THE AMAZING HUMAN BODY

COMPILED BY HOWI E BAUM
OUTLINE AND SCHEDULE - “YOUR AMAZING HUMAN BODY”

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WEEK 1

A. Introduction to the class
B. Anatomy and Physiology
C. Levels of organization of the Human Body
D. Characteristics and Maintenance of Life
E. Homeostasis and Feedback
F. Body Cavities, Membranes, and the 11 Body / Organ Systems
G. Diagnostic Imaging techniques and the different types of microscopes and devices for studying the body
WEEK 2
➢ Introductory Chemistry about the atoms and molecules in the body

➢ The importance of Minerals, Vitamins, and Trace mineral elements for the body

WEEK 3
➢ Cells and Tissues

➢ Circulatory System

WEEK 4
➢ Endocrine System

➢ Digestive System

WEEK 5
➢ Immune System

➢ Muscular System
WEEK 6

➢ Nervous System
➢ Integumentary System

WEEK 7

➢ Urinary System
➢ Respiratory System

WEEK 8

➢ Skeletal System/ Joints
➢ Reproductive Systems – Female and Male
AN INTRODUCTION TO THE HUMAN BODY

➢ The number of humans in the world now is 7.53 billion (7, 530,000,000) !!

➢ More than 250 babies are born every minute, while 150,000 people die daily, with the population increasing by almost three humans per second.

➢ Each of us lives, thinks, worries, and daydreams with, and within, that most complex and marvelous of possessions – a human body !!

➢ The body is a series of 11 integrated systems. Each system carries out one major role or task.

➢ The systems are, in turn, composed of main parts known as organs, the organs consist of tissues, and tissues are made up of cells.
A) **Anatomy** deals with the structure of the body and its parts; in other words, the names of the parts.

Pictures of the inside of the body are often shown in isolation, using techniques such as cutaways, cross-sections, and “exploded” views, which provide clarity and understanding.

But in reality, the inside of the body is a crowded place. Tissues and organs push and press against one another. There is no free space, and no stillness either. Body parts shift continually in relation to each other, as we move about, breathe, sleep, and eat.

B) **Physiology** studies the functions of these parts or asks the question, “how do they work?’’

The two disciplines are closely interrelated because the functional role of a part depends on how it is made.
Levels of Organization of the Body

The human body is the sum of its parts and these parts can be studied at a variety of levels of organization.

1. Chemicals:
   a. **Atoms** are the simplest level.
   b. Two or more atoms comprise a **molecule**.
   c. **Macromolecules** are large, biologically important molecules inside cells.

2. **Organelles** are groups of macro-molecules used to carry out a specific function in the cell.
Levels of organization of the Body

3. **Cells** are the basic units of structure and function for living things.

4. **Tissues** are groups of cells functioning together.

5. Groups of tissues form **organs** that have specialized functions.

6. Groups of organs function together as an **organ system**.

7. The 11 Body (Organ) systems functioning together, to make up an **organism**.
LEVELS OF ORGANIZATION OF THE BODY

- Carbon atom
- Chemical molecule
- DNA molecule
- Organelle
- Cell
- Tissue
- Organ system
- Organ
- Organism
CHARACTERISTICS OF LIFE

Fundamental characteristics of life are traits shared by all organisms.

1. **Movement** – change in position of the body or a body part; motion of an internal organ

2. **Responsiveness** – reaction to internal or external change

3. **Growth** – increase in size without change in shape

4. **Reproduction** – new organisms or new cells

5. **Respiration** – use of oxygen; removal of Carbon Dioxide

6. **Digestion** – breakdown of food into simpler forms
7. **Absorption** – movement of substances through membranes and into fluids

8. **Circulation** – movement within body fluids

9. **Assimilation** – changing nutrients into chemically different forms

10. **Excretion** – removal of metabolic wastes

**Taken together, these 10 characteristics constitute our metabolism** – the physical and chemical events that obtain, release, and use energy.
What Are the Main Characteristics of organisms?

1. Made of **CELLS**
2. Require **ENERGY** (food)
3. **REPRODUCE** (species)
4. Maintain **HOMEOSTASIS** (keeping the body systems in balance)
5. **ORGANIZED**
6. **RESPOND** to environment
7. **GROW** and **DEVELOP**
8. **EXCHANGE** materials with their surroundings (water, wastes, gases)
MAINTENANCE OF LIFE

Life depends on the availability of the following:

A) WATER
   1) The most abundant chemical in the body
   2) Required for many metabolic processes
   3) Transportation of cells and body materials
   4) Regulates body temperature
   5) Makes up intracellular and extracellular fluid compartments
What Does Water do for You?

- Forms saliva (digestion)
- Keeps mucousal membranes moist
- Allows body's cells to grow, reproduce and survive
- Flushes body waste, mainly in urine
- Lubricates joints
- Water is the major component of most body parts
- Needed by the brain to manufacture hormones and neurotransmitters
- Regulates body temperature (sweating and respiration)
- Acts as a shock absorber for brain and spinal cord
- Converts food to components needed for survival - digestion
- Helps deliver oxygen all over the body
1. Maintenance of life - (Continued)

B) FOOD

1) Provides the body with needed nutrients

2) Needed for energy, raw building materials for growth and repair, and to regulate chemical reactions

b. Oxygen – releases energy from food

c. Heat – product of metabolic reactions and muscle movement that controls and maintains the body temperature
1. Maintenance of life - (continued)

**C) PRESSURE**

1) Force applied to something

2) Atmospheric pressure is needed for breathing

3) Hydrostatic (water) pressure is needed to move blood through blood vessels – our blood pressure

2. Both the quality and quantity of these factors are important
HOMEOSTASIS

All organisms must maintain a constant internal environment to function properly

- Temperature
- pH (acidic or basic)
- Salinity (salt level)
- Fluid levels
HOMEOSTASIS

1. Maintenance of a stable internal environment of the body is called **homeostasis**.

2. Homeostasis is regulated through control systems which have **receptors (sensors)**, a set point, and **effectors** in common.

   a. **Receptors** are of many types whose job is to monitor for changes

   b. The **set point** is the normal value or range of values

   c. **Effectors** are muscles or glands that respond to the changes to return to stability
3. Examples include:

a. **Homeostatic mechanisms** regulate body temperature in a manner similar to the functioning of a home heating/cooling thermostat.

b. Another homeostatic mechanism employs pressure-sensitive receptors to regulate blood pressure.

4. Each individual uses homeostatic mechanisms to keep body levels within a normal range; normal ranges can vary from one individual to the next.
5. Many of the body's homeostatic controls are **negative feedback** mechanisms.

   a. Responses move in the opposite direction from the change

   b. Reduces the amount of change from the set point

   c. Includes most control mechanisms in the body
Body temperature falls

Blood vessels constrict so that heat is conserved. Sweat glands do not secrete fluid. Shivering (involuntary contraction of muscles) generates heat, which warms the body.

Body temperature rises

Blood vessels dilate, resulting in heat loss to the environment. Sweat glands secrete fluid. As the fluid evaporates, heat is lost from the body.

Normal body temperature

Heat is retained

Heat is lost to the environment

Stimulus
Body temperature drops below set point.

Receptors
Thermoreceptors send signals to the control center.

Control center
The brain detects the deviation from the set point and signals effector organs.

Effectors
Skin blood vessels constrict (decreasing skin blood flow) and sweat glands remain inactive.

Effectors
Skin blood vessels dilate (increasing skin blood flow), and sweat glands secrete.

Response
Body heat is lost to surroundings, temperature returns toward set point.

Stimulus
Body temperature rises above set point.

Normal body temperature
37°C (98.6°F)

too high
too low

Response
Body heat is conserved, temperature returns toward set point.

Effectors
Muscle activity generates body heat.

Control center
The brain detects the deviation from the set point and signals effector organs.

If body temperature continues to drop, control center signals muscles to contract involuntarily.
6. **Positive feedback** mechanisms

   a. Response moves further from the set point

   b. Change from set point gets larger

   c. Many positive feedback mechanisms produce unstable conditions in the body which eventually go back to normal.

   d. Examples associated with normal health

      1) Blood clotting

      2) Birth
<table>
<thead>
<tr>
<th>Internal Stimulus</th>
<th>Primary Organ Systems Involved</th>
<th>Functions of the Organ Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body temperature</strong></td>
<td>Integumentary system</td>
<td>Heat loss</td>
</tr>
<tr>
<td></td>
<td>Muscular system</td>
<td>Heat production</td>
</tr>
<tr>
<td></td>
<td>Cardiovascular system</td>
<td>Heat distribution</td>
</tr>
<tr>
<td></td>
<td>Nervous system</td>
<td>Coordination of blood flow, heat production, and heat loss</td>
</tr>
<tr>
<td><strong>Body fluid composition</strong></td>
<td>Digestive system</td>
<td>Nutrient absorption, storage, and release</td>
</tr>
<tr>
<td>Nutrient concentration</td>
<td>Cardiovascular system</td>
<td>Nutrient distribution</td>
</tr>
<tr>
<td></td>
<td>Urinary system</td>
<td>Control of nutrient loss in the urine</td>
</tr>
<tr>
<td></td>
<td>Skeletal system</td>
<td>Mineral storage and release</td>
</tr>
<tr>
<td>Oxygen, carbon dioxide levels</td>
<td>Respiratory system</td>
<td>Absorption of oxygen, elimination of carbon dioxide</td>
</tr>
<tr>
<td></td>
<td>Cardiovascular system</td>
<td>Internal transport of oxygen and carbon dioxide</td>
</tr>
<tr>
<td>Levels of toxins and pathogens</td>
<td>Lymphatic system</td>
<td>Removal, destruction, or inactivation of toxins and pathogens</td>
</tr>
<tr>
<td><strong>Body fluid volume</strong></td>
<td>Urinary system</td>
<td>Elimination or conservation of water from the blood</td>
</tr>
<tr>
<td></td>
<td>Digestive system</td>
<td>Absorption of water; loss of water in feces</td>
</tr>
<tr>
<td></td>
<td>Integumentary system</td>
<td>Loss of water through perspiration</td>
</tr>
<tr>
<td></td>
<td>Cardiovascular system and lymphatic system</td>
<td>Distribution of water throughout body tissues</td>
</tr>
<tr>
<td><strong>Waste concentration</strong></td>
<td>Urinary system</td>
<td>Excretion of wastes from the blood</td>
</tr>
<tr>
<td></td>
<td>Digestive system</td>
<td>Elimination of wastes from the liver in feces</td>
</tr>
<tr>
<td></td>
<td>Cardiovascular system</td>
<td>Transport of wastes products to sites of excretion</td>
</tr>
<tr>
<td><strong>Blood pressure</strong></td>
<td>Cardiovascular system</td>
<td>Pressure generated by the heart moves blood through blood vessels</td>
</tr>
<tr>
<td></td>
<td>Nervous system and endocrine system</td>
<td>Adjustments in heart rate and blood vessel diameter can raise or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>lower blood pressure</td>
</tr>
</tbody>
</table>
1. Body Cavities - A body cavity is a space created in an organism which houses organs.

2. It is lined with a layer of cells and is filled with fluid, to protect the organs from damage as the organism moves around.

3. Body cavities form during development, as solid masses of tissue fold inward on themselves, creating pockets in which the organs develop.

4. An example of a body cavity in humans would be the cranial cavity, which houses the brain.
THE HUMAN BODY HAS TWO MAIN BODY CAVITIES

The first, the **ventral cavity**, is a large cavity which sits ventrally to the spine and includes all the organs from your pelvis to your throat.

The first subdivision is the **diaphragm muscle**, which divides the **abdomino-pelvic cavity** from the **thoracic cavity**. This can be seen in the image below.
The abdomino-pelvic cavity is then further subdivided into the pelvic cavity and the abdominal cavity.

The abdominal cavity is where the majority of the body’s organs lie. These are sometimes referred to as the “viscera”, and they include organs like the liver, stomach, spleen, pancreas, kidneys and others involved in digestion, metabolism, and filtering of the blood.

The pelvic cavity holds the reproductive organs, bladder, and allows the intestines passage to the anus.

A special membrane holds all of these organs in place and is called the peritoneum.
Smaller cavities within the head include the oral cavity, nasal cavity, orbital cavities (eye sockets), and middle ear cavities.
THE 11 BODY (ORGAN) SYSTEMS
When groups of tissues work together, they are called organs. Some examples of organs are the heart, lungs, skin, and stomach.

When organs work together, they are called systems and each one depends, directly or indirectly, on all of the others..

**The 11 organ systems of the body** are:

- Integumentary (skin)
- Muscular
- Skeletal
- Nervous
- Circulatory
- Lymphatic
- Respiratory
- Endocrine
- Urinary/Excretory
- Reproductive
- Digestive.
All of your body systems have to work together to keep you healthy. If any system in your body isn't working properly, other systems are affected

- Your **bones and muscles** work together to support and move your body.

- Your **respiratory system** takes in oxygen from the air and gets rid of carbon dioxide.

- Your **digestive system** absorbs water and nutrients from the food you eat.

- Your **circulatory system** carries oxygen, water, and nutrients to cells throughout your body.

- **Wastes from the cells** are eliminated by your respiratory system, excretory system, and skin.

- Your **nervous system** controls all these activities with electrical impulses.
<table>
<thead>
<tr>
<th>System</th>
<th>Major structures</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circulatory</td>
<td>Heart, blood vessels, blood (cardiovascular) lymph nodes and vessels, lymph (lymphatic)</td>
<td>Transports nutrients, wastes, hormones, and gases</td>
</tr>
<tr>
<td>Digestive</td>
<td>Mouth, throat, esophagus, stomach, liver, pancreas, small and large intestines</td>
<td>Extracts and absorbs nutrients from food; removes wastes; maintains water and chemical balances</td>
</tr>
<tr>
<td>Endocrine</td>
<td>Hypothalamus, pituitary, pancreas and many other endocrine glands</td>
<td>Regulates body temperature, metabolism, development, and reproduction; maintains homeostasis; regulates other organ systems</td>
</tr>
<tr>
<td>Excretory</td>
<td>Kidneys, urinary bladder, ureters, urethra, skin, lungs</td>
<td>Removes wastes from blood; regulates concentration of body fluids</td>
</tr>
<tr>
<td>Immune</td>
<td>White blood cells, lymph nodes and vessels</td>
<td>Defends against pathogens and disease</td>
</tr>
<tr>
<td>Integumentary</td>
<td>Skin, nails, hair</td>
<td>Protects against injury, infection, and fluid loss; helps regulate body temperature</td>
</tr>
<tr>
<td>Muscular</td>
<td>Skeletal, smooth, and cardiac muscle tissues</td>
<td>Moves limbs and trunk; moves substances through body; provides structure and support</td>
</tr>
<tr>
<td>Nervous</td>
<td>Brain, spinal cord, nerves, sense organs</td>
<td>Regulates behavior; maintains homeostasis; regulates other organ systems; controls sensory and motor functions</td>
</tr>
<tr>
<td>Reproductive</td>
<td>Testes, penis (in males); ovaries, uterus, breasts (in females)</td>
<td>Produces gametes and offspring</td>
</tr>
<tr>
<td>Respiratory</td>
<td>Lungs, nose, mouth, trachea</td>
<td>Moves air into and out of lungs; controls gas exchange between blood and lungs</td>
</tr>
<tr>
<td>Skeletal</td>
<td>Bones and joints</td>
<td>Protects and supports the body and organs; interacts with skeletal muscles, produces red blood cells, white blood cells, and platelets</td>
</tr>
</tbody>
</table>
There are 11 main systems that keep our bodies functioning. Learn the primary roles of each in the diagram below.

- **Endocrine**: Regulation of body processes through hormone production.
- **Nervous**: Processing center for sensory input, using the input to elicit appropriate responses.
- **Respiratory**: Gas exchange between the internal and external environment.
- **Cardiovascular**: Circulation of blood, which transports gases, nutrients, hormones, and wastes.
- **Digestive**: Physical and chemical breakdown of food to allow absorption of nutrients.
- **Lymphatic**: Circulation of lymph, which maintains fluid balance and helps fight infection.
- **Reproductive**: Production of reproductive cells that will generate offspring.
- **Urinary**: Filtration of blood and excretion of wastes from the body.
- **Integumentary**: Protection against the external environment and regulation of temperature.
- **Skeletal**: Support and protection of many internal organs.
- **Muscular**: Voluntary and involuntary movement.
1) **INTEGUMENTARY SYSTEM (SKIN)**

Forms the external body covering and protects deeper tissues from injury.

Synthesizes vitamin D, and contains cutaneous (pain, pressure, etc.) receptors and sweat and oil glands.
2. Support and Movement
   (2 Parts)

A) The **skeletal system** is made up of bones and ligaments.

It supports, protects, provides frameworks, stores inorganic salts, and houses blood-forming tissues.
B) The **muscular system** consists of the muscles that provide body movement, posture, and body heat.
3. Integration and Coordination (2 parts)

A) The **nervous system** consists of the brain, spinal cord, nerves, and sense organs.

It integrates incoming information from receptors and sends impulses to muscles and glands.
B) The endocrine system, includes the hypothalamus, pituitary, thyroid, parathyroid, pineal, and thymus glands, pancreas, ovaries, and testes, along with other organs that secrete hormones.

It helps to integrate metabolic functions.
4. Transport (2 parts)

A) The **cardiovascular system**, is made up of the heart and blood vessels.

It distributes oxygen, nutrients, and hormones throughout the body while removing wastes from the cells.
B) The **lymphatic system**, consists of lymphatic vessels, lymph nodes, thymus, and spleen.

It drains excess tissue fluid and includes cells of immunity.
5. Absorption and Excretion (3 parts)

A) The **digestive system** is made up of the mouth, esophagus, stomach, intestines, and accessory organs.

It receives, breaks down, and absorbs nutrients.
B) The **Respiratory system** exchanges Oxygen and Carbon Dioxide between the blood and air and is made up of the lungs and passageways.
C) The **Urinary system**, consists of the kidneys, ureters, bladder, and urethra.

It removes wastes from the blood and helps to maintain water and electrolyte balance.
6) The **Reproductive system** produces new organisms.

A) The male reproductive system consists of the testes, penis, accessory organs, and vessels that produce and conduct sperm to the female reproductive tract.

B) The female reproductive system consists of ovaries, uterine tubes, uterus, vagina, and external genitalia.

She produces egg cells and also houses the developing baby.

5 minute video
[https://www.youtube.com/watch?v=Ae4MadKPJC0](https://www.youtube.com/watch?v=Ae4MadKPJC0)
WHAT IS YOUR BODY TYPE?

Ectomorph

Endomorph

Mesomorph
# Diagnostic Imaging Techniques and Microscopy methods

<table>
<thead>
<tr>
<th>Main characteristic</th>
<th>CT</th>
<th>MRI</th>
<th>PET</th>
<th>SPECT</th>
<th>Ultrasound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example</td>
<td><img src="image" alt="CT Example" /></td>
<td><img src="image" alt="MRI Example" /></td>
<td><img src="image" alt="PET Example" /></td>
<td><img src="image" alt="SPECT Example" /></td>
<td><img src="image" alt="Ultrasound Example" /></td>
</tr>
<tr>
<td>Scan body organs using X-rays and produce a series of cross-sectional based images via the computer</td>
<td>Produce “slices” that represents the human body through applying magnetic signals</td>
<td>Nuclear imaging technique example where the tracers are used in diseases diagnosis</td>
<td>A non-invasive based technique where cross-sectional images of radiotracer within the human body are structured</td>
<td>Sound waves based technique that possesses a high temporal frequency and which is capable of producing quantitative and qualitative diagnostic information through a set of comprised methodologies</td>
<td></td>
</tr>
</tbody>
</table>
What is Diagnostic Imaging?

Diagnostic imaging refers to technologies that doctors use to look inside your body for clues about a medical condition.

Different machines and techniques can create pictures of the structures and activities inside your body.

They are great because they are not invasive.
TYPES OF DIAGNOSTIC IMAGING

1. The technology your doctor uses will depend on your symptoms and the part of your body being examined.

2. Types of diagnostic imaging include:

   - X-rays
   - CT scans (Computed Tomography) previously called CAT scans – (Computed Axial Tomography)
   - Nuclear medicine scans
   - MRI scans (Magnetic Resonance Imaging)
   - Ultrasound
   - PET/CT (Positron Emission Tomography/ Computed Axial Tomography)
The X-ray Shoe Fitting machine

Shoe fitting x-ray machines were common in department stores in the late 1940’s and early 1950’s. It produced an image of how your shoe fit which you could look at and see your toe bones move as you wiggled them.

By the 1970s, the radiation hazard of the shoe fitting x-ray was realized, eliminating its use as a shoe fitting device.
X-ray

1. Used to look for broken bones, problems in your lungs and abdomen, cavities in your teeth and many other problems.

2. X-ray technology uses electromagnetic radiation to make images. The image is recorded on a film, called a radiograph.

3. Calcium in bones absorbs X-rays the most, so bones look white on the radiograph. Fat and other soft tissues absorb less and look gray. Air absorbs the least, so lungs look black.

4. X-ray examination is painless, and the amount of radiation exposure you receive during an X-ray examination is small.
Projectional radiography

- X-ray generator
- Object
- X-ray detector

Radiograph
X-rays are moving from film to digital files with both computed radiography and digital radiography.

This saves costs and the time to develop the x-ray films.
Scintigraphy, also known as a Gamma scan, is a diagnostic test in nuclear medicine, where radioisotopes attached to drugs that travel to a specific organ or tissue (radiopharmaceuticals) are taken internally and the emitted gamma radiation is captured by external detectors to form **two-dimensional images** in a similar process to the capture of x-ray images.

Hand radiography and bone scintigraphy findings in rheumatoid arthritis
Computed Tomography (CT) Scans

1. Computed tomography (CT) (or Computed Axial Tomography (CAT) scans are a diagnostic procedure that uses special X-ray equipment to create cross-sectional pictures of your body.

2. CT images are produced using X-ray technology and powerful computers.

3. The uses of CT include looking for:
   - Broken Bones
   - Cancer
   - Blood Clots
   - Signs of Heart Disease
   - Internal Bleeding
During a CT scan, you lie still on a table. The table slowly passes through the center of a large X-ray machine.

The test is painless. During some tests you receive a contrast dye, which makes parts of your body show up better in the image.
CT scan of the abdomen

CT (computed tomography) scans use computers to reconstruct sectional views.

The x-ray source completes one revolution around the body every few seconds. It then moves a short distance and repeats the process.
SPIRAL CT SCAN

A spiral CT scan is a form of three-dimensional imaging technology.

During a spiral CT scan, the patient is on a platform that advances at a steady pace through the scanner while the imaging source, usually x-rays, rotates continuously around the patient.

With this method, a higher quality image is generated, and the patient is exposed to less radiation.
3D reconstruction of CT Scan.
Objects are packets of cocaine.
PET scan of the brain

Positron emission tomography (PET) is an imaging technique that assesses metabolic and physiological activity of a structure.

A PET scan is an important tool in evaluating healthy or diseased brain function.
NUCLEAR SCANS USING A PET (POSITRON EMISSION TOMOGRAPHY) SCANNING PROCESS

1. Nuclear scanning uses radioactive substances to see structures and functions inside your body.

2. Nuclear scans involve a special camera that detects energy coming from the radioactive substance, called a tracer.

3. Before the test, you receive the tracer, often by an injection. Although tracers are radioactive, the dosage is small.
During most nuclear scanning tests, you lie still on a scanning table while the camera makes images.

Most scans take 20 to 45 minutes.

Nuclear scans can help doctors diagnose many conditions, including cancers, injuries and infections.

They can also show how organs like your heart and lungs are working.
Magnetic Resonance Imaging (MRI)

1. MRI’s do not use X-rays

2. Magnetic resonance imaging (MRI) uses a large magnet and radio waves to look at organs and structures inside your body.

3. Health care professionals use MRI scans to diagnose a variety of conditions, from torn ligaments, tumors, the brain, and spinal cord.
GE MRI SYSTEM

**MAGNET**
- Magnetic field
  - Aligns the nuclei of atoms inside the patient and a variable magnetic field that causes nuclear magnetic resonance.

**GRADIENT COILS**
- Gradient field
  - Precisely positioned conductive coils that deliberately vary the magnetic field

**RADIO FREQUENCY COIL**
- RF signal
  - Transmits and receives radiofrequency (RF) signals in the body.

**PATIENT TABLE**
- Supports and transfers patient for imaging examination.

**SYSTEM PROCESS**
- High performance electronics and computer.
1. During an MRI, the patient may be given an injectable contrast, or dye.

2. This contrast alters the local magnetic field.

3. Normal and abnormal tissue will respond differently to this contrast.
A magnetic resonance imaging scan, more commonly known as an MRI scan, is a detailed cross-sectional image of a part of the body.

It is similar to a CT scan, but has a higher quality, so it is easier to see differences in tissues, as shown in the picture below.

[CT and MRI images]

WHAT IS THE DIFFERENCE BETWEEN A MRI AND A CT SCAN?
https://www.youtube.com/watch?v=aQZ8tTZnQ8A
1. Ultrasound uses high-frequency sound waves to look at organs and structures inside the body.

2. Health care professionals use them to view the heart, blood vessels, kidneys, liver and other organs.

3. During pregnancy, doctors use ultrasound tests to examine the fetus.

4. Unlike x-rays, ultrasound does not involve exposure to radiation.
During an Ultrasound test, a special technician or doctor moves a device called a transducer over part of your body.

The transducer sends out sound waves, which bounce off the tissues inside your body.

The transducer also captures the waves that bounce back.

Images are created from these sound waves.

All Ultrasound is going toward real-time 3-D images.
ECHOCARDIOGRAPHY - When ultrasound is used to image the heart, it is referred to as an echocardiogram.

Echocardiography is a safe way to see detailed structures of the heart, including chamber size, heart function, the valves of the heart, as well as the pericardium (the sac around the heart).

It is a great method for those experiencing shortness of breath or chest pain, to those undergoing cancer treatments.

It is one of the most commonly used imaging methods in the world due to its portability and use in a variety of applications.
1. A PET/CT scan not only helps doctors locate a lesion more accurately (CT), but it also helps determine how active the lesion is on the molecular level (PET).

2. A lesion is any damage or abnormal change in the tissue of an organism, usually caused by disease or trauma.
PALPATION is the practice of feeling the stiffness of a patient's tissues with the practitioner's hands.

Manual palpation dates back at least to 1500 BC, with the Egyptian Ebers Papyrus and Edwin Smith Papyrus, both giving instructions on diagnosis with palpation.

In a breast self-examination, women look for hard lumps, as cancer is usually stiffer than healthy tissue.

Manual palpation, however, suffers from several important limitations: it is limited to tissues accessible to the physician's hand, it is distorted by any intervening tissue, and it is qualitative but not quantitative.

Elastography, the measurement of tissue stiffness, seeks to address these challenges.
ELASTOGRAPHY

Elastography is a relatively new imaging process that maps the elastic properties of soft tissue. It emerged in the last 20 years.

It is useful in medical diagnoses, as elasticity can discern healthy from unhealthy tissue for specific organs/growths.

For example, cancerous tumors will often be harder than the surrounding tissue, and diseased livers are stiffer than healthy ones.

While not visible on conventional grayscale ultrasound (left), a strain elastography image (center) of the prostate gland detects a cancer (dark red area at lower left). The finding is confirmed by histology.
Conventional ultra-sonography (lower image) and elastography (supersonic shear imaging; upper image) of papillary thyroid carcinoma, a malignant cancer. The cancer (red) is much stiffer than the healthy tissue.
ELECTRICAL ACTIVITY - Sensor pads applied to the skin detect electrical signals coming from active muscles and nerves.

The signals are coordinated, amplified, and displayed as a real-time trace, usually a spiky or wavy line.

This technique includes electrocardiography (ECG) of the heart and electro-encephalography (EEG) of the brain’s nerve activity.
**FLUOROSCOPY**

While other tests are comparable to still photography, a fluoroscopy is like a motion picture of bodily functions. That’s because it shows moving body parts.

The procedure is often done with contrast dyes, which show how they flow through the body. While all of this is being done, an X-ray beam sends signals to a monitor.

Fluoroscopies are used to evaluate both hard and soft tissue, including bones, joints, organs and vessels. Blood flow exams often involve fluoroscopy.
Thoracic fluoroscopy using handheld fluorescent screen in 1909. No radiation protection is used, as the dangers of X-rays were not yet recognized.
ENDOSCOPY - A variety of telescope-like endoscopes are inserted through natural orifices or incisions to produce images of the body’s interior, using their own light source.

Some types are rigid, but many are flexible, utilizing fiberoptic technology, and can be bent and controlled as they are guided along.

They carry their own light source and may be equipped with tubes to introduce or remove fluids or gases, blades for surgery, forceps to take samples (biopsy), and perhaps a laser to cauterize damaged tissue.

Endoscopes have been developed to fit different body parts – a bronchoscope for the airways, a gastroscope for the oesophagus and stomach, a laparoscope for the abdomen, and a proctoscope for the lower bowel.

A typical endoscope
<table>
<thead>
<tr>
<th>Type of endoscope</th>
<th>Put in through</th>
<th>Body part or area(s) looked at</th>
<th>Name(s) of procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthroscope</td>
<td>Cuts in the skin</td>
<td>Joints</td>
<td>Arthroscopy</td>
</tr>
<tr>
<td>Bronchoscope</td>
<td>Mouth or nose</td>
<td>Trachea (windpipe) and bronchi (tubes going to the lungs)</td>
<td>Bronchoscopy, flexible bronchoscopy</td>
</tr>
<tr>
<td>Colonoscope</td>
<td>Anus</td>
<td>Colon and large intestine</td>
<td>Colonoscopy, lower endoscopy</td>
</tr>
<tr>
<td>Cystoscope</td>
<td>Urethra</td>
<td>Bladder</td>
<td>Cystoscopy, cystourethroscopy</td>
</tr>
<tr>
<td>Enteroscope</td>
<td>Mouth or anus</td>
<td>Small intestine</td>
<td>Enteroscopy</td>
</tr>
<tr>
<td>Esophagogastro-duodenoscope</td>
<td>Mouth</td>
<td>Esophagus (swallowing tube), stomach, and duodenum (first part of small intestine)</td>
<td>Esophagogastro-duodenoscopy (EGD), upper endoscopy, panendoscopy, gastroscopy</td>
</tr>
</tbody>
</table>
## Capsule Endoscopy

Devices used to perform endoscopy operations

<table>
<thead>
<tr>
<th>Capsule</th>
<th>PillCam® SB 3 Given Imaging</th>
<th>EndoCapsule® Olympus America</th>
<th>MiroCam® IntroMedic Company</th>
<th>OMOM® Jinshan Science and Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size</strong></td>
<td>Length: 26.2 mm Diameter: 11.4 mm</td>
<td>Length: 26 mm Diameter: 11 mm</td>
<td>Length: 24.5 mm Diameter: 10.8 mm</td>
<td>Length: 27.9 mm Diameter: 13 mm</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>3.00g</td>
<td>3.50g</td>
<td>3.25-4.70g</td>
<td>6.00g</td>
</tr>
<tr>
<td><strong>Battery life</strong></td>
<td>8 hours or longer</td>
<td>8 hours or longer</td>
<td>11 hours or longer</td>
<td>6-8 hours or longer</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>340x340</td>
<td>512x512</td>
<td>320x320</td>
<td>640x480</td>
</tr>
<tr>
<td><strong>Frames per second</strong></td>
<td>2 fps or 2-6 fps</td>
<td>2 fps</td>
<td>3 fps</td>
<td>2 fps</td>
</tr>
<tr>
<td><strong>Field of view</strong></td>
<td>156°</td>
<td>145°</td>
<td>170°</td>
<td>140°</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>Radio frequency communication</td>
<td>Radio frequency communication</td>
<td>Human body communication</td>
<td>Radio frequency communication</td>
</tr>
<tr>
<td><strong>FDA approval</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Price per capsule</strong></td>
<td>$500</td>
<td>$500</td>
<td>$500</td>
<td>$250</td>
</tr>
</tbody>
</table>

* 25 mm (millimeters) = 1 inch
PLEASE STARE INTO MY EYES FOR ONE MINUTE
THEN SCROLL DOWN.

THANK YOU, YOUR CAT SCAN IS NOW COMPLETED.
BIBLIOGRAPHY

Wikipedia – Diagnostic Imaging

Diagnostic Imaging - Techniques & Treatments slide presentation – by Juliane Monko & Dr. Frank Flanders - CTAE Resource Network


Photo on slide 27 - By Andreaslorenzcommon - Own work, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=32760628
Microscopes

Magnification: refers to the microscope’s power to increase an object’s apparent size

Resolution: refers to the microscope’s power to show detail clearly

Light microscope like this one have a magnification range up to 1,000 times
Light Microscope

- 10x Widefield Eyepiece
- 360 Rotating Head
- Objective Lens 4x, 10x, 40x
- Stage
- Course & Fine Focusing
- Light Source

Diagram:
- Eye
- Final Image
- Eyepiece
- Projector Lens
- Objective
- Specimen
- Condenser Lens
- Light
Light Microscope

Elodea - Aquatic Plant

40X  400X
TYPES OF MICROSCOPES

Light microscopy (LM) uses magnifying lenses to focus light rays.

In light microscopy, light passes through a thin section of material and enlarges it up to 2,000 times.

Higher magnifications are achieved with beams of subatomic particles called electrons, with scanning electron microscopy (SEM) – 20 to 100,000 times. The beam runs across a specimen coated with gold film. Electrons bounce off the surface contours, to create a three-dimensional image, as shown below.

SALT GRAINS

DAISY POLLEN GRAINS
Electron microscopes produce an image of a specimen by using a beam of electrons rather than a beam of light, which produces much higher-resolution images. It has magnitude of 10,000x or more. They can be used to visualize the subcellular structures of the cells.

Electron microscopy can be of two types:

**Scanning electron microscope (SEM)**

**Transmission electron microscope (TEM)**

THE FIRST TIME THAT AN ATOM COULD BE SEEN WITH A MICROSCOPE WAS IN 1983 – 36 YEARS AGO!!

ZOOMING INTO A HAIR
https://www.youtube.com/watch?v=r0IK46rL6Ec
Microscopes

Light Microscopes
- Compound Microscopes
  - A fine slice or section of specimen required
  - Light passes through specimen
  - Image appears 2D
  - Stains are often required to see detail
- Stereo Microscopes
  - Whole or parts of specimen can be viewed
  - Light bounces off surface of specimen
  - Image appears 3D
  - Viewed with natural colours

Electron Microscopes
- Scanning Electron Microscopes
  - Whole or parts of specimen can be viewed
  - Electrons bounce off surface and are detected
  - Image appears 3D
  - Image in greyscale, but can be coloured
- Transmission Electron Microscopes
  - A very fine section of specimen required
  - Electrons pass through and interact with specimen
  - Image appears 2D
  - Image in greyscale but can be coloured later
Scanning Electron Microscope (SEM)
Scanning Electron Microscope (SEM)
Scanning Electron Microscope (SEM)

Mosquito Head

200X  2000X
Scanning Electron Microscope (SEM)

Fly Eye
Scanning Electron Microscope (SEM)

Neuron

Surface of Tongue

Inside of Stomach
Scanning Electron Microscope (SEM)

Yeast

Pollen

Red Blood Cell, Platelet, and White Blood Cell
Transmission Electron Microscope (TEM)
Transmission Electron Microscope (TEM)

Herpes Virus

Plant Root Cell
TEM vs. SEM

Viruses leaving a cell
TRANSMISSION CRYO-ELECTRON MICROSCOPY
The Microscope

- A Cryo-EM is a **TEM** with an additional specimen holder which:
  - Enable the viewing of the frozen-hydrated specimen
  - Maintains Liquid Nitrogen or Liquid Helium temperatures

(The EM stands for Electron Microscopy)
Specimen Preparation

- Two methods of specimen preparation are:
  - **Thin Film**: Specimen is placed on EM grid and is rapidly frozen without crystallizing it
  - **Vitreous Sections**: Larger samples are vitrified by high pressure freezing, cut thinly and placed on the EM grid

https://www.youtube.com/watch?v=BJKkC0W-6Qk
THE END
WITH A LONG ZOOM INTO A TOOTH !!
https://www.youtube.com/watch?v=t4RgBZlKlJI