Chapter 11
Introduction to the Human Body: Cells, Tissues, and the Body Compass

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Introduction

• Knowledge of anatomy and physiology is crucial to being an effective massage therapist
• Gives a clear visual picture of the body beneath your hands
• Anatomy and physiology are inseparable
• Form follows function

Preface to Anatomy and Physiology

• Anatomy—study of structures of the human body and their positional relationship to one another
  – Gross anatomy—study of larger body structures
  – Microscopic anatomy—study of smaller structures of the body that are best observed using a microscope

Preface to Anatomy and Physiology

• Physiology—study of how the body and its individual parts function in normal body processes
• Homeostasis—a relatively stable environment of the body, maintained by adjusting metabolism
• Metabolism—total of all physical and chemical processes that occur in an organism

Levels of Organization

• Chemical
• Cellular
• Tissue
• Organ
• Organ System
• Organism

The Cell

• Fundamental unit of all living organisms
• Simplest form of life that can exist as a self-sustaining unit
• 75 to 100 trillion cells in the human body
The Cell

- Cells require oxygen ($O_2$), hydrogen ($H_2$), nitrogen ($N_2$), and carbon ($C$)
- Trace elements are important for cellular function
  - Calcium—bones, blood clotting
  - Iron—hemoglobin (carries $O_2$ in the blood)
  - Iodine—helps control metabolism
- 60% to 80% of cells is water

Cell Components

- Membrane
- Cytoplasm
- Organelles
  - Nucleus
  - Ribosomes
  - Endoplasmic reticulum
  - Golgi body
  - Mitochondria
  - Lysosomes

Cell Membrane

- Semipermeable boundary between cytoplasm and external environment
- Governs nutrient and waste exchange via active and passive processes
- Responds to stimulation
- Projections aid in motility and protection:
  - Microvilli
  - Cilia
  - Flagella

Cytoplasm

- Gel-like fluid within cell membrane
- Functions:
  - Provide cellular nutrition
  - Support organelles

Organelles

- "Little organs" necessary for metabolism
- Functions:
  - Reproduction
  - Storage of materials
  - Metabolizing nutrients

Nucleus

- Largest organelle; control center
- Some cells have several nuclei (multinucleated)—e.g., skeletal cells
- Some have no nuclei (enucleated)—e.g., blood cells
- Nuclei contain DNA, which together with RNA helps make proteins for cells, tissues, and organs
Ribosomes

• Ribosomes—small granules of RNA and proteins in the cytoplasm that synthesize proteins
  – Many of these proteins are used within cell
  – Some are exported for use outside of cell

Endoplasmic Reticulum

• Also called ER
• Complex network of membranous channels from cell membrane to nucleus to organelles
• Helps transport materials for the synthesis of proteins and lipids
• Rough—ribosomes attached (granular ER)
• Smooth—no ribosomes (agranular ER)

Golgi Body

• Series of horizontal membranous sacs
• Stores, packages, and ships finished proteins and lipids to parts of cell or to other cells

Mitochondria

• Power plants of a cell
• Site of cellular respiration
• Provide ATP for energy
• Inner and outer membrane
  – Smooth outer shell
  – Inner membrane—projections called cristae increase surface area for enhanced ATP production

Lysosomes

• Contain digestive enzymes
• Engulf pathogens, cellular debris, and other waste
• Reusable material is returned to cytoplasm
• Useful for cellular reduction and disposal of cellular debris

Passive and Active Processes

• Nutrients and waste travel across cell membranes through passive and active processes
  – Passive transport—occurs due to differences in temperature, pressure, or concentration: e.g., diffusion, filtration, and osmosis
  – Active transport—requires energy expenditure (ATP) by the cell: e.g., endocytosis, phagocytosis, and pinocytosis
Passive Processes

• Diffusion—movement of particles from an area of high concentration to an area of low concentration

Passive Processes

• Filtration—movement of particle across a membrane due to differences in pressure
• Osmosis—movement of a pure solvent like water, from an area of low concentration (most dilute and few particles) to an area of high concentration (least dilute and lots of particles)
• Even if a membrane prevents diffusion of particles, osmosis allows fluid to flow

Active Processes

• Move atoms and molecules against concentration gradient—from low concentration to high concentration
• Energy (ATP) is used
  – Up to 40% of the body’s ATP
  – ATP drives movement of particles against a concentration gradient

Active Processes

• Endocytosis—moving large particles across a cell membrane into the cell
• Vital to immune defense systems

Active Processes

• Phagocytosis—specialized cells ingest harmful microorganisms or cellular debris
  – Breaks them down and expels harmless remains

Active Processes

• Pinocytosis—similar to phagocytosis, except the target is liquid
Body Tissues
• Groups of similar cells that act together to perform a specific function
• Four types of tissues in the human body:
  – Epithelial
  – Connective
  – Muscle
  – Nervous
• Organs are made up of two or more tissue types

Epithelial Tissue (Epithelium)
• Lines or covers internal and external organs
• Blood vessels, digestive, reproductive, urinary, and respiratory tracts
• Epithelium protects organs and functions to absorb nutrients and excrete waste

Connective Tissue
• Most abundant tissue of body
• Highly vascularized
• Composed of ground substance (water and carbohydrates) and collagen
• Fibroblasts within matrix give rise to connective tissue cells during healing
• Arrangement of collagen and ratio of collagen to ground substance determine type of connective tissue

Epithelial Tissue (Epithelium)
• Functions are diffusion, filtration, secretion, excretion
• Typically avascular
• Reproduces and regenerates quickly

Connective Tissue
• Five classifications:
  – Liquid
  – Bone
  – Cartilaginous
  – Loose
  – Dense
Liquid Connective Tissue

- Types of liquid (vascular) connective tissues:
  - Blood—made up of plasma and cells
  - Lymph—resides in lymph vascular system
  - Interstitial fluid—bathes cells and tissues
- Lymph and interstitial fluid are chemically similar to blood plasma

Bone

- Hardest and most dense connective tissue
- Consists of:
  - Compact bone
  - Spongy bone
  - Collagenous fibers
  - Mineral salts

Cartilaginous Tissue

- Cartilage—avascular, tough, and durable
- Types of cartilaginous tissue:
  - Hyaline cartilage—rubbery and smooth; most common type of cartilage
  - Fibrocartilage—greatest tensile strength
  - Elastic cartilage—soft and pliable

Loose Connective Tissue

- The packing material of the body
- Types of loose connective tissues:
  - Areolar—attaches skin to underlying tissues and structures (superficial fascia)
  - Adipose—stores fat for energy, insulates body, and cushions certain structures
  - Reticular—forms framework of organs

Dense Connective Tissue

- Types of dense connective tissues:
  - Regular—very strong and able to withstand pulling in two directions
    - ligaments, tendons, retinacula, and aponeuroses
  - Irregular—resists pulling in several different directions
    - deep fascial membranes, dermis of the skin, periosteum, and the capsules of organs

Muscle Tissue

- Highly elastic and vascularized, produces movement through elongation and contraction
- Types of muscle:
  - Smooth
  - Skeletal
  - Cardiac
Smooth Muscle
- Also known as visceral muscle
- Involuntary
- Cells are spindle-shaped
- Forms hollow organs and tubes
- Contains single oval-shaped nucleus
- Consumes little energy and can sustain long contractions

Skeletal Muscle
- Voluntary
- Cells are cylindrical or rod-shaped
- Multinucleated; located peripherally
- Designed for power and support
- Appears striped (striated)

Cardiac Muscle
- Exclusively in the heart wall
- Y- or H-shaped
- Multinucleated
- Contain intercalated disks between cells
- Allows rhythmic contraction for blood flow

Nervous Tissue
- Neurons convert stimuli into electrical signals for a mental, physical, or emotional response

Thixotropy
- Thixotropism—the ability to change states
- Fascia has two states:
  - Gel-state—muscles and tissue must assume firm, supportive roles
  - Sol-state—more flexible for greater range of motion and relaxation; achieved by applying pressure and heat through massage, exercise, and stretching
- Hydration of body aids thixotropism

Body Membranes
- Thin, soft, pliable sheets of tissue that cover the body, line tubes or body cavities, cover organs, and separate one part of a cavity from another
  - Cutaneous—cover entire surface of the body
  - Mucous—line openings to outside of the body
  - Serous—line closed body cavities
  - Synovial—line joint cavities of freely moveable joints
Body System Overview

- Body systems:
  - Circulatory
  - Skeletal
  - Integumentary
  - Respiratory
  - Reproductive
  - Muscular
  - Endocrine
  - Nervous
  - Urinary
  - Digestive

Circulatory

- Heart, blood, blood vessels, lymph, lymph vessels, and glands
- Transports and distributes gases, nutrients, antibodies, hormones
- Eliminates waste
- Prevents hemorrhage by clotting

Skeletal

- Bones, cartilage, ligaments, joints
- Supports body with a framework of bone
- Protects vital organs
- Gives leverage for locomotion
- Site of blood cell production
- Stores fats and minerals

Integumentary

- Skin, hair, nails, oil glands, sweat glands
- Protects from infection
- Absorbs fat, fat-soluble vitamins, salts
- Receives stimuli
- Regulates body temperature
- Eliminates waste
- Converts UV to vitamin D

Respiratory

- Nose, nasal cavity, pharynx, larynx, trachea, bronchi, bronchioles, alveoli, lungs, diaphragm
- Exchanges gases
- Detects smells
- Produces speech
- Regulates body pH
Reproductive
- Females—ovaries, fallopian tubes, ova, uterus, vagina
- Males—testes, spermatic ducts, spermatozoa, penis, prostate
- Produces offspring to propagate the species

Muscular
- Skeletal muscles, fascia, tendons
- Create movement
- Produce heat
- Maintain posture

Endocrine
- Pituitary, pineal, thyroid, parathymus, thymus, adrenals, pancreas, gonads, hormones
- Produces and secretes hormones
- Regulates body activities, maintains body in times of stress
- Contributes to reproductive process

Nervous
- Brain, spinal cord, meninges, cerebrospinal fluid, cranial nerves, spinal nerves, special sense organs
- Receives sensory input
- Interprets and integrates stimuli
- Initiates motor output
- Houses mental processes and emotional responses

Urinary
- Kidneys, ureters and urethra, urinary bladder, urine
- Eliminates metabolic waste
- Regulates blood pH, chemical composition, volume, pressure, homeostasis

Digestive
- Teeth, tongue, alimentary canal (from mouth to anus), accessory glands (liver, gall bladder, pancreas, salivary)
- Ingestion
- Digestion
- Absorption
- Defecation
Body Compass
- Map of body with respect to anatomical position
  - body erect; facing forward
  - arms at side; palms facing forward; thumbs to the side
  - feet hip distance apart; toes pointing forward
- Helps you find your way around human body

Planes of Reference
- Midsagittal—divides body into equal left and right halves
  - Sagittal—parallel to, but left or right of midsagittal plane
- Frontal—anterior and posterior halves; also called coronal plane
- Transverse—horizontally divides body; superior and inferior halves

Planes of the Body
- Midsagittal—divides body into equal left and right halves
- Sagittal—parallel to, but left or right of midsagittal plane
- Frontal—anterior and posterior halves; also called coronal plane
- Transverse—horizontally divides body; superior and inferior halves

Body Cavities
- Dorsal cavity
  - Cranial—brain
  - Spinal (vertebral)—spinal cord
- Ventral cavity
  - Thoracic—lungs, heart, esophagus, trachea
  - Abdominopelvic
    - Abdominal—digestive system
    - Pelvic—reproductive and urinary systems, rectum

Major Body Cavities
- Dorsal cavity
  - Cranial—brain
  - Spinal (vertebral)—spinal cord
- Ventral cavity
  - Thoracic—lungs, heart, esophagus, trachea
  - Abdominopelvic
    - Abdominal—digestive system
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Abdominopelvic Quadrants
Directional Terminology

- Anterior (ventral)—front side
- Posterior (dorsal)—back side
- Superior (cranial)—above, or toward head
- Inferior (caudal)—below, toward tail end
- Medial—toward or near midline
- Lateral—farther from midline
- Homolateral (ipsilateral)—on same side
- Contralateral—on opposite side of body

Directional Terminology

- Proximal—near a point of reference, usually toward center of body
- Distal—farther from a point of reference, usually away from center of body
- Central (deep)—at center of body
- Superficial (peripheral)—outside or surrounding surface
- Internal—nearest inside of a body cavity
- External—nearest outside of a body cavity

Regional Terms

- Head and neck:
  - Buccal—cheek
  - Cervical—neck
  - Cephalic—head
  - Cranial—head
  - Facial—face
  - Frontal—forehead
  - Mandibular—lower jaw

Regional Terms

- Head and neck (cont’d.):
  - Mental—chin
  - Nasal—nose
  - Nuchal—posterior neck
  - Occipital—posterior, inferior head
  - Oral—mouth
  - Orbital (ophthalmic)—eye
  - Otic (auricular)—ear

Regional Terms

- Upper extremity:
  - Acromial—top of shoulder
  - Antebrachial—forearm
  - Antecubital—front or bend of elbow
  - Axillary—armpit region
  - Brachial—upper arm
Regional Terms

• Upper extremity (cont’d.):
  – Carpal—wrist area
  – Cubital—elbow
  – Deltoid—curve of shoulder and upper arm
  – Digital (phalangeal)—fingers and/or toes
  – Palmar (volar)—anterior surface of hand
  – Pollex—thumb

• Anterior torso:
  – Abdominal (celiac)—anterior trunk
  – Costal—ribs
  – Groin (inguinal)—area where thigh meets abdomen
  – Mediastinal—area in thoracic cavity between lungs

• Anterior torso (cont’d.):
  – Abdominal (celiac)—anterior trunk
  – Costal—ribs
  – Groin (inguinal)—area where thigh meets abdomen
  – Mediastinal—area in thoracic cavity between lungs

  – Pectoral (mammary)—upper anterior thorax
  – Pelvic—inferior region of abdominopelvic cavity
  – Perineal—between pubis and coccyx; inferior pelvic cavity
  – Pubic—genital area
  – Thoracic—upper chest
  – Umbilical—navel (belly button) area

• Posterior torso:
  – Coccygeal—bottom of spine, top of gluteal cleft
  – Gluteal (buttock)—curve of buttocks
  – Lumbar—low back
  – Sacral—sacrum of spine, superior to coccyx
  – Sacroiliac—between sacrum and pelvic bone
  – Scapular—shoulder blade area
  – Vertebral—vertebrae, spinal column

Regional Terminology

• Lower extremity:
  – Calcaneal—heel
  – Calf (sural)—posterior leg
  – Coxal—hip region
  – Crural—entire leg
  – Digital (phalangeal)—fingers and/or toes
  – Dorsum—top of foot
  – Femoral—femur, thigh area, between knee and hip

• Lower extremity (cont’d.):
  – Hallux—great toe
  – Patellar—kneecap
  – Pedal—foot/feet
  – Plantar (volar)—bottom of foot, sole
  – Popliteal—posterior aspect of knee
  – Tarsal—ankle
Summary

- Knowledge of anatomy and physiology is crucial to being an effective massage therapist
- The body is a hierarchy of components
- Cells organize to form tissues; tissues organize to form organs
- Our map of the body consists of anatomical directions, planes of reference, body cavities, and regional body landmarks