- Generally appears after age 40
- Characterized by progressive pain, stiffness, limitation of motion, and deformed joints
- Morning stiffness common

Bursitis
- Inflammation of a bursa
- Bursa: saclike pouch filled with synovial fluid located at friction site
  - Point where a muscle or tendon passes over
- Unknown cause

Rheumatoid Arthritis (RA)
- Autoimmune disease that attacks and destroys connective tissue
- Characterized by inflammation of a joint’s synovial membrane
- Bone and cartilage reabsorption leaving bone-to-bone contact, can lead to joint fusion

Treating Autoimmune Disease
- Drugs used to treat RA turn off the immune system
- Makes the body susceptible to infections, cancer, other diseases
- Primary side effects of drugs: infection, malignancies

Healthy Wrist and Hand
RA Affected
Characteristics of RA
• Pain originates from bone, tendon, ligament, and muscle
• Symmetric morning stiffness lasting longer than 60 minutes
• Same joints on both sides affected about 70% of the time
• Small joints of fingers usually first affected

Laboratory Tests for RA
• Erythrocyte sedimentation rate (ESR) indicates presence of inflammation
• Rheumatoid factor (RF)—80% of arthritis patients have positive result

Criteria for Diagnosis of RA
• Joint tenderness or pain on motion
• Morning stiffness
• Presence of RF
• Soft-tissue swelling in a 1st joint, followed within 3 months by swelling in a 2nd joint
• Sterile, turbid synovial fluid
• X-ray changes showing erosions

Therapy for Arthritis
• Aimed at relieving pain, maintaining or improving mobility, and minimizing disability
• May include medications, physical therapy, and patient education

NSAIDs
• Relieve inflammation and swelling and therefore pain
• Take longer to reduce fever than other products, but effects last longer

Therapeutic Uses of NSAIDs
• Inflammation and pain of arthritis and rheumatism
• Headache
• Menstrual cramps
• Backache
• Muscle aches
• Flu
• Fever
• Gouty arthritis
Mechanism of Action of NSAIDs

- Inhibit PG synthesis in inflamed tissues
- Prevents sensitization of pain receptors to mediators of inflammation
- Generally act peripherally, not centrally like other pain killers

The GI System and NSAIDs

- Primary side effect is GI upset
- One in five chronic NSAID users develop some type of GI gastropathy
- Many patients need to take a proton pump inhibitor with NSAIDs

Discussion

Why do NSAIDs cause GI upset?
PGs are responsible for increased mucosal blood flow, mucus production, and decreasing free acid in the GI tract.

COX-2 Inhibitors

- 2 enzymes critical in inflammation process
- Cyclooxygenase-1 (COX-1): extensive role in body, including protecting GI lining
- Cyclooxygenase-2 (COX-2): pain, inflammation
- Drugs only block the COX-2 enzyme which is induced during inflammation

Disease-Modifying Antirheumatic Drugs (DMARDS)

- Early, mild RA should be treated with more than NSAIDs
  - Joint damage occurs earlier than previously thought
- DMARDs modify disease progression
  - Second-line treatments
  - May slow progression of disease, but side effects limit use

Discussion

Why does depression of the bone marrow lead to increased risk of infection?
Depressing bone marrow depresses the formation of leukocytes which weakens the immune system.
Gouty Arthritis (Gout)

- Usually affects single joints
  - Causes a tophus (deposit of sodium urate) to form around the joint
- Big toe usually the first affected
  - Painful, swollen, and red
- Usually inherited

Gouty Arthritis (Gout)

- Overproduction or improper excretion of uric acid
- Avoid medications that can precipitate a gout attack
  - Cytotoxic agents
  - Diuretics
  - Ethanol
  - Nicotinic Acid
  - Salicylates, including aspirin

Colchicine

- Drug of choice for acute gout attacks
- Reduces uric acid production
- High potential for phlebitis (inflammation of a vein)

Assignments

- Complete Chapter Review activities
- Answer questions in Study Notes document
- Study Partner
  - Quiz in review mode
  - Matching activities
  - Drug tables

Chapter 14 Topics

- The Endocrine System
- Thyroid Disorders
- Male Hormones and Impotence
- Female Hormones
- Hormones in Gender Reassignment
- Pregnancy and Childbirth
Chapter 14 Topics

- Sexually Transmitted Diseases
- Drug Therapy for Bone Disease
- Adrenal Gland Disorders and Corticosteroid Therapy
- Diabetes
- Growth Disorders

Learning Objectives

- Explain the concept of hormones and how they regulate the body.
- Discuss thyroid replacement therapy.
- Discuss adrenal sex hormones and male dysfunction.
- Understand the concept of hormone replacement therapy.

Learning Objectives

- Understand the formulation of oral contraceptives.
- Recognize the urgent need for the drugs used at delivery.
- Describe the diseases of the genital systems and how to avoid them.
- Discuss corticosteroids.

Learning Objectives

- Understand diabetes and the proper treatment and care of patients.
- Know the applications for growth hormone.

The Endocrine System

- Consists of glands and other structures that produce hormones released into the circulatory system.
- Tissue affected by a hormone is called the target.
- Endocrine system maintains homeostasis of the body.

Endocrine System
Regulation

- Hormones of pituitary gland regulate other endocrine glands and body activities
- Regulation of hormone synthesis by negative feedback involving the hypothalamic-pituitary axis, and autoregulation

Thyroid Disorders

- Produces hormones (T₃ and T₄) that stimulate metabolic activity of body tissues
- Hypothalamus and pituitary glands work together to release TSH
- TSH stimulates T₃ and T₄ release

Thyroid Gland

- Produces hormones (T₃ and T₄)
- Stimulates metabolic activity of body tissues
- Hypothalamus and pituitary glands work together to release TSH
- TSH stimulates T₃ and T₄ release

Thyroid Hormone Feedback Loop

- Thyroid hormones build up in blood
- Signals sent to the hypothalamic-pituitary axis that adequate levels have been met
- TSH levels decrease
- TSH levels determine if thyroid is functioning normally

Hypothalamic-Pituitary Axis

- Hypothalamus releasing factors
- Thyroid-stimulating hormone (TSH)
- Thyroid hormones (T₃ and T₄)
Pharmacology for Technicians, Fourth Edition

Hypothyroidism

- Production of thyroid hormones below normal
- Cretinism in children at birth due to inadequate maternal iodine
  - Mental retardation, thick tongue, altered lack of response, short stature
  - Can be corrected if treated

Symptoms of Hypothyroidism

- Apathy
- Constipation
- Decreased heart rate
- Depression
- Dry skin, nails, scalp
- Easy fatiguing
- Enlarged thyroid
- Low voice pitch
- Myxedema
- Puffiness
- Reduced acuity
- Swelling of eyelids, tongue enlarged and thickened
- Weight gain

Causes of Hypothyroidism

- Autoimmune destruction of the gland
- Radioactive iodine therapy
- Surgical removal of the gland
- Pituitary dysfunction or abnormality in hypothalamus

Treatment for Hypothyroidism

- Thyroid replacement therapy
- Increases metabolism, but should not be used to treat obesity

Hyperthyroidism

- Excessive thyroid hormone
- Most common cause: Graves disease
- Other causes
  - Excessive exogenous iodine
  - Thyroid nodules
  - Tumor in the pituitary causing overproduction of TSH

Symptoms of Hyperthyroidism

- Hair loss
- Exophthalmos (protrusion of the eyeballs)
- Weight loss
Exophthalmos

Discussion
What are the treatment options for hyperthyroidism?
In children: surgery and hormone replacement
In adults: surgery or medications

Male Hormones and Impotence
- Androgens: hormones that promote development and maintenance of male physical characteristics
- Androgens produced by:
  - Testes: produces testosterone, most important male hormone
  - Ovaries, adrenals, peripheral fat tissue

Responsibilities of Testosterone
- Initiating sperm production
- Behavioral characteristics
- Libido
- Sexual potency
- Fertility
- Muscle mass and strength
- Fat distribution
- Bone mass
- Erythropoiesis
- Prevention of baldness

Hypogonadism
- Deficient hormone production and secretion
- Medications must replace androgens
  - May cause virilization, anabolic treatment (muscle building), and stimulation of erythropoiesis
  - Can be used to treat anemia, breast cancer, or endometriosis

Side Effects of Androgens
- Virilization
- Hirsutism (abnormal hairiness)
- Acne
- Hepatotoxicity
- High levels of erythrocytes
- Oily skin
- Ankle edema
- Gynecomastia
- Priapism
Testosterone Derivatives and Dosage Forms

- Oral testosterone undergoes extensive first-pass metabolism in the GI tract and liver
- Various testosterone derivatives and dosage forms developed
- Testosterone substances classified as Schedule III

Scrotal Transdermal Systems

- Provides serum concentration that mimics natural circadian secretion of hormone
- Increases libido and sexual potency
- Improves patient’s sense of well-being

Male Impotence

- Failure to initiate or maintain an erection until ejaculation
- Causes
  - Testosterone deficiency
  - Alcoholism
  - Cigarette smoking
  - Psychological factors
  - Medications

Drugs That May Cause Impotence

- Alcohol (most significant)
- Amphetamines
- Antihypertensives
- Corticosteroids
- Estrogens
- H₂ blockers
- haloperidol
- lithium
- Opiates
- Some antidepressants

Female Hormones

- Can prevent conception, ease symptoms of menopause, and help prevent osteoporosis
- Two main female hormones
  - Estrogen, formed in ovaries when FSH is released
  - Progesterone

Responsibilities of Estrogen

- Endometrial growth
- Increased cervical mucus
- Cornification of vaginal mucosa
- Growth of breast tissue
- Increased epiphyseal closure
- Sodium retention
- Calcium utilization
Symptoms of Estrogen Deficiency

- Irregular bleeding and cycles
- Vasomotor symptoms: hot flashes
- Atrophic vulvovaginitis (excessive dryness)
- Dyspareunia (painful intercourse)
- Frequent infections

Menopause

- As women reach menopause, estrogen production decreases
- Hormone therapy (HT) relieves symptoms of estrogen deficiency
- Climacteric characterized by gradual loss of ovarian function and irregular bleeding before menses ends

Menopausal Symptoms

- Hot flashes
- Drying and atrophy of vaginal mucosa
- Insomnia
- Irritability and other mood changes
- Depression

Hormone Therapy

- Reduces symptoms of menopause
- Decreases bone loss
- Lowers risk of cardiovascular disease
- Improves color and turgor of skin

Progestin

- Synthetic progesterone
- Used primarily in birth control and to prevent uterine cancer
- Also used for menstrual dysfunction
- Lowers incidence of endometrial hyperplasia

Hormone Therapy

- Estrogen supplements for hormone therapy for menopause may have same ingredients, but
  - They are not interchangeable
  - Doses differ slightly in each
- Estrogen plus nicotine increases risk of blood clots, increasing risk of DVT
Risks and Benefits of Hormone Therapy

- Research constantly reveals new information about HTs
- Some studies: limit to shortest duration possible
- Some risk of breast cancer

Risks and Benefits of Hormone Therapy

- Decision to use HT up to the woman and her physician
- Advantages and disadvantages allows for each woman, depending on:
  - Family history
  - Physical condition

Oral Contraceptives

- Advantages of OCs: ease of use, high efficacy rate, relative safety
- Most oral contraceptives (OCs) are combinations of estrogen and progestin
- Interfere with hormones responsible for regulation of the menstrual cycle
- Change the consistency of cervical mucus and alter the endometrial lining

Progestin-Only Pills

- Rely on the effects of progestin on the cervical mucus and endometrium

Benefits of Oral Contraceptives

- Prevent pregnancy, regulate menstrual cycle, reduce menstrual flow, lessens severe menstrual cramps and pain
- Protect against ovarian and endometrial cancer, benign breast disease, hyperplasia, pregnancy, and ovarian cysts
- May reduce risk of pelvic inflammatory disease

Oral Contraceptives

- Some studies: OCs not prescribed if
  - Hypertension
  - Diabetes
  - Elevated cholesterol
- Patients should not smoke while taking OCs
Contraceptives

- Many forms of contraceptive on the market
- Available in pill form, creams, patches, rings, and implants
- Take OCs same time each day
- Taking OCs at bedtime reduces possibility of nausea

Emergency Contraception

- In great demand
- Patients want them to be available OTC

Discussion

What is one of the arguments for emergency contraceptives being OTC?

After making a doctor’s appointment and then going to get the prescription, sometimes it is too late to take the medication.

Pregnancy Tests and Pregnancy

- Critical organ systems develop in the first month which is affected by
  - Mother’s diet
  - Environment (smoking)
  - Medications
  - Consumption of alcoholic beverages

Home Pregnancy Tests

- Based on detecting human chorionic gonadotropin (hCG)
- Levels can be measured as early as 6-8 days after conception
- Results are given within 1-5 minutes
- Tests are better than 95% accurate

START HERE 12/17

Pregnancy Needs

- Pregnancy often occurs without woman knowing
- Sexually active women get daily requirements
  - Folic acid: prevents tubular defects
  - Iron: prevents anemia, preterm delivery, low birth weight in infants
  - Calcium: bone development
- Pregnant women: few OTC drugs
**Drugs Used During Childbirth**
- Women may choose not to use drugs for simple delivery
- Drugs are necessary in emergencies
  - To restart labor
  - To decrease uncontrolled bleeding

**Sexually Transmitted Diseases (STDs)**
- Most genital system diseases are transmitted by sexual activity

**Female Genital System Anatomy**

**Male Genital System Anatomy**

**Chlamydia**
- If untreated, can progress to serious reproductive and other health problems
- Caused by *Chlamydia trachomatis*
- “Silent” disease, many have no symptoms
- Often occurs with gonorrhea
- Treated and cured with antibiotics

**Gonorrhea**
- Caused by *Neisseria gonorrhoeae* that attaches to mucosal cells in
  - Oropharyngeal area
  - Eye
  - Joints
  - Rectum
  - Male and female genitalia
- Treated with penicillin
Untreated Gonorrhea
- Can cause systemic infection
  - Heart, meninges, eyes, pharynx, and joints (arthritis)
  - Eye infections occur most frequently in newborns and can cause blindness

Syphilis
- Caused by *Treponema pallidum*
- Incubation averages three weeks
- Infection develops in three stages
  - Primary stage
  - Secondary stage
  - Tertiary stage

Syphilis: Primary-Stage Infection
- Small, hard-based sore (chancre) develops at site of infection
  - May be painless and patient may not be aware
- Fluid in the sores is highly infectious
- Bacteria enter the bloodstream and lymphatic system

Syphilis: Secondary-Stage Infection
- Skin rashes, patchy hair loss, malaise, and mild fever
- Symptoms subside after a few weeks and disease becomes latent
- After 2 to 4 years of latency, disease is usually no longer infectious

Syphilis: Tertiary-Stage Infection
- Occurs after an interval of at least 10 years
- Lesions appear as a rubbery mass in many organs and sometimes the skin
- May cause extensive damage to internal organs, blindness, CNS lesions, perforation of roof of mouth

Congenital Syphilis
- Crosses the placenta into the fetus
- Neurologic damage if pregnancy occurs during the tertiary stage
- Pregnancy during primary or secondary stage likely to produce a stillborn child
Nongonococcal Urethritis

- NGU may be caused by catheters or chemical agents
- Sometimes acquired sexually
- Symptoms: mild in males, serious in females

Vaginitis

- Caused by Gardnerella vaginitis
- Results from interaction between this organism and anaerobic bacterium in the vagina
- Symptoms: frothy discharge with fishy odor and vaginal pH of 5 to 6

Drug Therapy for Bone Disease

- Bone is living tissue continuously being replaced
- Osteoclast cells resorb bone
- Osteoblast cells form bone
- In healthy bones, balance between the two

Microscopic View of Bone

Bones and Age

- As age progresses, reabsorption of bone exceeds deposit of new bone
- Newly formed bone less dense and more fragile than original bone
  - Increases risk of bone fracture

Osteoporosis

- Condition of reduced bone mineral density, disrupted bone structure, and increased risk of fracture
- Deficiency in estrogen, calcium, and vitamin D
- Women with less estrogen production or intake may be at higher risk
- Prevention of bone loss: dietary calcium with vitamin D
Risk Factors for Osteoporosis

- Not Modifiable
  - Gender
  - Race
  - Heredity
  - Age

- Modifiable
  - Low calcium intake
  - Alcohol abuse
  - Lack of weight-bearing exercise

Osteoporosis

- Weight-bearing exercise helps strengthen bones
  - Walking
  - Jogging
  - Weight lifting
  - Dancing
- HRT also reduces rate of bone loss

Biphosphonates

- Interfere with bone reabsorption by osteoclasts
- Drug class used most to treat osteoporosis
- Taken weekly or monthly 30 minutes before first meal of the day with 8 ounces of water
- Remain upright for at least 30 minutes

Discussion

What definite instructions should this patient be given?

Take the medication with a full glass of water 30 minutes before any other food or drink. Do not lie down for 30 minutes afterward.

Adrenal Gland Disorders and Corticosteroid Therapy

- Adrenal glands are on top of kidneys, produce steroid hormones: corticosteroids
- Each hormone has
  - Glucocorticoid: involved in metabolism, protein metabolism
  - Mineralocorticoid: involved in regulating electrolyte and water balance

Cortisol

- Principal adrenal steroid hormone
- Responsible for
  - Gluconeogenesis
  - Protein catabolism
  - Anti-inflammatory reactions
  - Stimulation of fat deposition
  - Sodium and water retention
**Corticosteroids**

- Adrenal hormones (excluding sex hormones)
- Steroid production follows a circadian rhythm

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**Addison Disease**

- Life-threatening deficiency of glucocorticoids and mineralocorticoids
- Treated with daily corticosteroids

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**Symptoms of Addison Disease**

- Debilitating weakness
- Hyperkalemia
- Bronze color of skin
- Low levels of serum sodium and glucose
- Reduced blood pressure
- Weight loss

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**Cushing Disease**

- Caused by an overproduction or excessive administration of corticosteroids over time
- Symptoms: protruding abdomen; round, puffy face; fat over the shoulders

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**Reasons for Using Corticosteroids**

- Inhibit inflammation
- Useful in treating asthma, rashes, and skin disorders
- Available in many different dosage forms
Problems with Corticosteroids

- Lessen the ability of leukocytes to destroy infection which decreases fever, redness, and swelling
- Also may cause infection to spread

Corticosteroids

- Usage must be tapered off, not abruptly stopped
- May cause withdrawal symptoms:
  - Anorexia, nausea, vomiting, arthralgia, lethargy, headache, insomnia
  - Weight loss, postural hypotension, fever, depression
- Doses should be given in the morning

Diabetes

- Serious disease affecting millions of people
- Characterized by high blood sugar, due to insufficient levels of the hormone insulin
- If untreated, can cause range of serious conditions, eventually death

Functions of Insulin

- Pancreas contains islets of specialized cells producing insulin
- Insulin:
  - Helps cells burn glucose for energy
  - Works with receptors for glucose uptake
  - Increases ion transport and incorporation of amino acids into protein
  - Increases ion transport into tissues
  - Inhibits fat breakdown

Type I Diabetes

- Most commonly occurs in children and young adults
- Average age of diagnosis is 11 or 12
- Patients must have insulin
- Accounts for 5 to 10% of diabetic population
**Type II Diabetes**
- 80-90% of diabetic cases
- Most over 40, majority are women
- Most overweight
- May be able to control disease through diet and exercise, but often need to add a drug or insulin

**Gestational Diabetes**
- Occurs during pregnancy
- Increases risk of fetal morbidity and death
- Treated with diet, exercise, insulin
- 30-40% of women with gestational diabetes develop type II diabetes in 5 to 10 years

**Secondary Diabetes**
- Caused by medications
  - Oral contraceptives
  - Beta blockers
  - Diuretics
  - Calcium channel blockers
  - Glucocorticoids
  - Phenytoin
- May return to normal when drug is stopped

**Symptoms of Diabetes**
- Frequent infections
- Glycosuria
- Hunger
- Increased urination and nocturia
- Numbness, tingling
- Slow wound healing
- Thirst
- Visual changes
- Vomiting
- Weight loss, easy fatigability, irritability, nausea, ketoacidosis

**Hypoglycemia and Hyperglycemia**
- Short-term hypoglycemia (drug level falls below 70 mg/dL) more dangerous
- Untreated long-term hyperglycemia has devastating consequences

**Complications of Long-Term Diabetes**
- Retinopathy leading to blindness
- Neuropathy
- Vascular problems lead to atherosclerosis, decreased blood flow, and inadequate healing. Could lead to amputation
- Dermatologic involvement
- Nephropathy is primary cause of end-stage renal disease
Treating Diabetes

- Goal of treatment is to approximate nondiabetic physiology
- Treatment consists of diet, exercise, and medications
- Regular blood glucose monitoring

Five-Step Treatment for Type II

1. Lifestyle changes
2. Oral monotherapy
3. Combination oral therapy
4. Oral drug plus insulin
5. Insulin only

General Treatment Guidelines

- Attention to diet
- Blood pressure control
- Compliance with medications
- Control of hyperlipidemia
- Daily foot inspections
- Increased physical activity
- Recognizing hypoglycemia
- Blood glucose testing
- Monitoring in doctor’s office
- Therapy adjustment
- Setting goals
- Patient education
- Prompt treatment of infections
- Setting goals

Insulin

- Administered subcutaneously due to degradation in the GI tract
- Different types of insulin have different onset of action times and duration of action times

Insulin Duration of Action

<table>
<thead>
<tr>
<th>Type</th>
<th>Duration of Action</th>
</tr>
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<tbody>
<tr>
<td>Humalog, NovoLog, Apidra</td>
<td>Rapid-Acting: Onset 10 to 30 minutes, duration 3 to 5 hours</td>
</tr>
<tr>
<td>Humulin-R, Novolin R (regular)</td>
<td>Short-Acting: Onset 20 to 60 minutes, duration 5 to 6 hours</td>
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<table>
<thead>
<tr>
<th>Type</th>
<th>Duration of Action</th>
</tr>
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<tbody>
<tr>
<td>Novolin N (NPH)</td>
<td>Intermediate-Acting: Onset 1 to 3 hrs, duration 16 to 24 hours</td>
</tr>
<tr>
<td>Lantus, Levemir</td>
<td>Long-Acting: Onset 1 to 2 hrs, duration 24 to 36 hours</td>
</tr>
<tr>
<td>mixed</td>
<td>Quick onset, different duration, dosed twice daily</td>
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</table>
**Rotation of Insulin Administration Sites**

**Hypoglycemia**
- Blood glucose levels of <70 mg/dL
- Can be caused by
  - Skipping meals
  - Too much exercise
  - Poor medication regimen
  - Certain drugs

**Signs and Symptoms of Hypoglycemia**
- Confusion
- Double vision
- Headache
- Hunger
- Numbness and tingling in mouth and lips
- Nervousness
- Palpitations
- Sweating
- Thirst
- Visual disturbances
- Weakness

**Treatment of Hypoglycemia**
- Give patient milk or sugars such as fruit juices, soft drinks, or candy
- Glucose tablets
- Type I should have Rx glucagon available

**Emergencies**
- In an emergency, insulin does not require a Rx
- The 500 Units per mL and some new insulins always require a Rx
- Some states require a Rx for needles

**Oral Hypoglycemic Agents**
- Cause pancreas to release stored insulin
- Not effective in type I diabetes—no insulin for body to release
- Goal of therapy: maintain an HbA1C (glycosylated hemoglobin) level of less than 7%
Peripheral Neuropathy

- Many diabetic patients have some form of peripheral neuropathy
- Numbness, insensitivity to pain or temperature, tingling in arms or legs
- Therapy: first deal with underlying cause (hyperglycemia), then symptom relief
- Anticonvulsants and antidepressants help with pain management

Growth Disorders

- Growth hormone (GH) has fundamental role in metabolism
- Deficiency of endogenous growth hormone causes growth retardation
- Therapy: GH therapy
  - Younger the patient at time of treatment, greater the height that may be achieved through GH therapy
  - Due to epiphyseal fusion, little response seen after:
    - Age 15 to 16 in boys
    - Age 14 to 15 in girls

Causes of Growth Delay

- Family growth patterns, genetic disorders, malnutrition, systemic or chronic illness, psychosocial stress, or a combination of these
- Endocrine deficiency, or problems with GH, thyroxine, cortisol, insulin

Growth Hormone

- Release of GH stimulated by release of growth hormone releasing factor (GHRF) secreted by the hypothalamus
- GH inhibited by:
  - Glucocorticoids
  - Obesity
  - Depression
  - Afferent thyroid function

Human Growth (GH) Hormone

- Supplied through recombinant DNA technology

Growth Hormone Therapy

- Younger the patient at time of treatment, greater the height that may be achieved through GH therapy
Assignments

- Complete Chapter Review activities
- Answer questions in Study Notes document
- Study Partner
  - Quiz in review mode
  - Matching activities
  - Drug tables

Chapter 15 Topics

- Skin Ailments and Their Treatment
- Eye Conditions and Ophthalmic Medications
- Ear Conditions and Otic Medications

Learning Objectives

- Describe the skin as an organ.
- Understand the physiology of the skin.
- Know the topical drugs and the conditions they treat.
- Explain the action of the topical corticosteroids and their application.

Learning Objectives

- Recognize the classes of antiseptics and disinfectants.
- Recognize the ophthalmic and otic agents and their uses.

Skin Ailments and Their Treatment

- Skin is a major organ
- Accounts for 10% of body weight
- Offers protection
- Source of sensory input
- Main organ involved in temperature regulation
Anatomy of the Skin

- Epidermis
  - Top layer of skin
  - Continually forms new cells and sheds old, dead cells
  - Produces nails, hair, glands
- Dermis
  - Below epidermis
  - Made up of connective tissue with upward projections into the epidermis

Types of Skin Glands

- Two types of glands widely distributed in the skin: sebaceous and sweat
  - Sebaceous glands
    - Secrete sebum, a substance that oils skin and hair and is toxic to some bacteria
  - Sweat glands
    - Produce water and salts

Types of Skin Glands

- Apocrine glands in skin of external ear canal produce cerumen (earwax)
  - Cerumen
    - Has antibacterial and antifungal activity
    - Made up of secretions, squamous cells, and dust

Filling Prescriptions for Skin Ailments

- Physicians generally prescribe creams more than ointments
- Dermatologists prescribe ointments more than creams
- When filling a Rx, creams, gels, and ointments are not interchangeable

Sun and the Skin

- Suntans can permanently damage the skin
- Sunscreens should contain combination of
  - Oxybenzone and para-aminobenzoic acid, or
  - Other UV-absorbing agents
  - Protect against both UV-A and UV-B rays
Phototoxicity and Photosensitivity

- Phototoxicity: a property of a chemical that becomes toxic on exposure to light
- Photosensitivity: an abnormal response of the skin or eye to sunlight
  - Many different classes of drugs cause photosensitivity
  - Patients need to be alerted to avoid sun exposure when taking these medications

Some Drugs That Cause Photosensitivity

- ACE inhibitors
- Antibiotics
- Antidepressants
- Antihistamines
- Antipsychotics
- Cardiovascular drugs
- Chemotherapeutic agents
- Diuretics
- NSAIDs

Skin and the Sun

- Fair-skinned people more likely to have atrophy, scaling, and skin cancer than dark-skinned people

Skin Cancers

- Actinic Keratosis
- Basal Cell Carcinoma
- Melanoma
- Squamous Cell Carcinoma

Skin Cancers

- Actinic Keratosis: precancerous condition
- Basal Cell Carcinoma: slow-growing tumor, rarely metastasizes
- Melanoma: highly malignant, sunburn increases risk
- Squamous Cell Carcinoma: grows rapidly, metastasis is uncommon

Discussion

It is the middle of July and you have a patient receiving a new prescription for Bactrim. What precautions should the patient follow? Do not stay out in the sun for an extended period of time; wear sunscreen that blocks UV-A and UV-B rays.
Skin Disorders and Their Pharmaceutical Treatment

- Many drugs used for skin disorders and diseases may overlap
- Many are used to treat more than one skin disease
- One drug can be used for several ailments

Acne Vulgaris

- Acne vulgaris: increased glandular activity at puberty
  - Usually resolves in early adulthood
  - Lesions most common on the head and neck

Acne Treatment

- Acne is treated
  - With tretinoin, azelaic acid, and adapalene
  - Systemically and topically with erythromycin, azithromycin, or clindamycin
- Oral contraceptives can have a beneficial effect on acne

Actinic Keratosis

- Precancerous condition resulting from excessive exposure to the sun

Treatment of Actinic Keratosis

- fluorouracil (Efudex)
  - Used topically
  - Antimetabolite, chemotherapy agent (antineoplastic drug that inhibits tumor development and growth)
- aminolevulinic acid (Levulan)
  - Topical compound
  - Photodynamic reaction upon exposure to an appropriate wavelength of light

Treatment of Actinic Keratosis

- Imiquimod (Aldara)
  - Stimulates immune process at lesion sites
  - Approved for treatment of external genital and perianal warts, and psoriasis
Allergic and Inflammatory Reactions
- Pruritis: itching associated with number of skin disorders or irritation from chemical substances
- Causes of excessive itching
  - Some systemic diseases: liver disease, uremia, Hodgkin disease, diabetes, thyroid disease
  - Pregnancy, senility, and various psychological disorders

Treatment of Pruritis
- Topically applied baths with starch, sodium bicarbonate, magnesium sulfate (Epsom salts), colloidal oatmeal, potassium permanganate
- Camphor in liniments and ointments
- Antihistamines

Rash Caused By Drugs
- Rash most common allergic reaction to a drug
- Pharmacy technician—notify pharmacist if you hear of a drug-caused rash

Dandruff
- Rapid shedding of scales from the scalp

Eczema
- Eczema: a hot, itchy, red, oozing condition; two types: atopic and contact
- Atopic eczema (atopic dermatitis)
  - Chronic pruritic eruption
  - Allergic, hereditary, and psychological factors may be involved
- Contact dermatitis
  - Inflammatory reaction in response to contact with irritating agent: poison oak, poison ivy

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**Seborrhea**

- Seborrhea: excessive secretion of sebum
  - Usually on elbows and knees, but any part of body can be affected
- Condition genetically predetermined
  - Attacks brought on by illness, injury or stress
  - No cure

**Fungal Infections**

- **Candidiasis**
  - Causes lesions in the mouth (thrush) or vagina
- **Ringworm**
  - Infects horny (scaly) layer of the skin or nails
  - Infection spreads outward as center heals, leaving a ring

**Psoriasis**

- **Psoriasis**: chronic noncontagious condition producing patches of red, scaly skin (plaques)
  - Usually on elbows and knees, but any part of body can be affected
- Condition genetically predetermined
  - Attacks brought on by illness, injury or stress
  - No cure

**Treatment of Psoriasis**

- Topical therapy, phototherapy, systemic therapy; may be combined
- methotrexate (Rheumatrex, Trexall)
  - Oral or injectable
  - May inhibit normal cell growth of bone marrow tissues
- alefacept (Amevive)
  - Attacks T cells, intramuscular injections for 12 weeks and may require second course of treatment, requires periodic blood tests
- calcipotriene (Dovonex)
  - Topical, not used on the face, wash hands after application, no more than 100 g of ointment per week
**Treatment of Rosaeca**
- Topical agents: MetroGel, Azelex, Sulfacet R, and Finacea
- Oral agent: Oracea

**Viral Infections**
- Shingles
  - Caused by herpes zoster
  - Treatment relieves symptoms, no cure
- Cold sores
  - Caused by herpes simplex I
- Warts
  - Virologically caused epidermal tumors; virus can lie dormant, then cause reinfection
  - Genital warts transmitted by sexual contact

**Treatment of Shingles and Cold Sores**
- Shingles
  - Palliative. Antivirals such as acyclovir may prevent recurrent outbreaks
- Cold sores
  - Docosanol (Abreva)

**Treatment of Warts**
- Surgically removed or destroyed by local freezing
- Some OTC products may work
  - Contain salicylic acid

**Treatment of Wrinkles**
- Tretinoin (Renova)
  - Lower dose of tretinoin used for wrinkles
- Botulinum toxin type A (Botox)
  - Neuromuscular blocking agent; temporary (about 3 months) improvement of wrinkles
  - Treatments very expensive

**Skin Infections**
- Skin infections are common
- Most can be treated with OTC topical antimicrobial medications
- Impetigo, erysipelas, folliculitis, furuncle, rosacea
Impetigo and Erysipelas

• Impetigo is a superficial, but highly contagious skin infection
  – Common in early childhood
  – Caused by *Staphylococcus* or *Streptococcus*

Erysipelas

• Erysipelas is a form of cellulitis
  – Characterized by redness, warmth, local pain, edematous plaque with sharp borders, chills, malaise, fever
  – Spreads rapidly
  – Oral antibiotics usually work well, but if the infection is systemic, parenterals should be used

Folliculitis, Furuncle, and Rosacea

• Folliculitis: inflammation of a hair follicle
• Furuncle (boil): staphylococcal infection of a sebaceous gland and hair follicle
• Rosacea: chronic dermatologic disorder with erythema, papules and pustules that may become infected
  – Symptoms are treated with antibiotics

Antifungals Under the Nails

• Antifungals often administered through pulse dosing to treat conditions under the nails

Discussion

What different types of medications can be used to treat acne vulgaris?
Oral and topical antibiotics and topical preparations to remove dead keratinocytes

Topical Corticosteroids

• Suppress the immune response
• Relieve redness, swelling, and itching
External Parasites

- Lice and scabies are external parasites
- Use the human body as a host

Lice

- Remain on host’s skin surface, hair, and clothing fibers
- Cause itching
- Live up to 45 days
- Human blood only nourishment
- Spread by direct contact

Three Types of Lice

- Body lice in clothing and moist areas of body
- Head lice on scalp and hair
  - Transmitted by direct contact
- Pubic lice in pubic area
  - Transmitted by sexual contact

Scabies

- Small white mites cause scabies
- Causes intense itching
- Transmitted by close contact
- Itching is worse at night after body warmed by body heat
- Lesions appear as very narrow, wavy, threadlike, slightly elevated, grayish-white burrows

Common Sites of Scabies Infestation
Treatment of Lice and Scabies

• For head and public lice, comb hair with a clean, fine-toothed comb to remove nits (eggs)
• When treating lice, OTC drugs are as effective as prescription drugs
• Some products used for lice infestations are effective for treating scabies.

Antiseptics and Disinfectants

• Most desirable quality is the ability to destroy microorganisms
• Two uses: disinfect instruments and treat infections in oral cavity and body surfaces
• Two different agents may need to be used to achieve adequate cleaning.

Antiseptics and Disinfectants

• When an antiseptic is used to disinfect instruments or to maintain sterility in a clean room, best to use two separate cleansers with different mechanisms of action.

Actions of Antiseptics and Disinfectants

<table>
<thead>
<tr>
<th>Agent</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antiseptic</td>
<td>Inhibits growth of microorganisms</td>
</tr>
<tr>
<td>Disinfectant</td>
<td>Chemical applied to objects</td>
</tr>
<tr>
<td>Fungicide</td>
<td>Destroys fungi</td>
</tr>
<tr>
<td>Germicide</td>
<td>Destroys germs</td>
</tr>
</tbody>
</table>

Discussion

What characteristics make an ideal antiseptic?

One that can inhibit all forms of microorganisms; is nontoxic; does not induce sensitization; can penetrate tissues and body fluids; and is water soluble, noncorrosive, and inexpensive.
Eye Conditions and Ophthalmic Medications

- Ophthalmic medications are used to treat the eyes
- Some disorders that affect the eye
  - Cytomegalovirus (CMV) retinitis
  - Age-related macular degeneration
  - Chronic dry eye
  - Conjunctivitis

The External Eye

- CMV Retinitis
  - Inflammation of the retina caused by cytomegalovirus (CMV)
  - Treated with antivirals

- Age-Related Macular Degeneration (AMD)
  - Macula has highest concentration of photoreceptors in the retina
  - Dry AMD: macular cells slowly break down and vision is slowly lost
  - Wet AMD: new blood vessels in the retina grow toward the macula, damage occurs rapidly and vision is lost rapidly

AMD

- Neither form causes pain
- Unknown cause
- Age greatest risk factor
- Dry AMD has no treatment
- Wet AMD can be treated with surgery
Chronic Dry Eye
- Eye cannot produce sufficient tears to lubricate and nourish the eye
- Rx cyclosporine (Restasis)
  - Increases tear production
  - Decreases immune function in the eye
  - Not absorbed systemically

Conjunctivitis
- Known as “pink eye”
- Common eye disorder, very contagious
- Increased tearing, itching, conjunctival swelling, redness
- Treatments include topical vasoconstrictors, mast cell stabilizers, antihistamines, corticosteroids, antibiotics, and antivirals

Glaucoma
- Chronic disorder, causes vision loss, no cure
  - Most common eye disease
- Abnormally high internal eye pressure destroys the optic nerve
  - Pressure due to imbalance with liquid (aqueous humor) in front portion of the eye
- Treatment: eyedrops and an oral medication

Treatment Goals for Glaucoma
- Prompt reduction of intraocular pressure
- Stabilization of eye status for corrective surgery
- Gradual reduction of pressure
- Long-term normalization
- Prevention of optic nerve damage
- Preservation of eyesight

Ear Conditions and Otic Medications
- Disorders of the ear include
  - Otalgia (ear pain)
  - Earache
  - Buildup of earwax (cerumen)

Otalgia
- Otalgia usually treated with a prescription
- OTC products
  - Ear wax solvents
  - Products to dry water in the ear
**The Ear: Structural Components**

**Discussion**

Why can eyedrops be used in the ear, but eardrops cannot be used in the eye?

**Eyedrops must be sterile, but eardrops do not need to be sterile.**

**Assignments**

- Complete Chapter Review activities
- Answer questions in Study Notes document
- Study Partner
  - Quiz in review mode
  - Matching activities
  - Drug tables

**Chapter 16 Topics**

- Recombinant DNA
- Immune System
- Cancer

**Learning Objectives**

- Understand recombinant DNA and the process for producing medications in this manner.
- Identify colony-stimulating factors and their uses.
- Understand the immune system and how it works.
Learning Objectives

• Identify drugs used to treat specific disease states and the classifications of drugs used in its treatments.

Recombinant DNA

• Biotechnology: the method of applying biologic systems and organisms to industrial and technical use
• Recombinant DNA: technique that uses the information-processing capabilities of living cells for human purposes

Natural Process for Making Proteins

• Proteins – Large, complex organic molecules that carry out many chemical processing tasks for a cell – Can be reproduced by replicating its genes
• 3 steps to producing a protein – Replication of DNA – Transcription to RNA – Translation to manufacture the protein

Recombinant Process for Manufacturing Proteins

• DNA that codes for a valuable protein in the body is inserted into the DNA of a different organism • Cell then multiplies and produces the protein in large quantities • Desired gene introduced into a different kind of cell: bacterial (most often), fungal, or mammalian

Plasmids

• Small circular rings of DNA in bacteria • Often used to transport a gene into a host cell in recombinant process • Characteristics of plasmids – Present in bacteria – Replicate themselves – Move freely between bacterial cells – Can carry genes such as those that make a bacterium resistant to antibiotics

Protein Replication

• Environment of the host cell is critical to replicate protein • Once a cell that produces a desired protein is identified, cloning (duplication) proceeds • By using recombinant DNA technology, large quantities of protein can be made without risk of contamination
Production of Protein Through Recombinant DNA Technology

Economic Challenges
- High cost of these products is offset by the savings in hospital bills for the patients

Colony-Stimulating Factors (CSFs)
- Stimulate bone marrow to produce blood cells, well tolerated agents
- Decrease period of severe neutropenia (low number of white blood cells)
  - Chemotherapy or marrow ablation
  - Treatment of noncancerous anemia
  - Treatment of other immunodeficiency states associated with cytopenia (reduction in number of blood cells)

Therapeutic Uses of CSFs
- Hematopoietic (red blood cell) malignancies
- Testicular cancer
- Ovarian cancer
- Small-cell carcinoma of the lung

Biologic-Response Modifiers
- Chemicals that enhance immune system activity so that the body will attack and kill invading organisms

Discussion
What are the three types of cells into which a desired gene can be introduced?
- bacterial, fungal, or mammalian cell
Immune System

• Highly complicated system
• Protects the body from invading pathogens

The Body’s Three Lines of Defense

• Body surfaces of intact skin and mucous membranes, body fluids, sneezing, coughing
• Nonspecific internal defense: inflammation, macrophages, and other infection-fighting chemicals
• Immune response: T cells and B cells

Immune Response

• Provides resistance to disease and malignancy by producing active phagocytic cells and antibodies
• Antibody: specialized protein produced in response to an antigen
• Antigen: any substance the immune system cells view as foreign

Immune System Cells

• Immune system has different types of white blood cells (leukocytes): T cells, B cells, small lymphocytes, and macrophages
• These cells give the immune system its specificity and memory:
  – Specificity: ability to attach to a specific antigen
  – Memory: ability to remember an antigen for future invasion

T Cells

• Participate in cellular immunity
• Formed in bone marrow, reside in lymph nodes and spleen
• Respond to antigens by forming clones:
  – Effector T cells: release cytokines
  – Cytotoxic T cells: direct infected cells
  – Memory T cells: reproduce forever afterward

B Cells

• Involved in humoral immunity
• Formed in bone marrow
• Do not enter the thymus and differentiate
• Responsible for producing antibodies
• Antibodies attach to specific antigens, forming a complex that is destroyed or inactivated
Small Lymphocytes and Macrophages

- Small lymphocytes produced by clones of T and B cells
  - Recognize and rapidly attack particular antigens (more so than initial attack)
- Macrophages ingest and digest foreign substances

Immunoglobulins: Proteins with Antibody Activity

- IgG: Most common and smallest. In saliva, tears, cerebrospinal fluid. Main defense against fever-producing organisms
- IgM: Form when gram-negative bacteria present, highest molecular weight
- IgA: Found in mucous membranes, saliva, bile, tears, and breast milk
- IgE: Causes hypersensitivity reactions
- IgD: May affect B-cell maturation

Immune Response: Humoral Immunity

- Antigens enter the body, ending up in a lymph node or the spleen
- B cells are stimulated; plasma cells and memory cells are activated
- Antigen-antibody complex undergoes opsonization (pathogen marked for ingestion and destruction by a macrophage)
- Macrophages recognize and destroy the complex

Antibody Response

- Magnitude of an antibody response depends on
  - Nature of the antigen
  - Frequency of exposure
  - Duration of each exposure

Immune Response: Cellular Immunity

- Responsible for
  - Organ transplant rejections
  - Killing of tumor or virus-infected cells
  - Hypersensitivity reactions
- Main-line defense against invaders

Lymphatic System

- Key part of immune system
- Includes
  - Network of capillaries and vessels for collecting and transporting lymph
  - Lymph nodes
  - Lymphoid organs: tonsils, thymus, lymph nodes
Lymphatic System

- Lymphocytes formed in bone marrow pass to the thymus, maturing to become T cells
  - Recognize and respond to specific antigens
  - Move to peripheral tissues
- Lymphocytes formed from stem cells in bone marrow and do not migrate to the thymus become B cells

Antirejection Drugs

- Given to patients who undergo a transplant to prevent the body from attacking the transplanted tissue
- Also decreases normal immunity

Cancer

- Neoplastic disease (cancer): when cells become resistant to normal growth controls and growth patterns are altered
- Structural alteration with cell death occurs regardless of cell type
- Uncontrolled reproduction results in nonfunctional cells that may multiply at a faster rate than other normal cells

Characteristics of Malignancy

- Abnormal, uncontrolled growth that threatens normal body functions and can lead to death
- DNA and RNA synthesis increases
- Tumors rob other cells of nutrients
- Cells lose their contact inhibition

A seminoma is a cancerous tumor found in the testis
Types and Sites of Cancer

- Types of cancer
  - Solid tumors: a palpable growth
  - Diffuse tumors: a growth scattered throughout the body
- Sites of cancer
  - Primary site: where disease began
  - Secondary Site: metastasis

Agents for Chemotherapy

- Surgery is available for solid tumors that are accessible
  - Followed by radiation or chemotherapy
- Chemotherapy is used for diffuse tumors
- Goal of chemotherapy: put the cancer into remission
- Resistance: cancer cells do not respond to chemotherapy

Agents for Chemotherapy

- Alkylating agents
- Antibiotics
- Antimetabolites
- Hormones
- Nitrogen mustards
- Plant alkaloids
- Topoisomerase Inhibitors
- Tyrosine Inhibitors
- Macrocyclic Agents
- Cytoprotective (Rescue) Agents

Alkylating Agents

- Prevent cell division by binding cross-links in DNA strands
- Result: death within the cell

Antibiotics

- Inhibit DNA-dependent RNA synthesis or delay or inhibit mitosis

Antimetabolites

- Inhibit the normal function of a key enzyme and make them nonfunctional
- Most antimetabolites used in chemotherapy prevent DNA replication or transcription
**Hormones**

- Act against neoplasms of reproductive issues.
- Some of the target tissues:
  - bicalutamide (Casodex): prostate
  - goserelin (Zolade): prostate, endometriosis, metastatic breast cancer
  - megestrol: breast, endometrial
  - mitotane (Lysodren): adrenal cortex

**Nitrogen Mustards**

- Bind irreversible cross-links in cellular DNA
- Result: DNA and RNA cannot reproduce

**Plant Alkaloids**

- Inhibit formation of spindle fibers, arresting the metaphase stage of cell division

**Topoisomerase I Inhibitors**

- Lead to DNA damage when cells replicate
- Target tissues:
  - irinotecan (Camptosar): colorectal cancer
  - topotecan (Hycamtin): ovarian cancer

**Tyrokinase Inhibiting Agents**

- Block tyrosine kinase activity, thus inhibiting cell growth and multiplication
- Seem as effective as other chemotherapy agents with fewer and less severe side effects

**Miscellaneous Agents**

- A number of anticancer drugs do not fit into the previous categories
- They have different mechanisms of action and destroy malignant cells in a variety of ways
Biologic-Response Modifiers

- Alter the host immune response to promote destruction of human malignancies

Three Biologic-Response Modifiers

- Interferon inhibits viral replication
- Interleukin-2 secreted by T cells to activate lymphocytes and enhance ability to lyse broad variety of tumor cells
- Tumor-necrosis factor secreted by macrophages in response to endotoxin, causing lysis of susceptible tumor cells

Cytoprotective (Rescue) Agents

- Reduce side effects and toxicity of chemotherapy
- Timing is critical to prevent destruction of healthy cells
  - Chemotherapy agent must be active long enough to kill malignant cells
  - Then the rescue agent is given

Complications of Cancer and Chemotherapy: Pain

- Many times pain is not adequately controlled
- Weakens the patient’s appetite, reduces sleep, and increases fear and anxiety
- Little need to worry about addiction to pain medications

Complications: Nausea and Vomiting

- Primary side effects of chemotherapy
- Drugs to control emesis discussed in Chapter 10

Oral Complications

- Commonly occur due to toxicity and tissue injury of anticancer drugs and radiation
- Most common are mucositis and concomitant ulceration and infection
- Can affect the patient’s ability to eat
- Patients may need to increase intake of analgesics
- May increase risk of septicemia
Discussion

What should the Technician do with this prescription?

Mix lidocaine, diphenhydramine, and Maalox in equal parts.

Breast Cancer

• Hormonal therapies are used to prevent recurrence of breast cancer
• Tumor growth is stimulated by estrogen
• These drugs cause hot flashes, nausea, and weight gain

Assignments

• Complete Chapter Review activities
• Answer questions in Study Notes document
• Study Partner
  – Quiz in review mode
  – Matching activities
  – Drug tables