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# BIOLOGY

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## PHOTOSYNTHESIS

### Stomata

- Macro view of a leaf
- Close up of stomata with night and day option
- Close up of the cells in the leaf

### Photosynthesis

- The chemical reaction in one cell
- Cells dividing

### Chloroplast

- Close up of the chloroplast
- The inside of the chloroplast
- Chloroplast outer membrane
- Chloroplast inner membrane
- Stroma lamellae
- Stroma
- Granum
- Thylakoid

## THE HUMAN BODY

### Digestive System

- The intestines
  - Stomach
  - Small and large intestines
  - Esophagus
- The gallbladder
  - Gallbladder orientation and macro view
- The liver
  - The liver orientation and macro view
- The pancreas
  - The pancreas orientation and macro view
- Digestion
  - The liver, the stomach, large and small intestines and esophagus
  - Cut section of the small intestines
  - Cut section of the stomach
  - Stomach acid
  - Inside of small intestines
  - Villi and cut plane of villi

- Fatty acid protein chain that becomes amino acids, carbohydrates and where they go
- Protein broken down in to amino acids by micro villi
- Amino acids journey from villi to liver
- Chewing
- Human salivary amylase
- Starch
- Maltodextrin
- Swallow movement
- Esophagus muscle movement (Peristalsis)
- Stomach cells (surface epithelium, lamina propria and musclaris mucosae)
- Gastric pits
- Gastric glands
- Parietal cell
- Chief cell
- Enteroendocrine cell
- HCl (Hydrochloric acid/Hydrogen chloride), Pepsinogen, Pepsin, proteins and amino acids
- Chyme
- Bolus
- Stomach movement

## Lymphatic System

- Lymphatic system
  - Lymphatic system orientation and macro view
- The spleen
  - The spleen orientation and macro view

## Urinary System

- The kidneys
  - Structure
  - The kidneys orientation and macro view
  - The kidneys attached to the arterial tree
  - Adrenal gland, cortex, hilus, renal pelvis, renal vein, renal artery, medulla
- Medulla
  - Medullas
  - Renal pelvis
- The Nephron
  - Bowman's capsule
  - Loop of Henle
  - Collecting duct
  - Glomerulus
  - Proximal tubule

- Bowman's capsule
  - Bowman's capsule (close up)
  - Glomerulus (close up)
  - Loop of Henle (close up)
- Glomerulus
  - Inside of glomerulus (journey)
  - Primary urine (follow it out of the blood stream)

## Cardiovascular System

- The lungs
  - Lung lobes
  - Lung sacs
  - Muscles
  - Skeleton
  - Heart
  - Intestines
  - Liver
  - Stomach
  - Diaphragm
  - Accessory muscles
  - Intercostal muscles
  - Punctured lungs
  - Normal breathing schematic view
  - FRC – amount of air remaining after normal breath, schematic
  - Trachea
  - Bronchus
  - Tertiary bronchus
  - Bronchiole
  - Laryngeal
  - Upper respiratory tract
  - Journey following a breath of air from the outside of the body all the way to the alveoli
  - Alveoli (outside)
  - Alveoli (inside)
  - Alveolus
  - Gas exchange (cut plane alveolus and capillary)
  - O<sub>2</sub> traveling in to bloodstream
  - CO<sub>2</sub> traveling from bloodstream to alveolus
  - H<sub>2</sub>O traveling from bloodstream to alveolus
  - Blood cell
  - Hemoglobin
  - Hemoglobin attracting O<sub>2</sub> and releasing O<sub>2</sub>
  - Hemoglobin attracting CO<sub>2</sub> and releasing CO<sub>2</sub>

- Journey following a breath of air from the alveoli all the way to the outside of the body
- Pulmonary circulation (macro)
- Systemic circulation (macro)
- Cilia (on cells)
- Transportation from bronchus
- Mucus (and mucus producing cells)
- Smoking
- Damaged transportation system in bronchus
- Damaged alveoli
- Emphysema
- The Heart
  - Heart (outside)
  - Heart (inside, dynamic cut plane)
  - Rib cage
  - Lung lobes
  - Right and left ventricle
  - Right and left atrium
  - Aortic valve
  - Pulmonary valve
  - Tricuspid valve
  - Mitral valve
  - Inferior vena cava
  - Superior vena cava
  - Pulmonary artery
  - Aorta
  - Coronary vessels
  - Pulmonary circulation
  - Systemic circulation
- The Arterial Tree
  - Systemic circulation
  - Circulation in foot
  - Circulation in hand
  - Circulation in kidney connection
  - Circulation in head
  - Pulmonary circulation

## Nervous System and Senses

- The Eyes
  - Eyes (macro)
  - Extra ocular muscles
  - Ciliary body
  - Cornea
  - Iris

- Sclera
- Vitreous body
- Optic nerve
- Retina
- Optic disc
- Choroid
- Lens
- Aqueous
- Pupil (reaction to light)
- Color perception low light simulation
- Lens function
- Lens function simulation
- Hyperopia (function and correction)
- Myopia (function and correction)
- Hyperopia function simulation
- Myopia function simulation
- The Ears
  - Outer ear
  - Ear canal
  - Eardrum (tympanic membrane)
  - Tympanic cavity
  - Malleus
  - Incus
  - Stapes
  - Semicircular canals
  - Cochlea
  - Vestibular nerve
  - Cochlear nerve
  - Cochlear wall
  - Scala vestibuli
  - Cochlear duct
  - Scala tympani
  - Tectorial membrane
  - Basilar membrane
  - Organ of Corti
  - Spiral ganglion
  - Hair cells
  - Stereocilia (hair)
  - Sound waves
  - Sound waves simulation all the way from outside of the ear to the spiral ganglion
- The nervous system
  - The nervous system (macro)
  - Peripheral nervous system

- Human brain
- Cerebellum
- Brain Stem
- Pituitary gland
- Cerebrum
- All the lobes
- Medulla oblongata
- Mid brain
- Pons
- Hypothalamus
- Spinal nerves

## Reproduction

- Female reproduction
  - Female reproduction organ
  - Vagina
  - Body of uterus
  - Fallopian tube
  - Fimbriae
  - Ovary
- Male reproduction
  - Male reproduction organ
  - Penis
  - Prostate gland
  - Testes
  - Epididymis
  - Ductus deferens
  - Seminal vesicle
  - Urine bladder

## Anatomy

- All the muscles with see through feature
- See through skin
- Skeleton
- Lungs
- Digestion, the liver, the stomach, large and small intestines, esophagus, and gallbladder
- Urinary system
- Circulatory system
- Lymphatic system, spleen
- Nervous system
- The brain, brain stem
- The eyes
- The ears

## Skeleton and Muscles

- The skeleton
  - Skeleton (macro view)
  - Shoulder joint
  - Elbow joint
  - Hand
  - Skull and spine joint
  - Pelvis
  - Hip joint
  - Knee joint
  - Foot
- The skull
  - Skull (macro view)
- The spine
  - Spine (macro view)
  - Vertebrae
  - Vertebral discs
  - Sacrum
  - Coccyx
  - Vertebral foramen
- Muscles and movement
  - Human knee in motion
  - Four motions, bend/roll/flex/twist
  - Patella
  - Synovial membrane
  - Bursas
  - Ligaments
  - Meniscus
  - Muscles (for the whole leg including foot and hip)
  - Tibia
  - Femur
  - Fibula

## The Cells

- Cells
  - Cocci bacteria (macro view)
  - Prokaryotic cell (macro view)
  - Plant cell (macro view)
  - Animal cell (macro view)
- Endosymbiotic theory
  - Prokaryotic cell
  - Single celled organism
  - Visualization of the process

- Animal and plant cell
  - Cell membrane
  - Golgi apparatus
  - Endoplasmic reticulum
  - Nuclear envelope
  - Nucleus
  - Nucleolus
  - Vacuole 7
  - Chloroplast, inner and outer membrane, stroma lamellae, stroma, granum and thylakoid
  - Mitochondrion
  - Peroxisome
  - Chromosomes
  - DNA
  - Centrioles
  - Lysosome
  - Ribosomes
  - Vesicles
- Meiosis
  - Interphase
  - Early Prophase
  - Late Prophase
  - Metaphase
  - Anaphase
  - Telophase
  - Cytokinesis
  - Prophase II
  - Metaphase II
  - Anaphase II
  - Telophase II
  - Cytokinesis II
  - Centrioles
  - Nuclear envelope
  - Spindle fibers
  - Chromatin threads
  - Chromosomes
  - Cytoplasm
  - Centromere
- Mitosis
  - Interphase
  - Early Prophase
  - Late Prophase
  - Metaphase
  - Anaphase

- Telophase
- Cytokinesis
- Chromatin
- Threads
- Centrioles
- Asters
- Nucleolus
- Nuclear envelope
- Spindle fibers
- Chromosomes
- Cytoplasm
- Centromere

## DNA

- Structure
  - DNA double helix
  - Base pairs
  - Sugar phosphate back bone
  - Adenine
  - Thymine
  - Guanine
  - Cytosine
- G-C and T-A Molecule
  - G-C and T-A molecule with all the elements
  - Labeled elements
- Replication
  - Double helix dividing (visualization)
  - Hydrogen bonding, G-C and T-A molecules (visualization)
  - Nitrogen containing base
  - Phosphate group
  - Deoxyribose sugar
  - Helicase
  - Polymerase
- Repelling Molecules
  - G-C and T-A molecules with wrong polarity (visualization)
  - Double helix flat with one base pair with wrong polarity
  - Double helix twisted with one base pair with wrong polarity
- Transcription
  - Transcription factors
  - Activator protein
  - mRNA
  - Look inside the polymerase
  - Uracil
  - Thymine

- Adenine
- Translation
  - mRNA
  - Nucleus
  - Ribosome
  - tRNA
  - Amino acid
  - Polypeptide

## Fertility

- IVF
  - Vagina
  - Cervix
  - Uterus
  - Uterine cavity
  - Fallopian tube
  - Fimbria
  - Ovary
  - Ultrasound probe
  - Needle
  - Vesicular follicle
  - Ovary cortex
  - Ovary fluid
  - Oocyte (egg)
  - Antrum
  - Lab environment with glass for fertilization
  - Sperm penetrating egg
  - Fertilized egg
  - Embryonal development, Zygote, 2 cell stage, 4 cell stage, 8 cell stage, morula (72 hours)
  - Insertion of embryo to uterus
- Sperm
  - Sperm
  - Acrosome
  - Cell membrane
  - Nucleus
  - Centrioles
  - Mitochondria
  - Axial filament

## GEOGRAPHY

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# CLIMATE

## Temperature

- Earth
- Earth axis
- The sun with vectors
- Temperature visualization (on planet earth)
- Temperature reference
- Changes in temperature over a year (visualization)
- Interaction, all twelve months

## Precipitation

- Planet earth
- Earth axis
- The sun with vectors
- Precipitation visualization (on planet earth)
- Precipitation reference
- Changes in precipitation over a year (visualization)
- Interaction, all twelve months

## Vegetation

- Planet earth
- Equator
- Tropical lines
- The Köppen System
- Tropical/mega thermal climates (group A)
- Tropical rainforest climate (Af)
- Tropical monsoon climate (Am)
- Tropical wet and dry climates (dry season during time of higher sun and longer days) (As)
- Tropical wet and dry or savanna climate (Aw)
- Dry (arid and semiarid) climates (group B)
- Desert climate (at least one month averages below 0°C, 32°F) (BWk)
- Desert climate (coldest month has an average temperature above 0°C, 32°F) (BWh)
- Steppe climate (middle-latitude climate) (BSk)
- Steppe climate (low-latitude climate) (BSh)
- Humid subtropical (Cfa)
- Marine mild winter (Cfb)
- Marine cool winter (Cfc)
- Interior Mediterranean (Csa)
- Coastal Mediterranean (Csb)
- Dry winter, Wet summer (Cwa, Cwb, Cwc)

- Humid continental, hot summer, wet all year (Dfa)
- Humid continental, mild summer, wet all year (Dfb)
- Subarctic, cool summer, wet all year (Dfc)
- Subarctic, cold winter, wet all year (Dfd)
- Humid continental, hot summer, dry summer (Dsa)
- Humid continental, mild summer, dry summer (Dsb)
- Subarctic, cool summer, dry summer (Dsc)
- Subarctic, cold winter, dry summer (Dsd)
- Humid continental, hot summer, wet all year (Dwa)
- Humid continental, mild summer, dry winter (Dwb)
- Subarctic, cool summer, dry winter (Dwc)
- Subarctic, cold winter, dry winter (Dwd)
- Tundra (EF)
- Ice cap (ET)

## THE EARTH

### The Earth

- Earth
- Moon
- Sun
- Earth, moon and sun moving at correct speed
- All the moon phases
- Interaction with the time scale (changing time)
- Ability to produce eclipse
- Choose if you want the weather texture and moon

### The Sun, Earth and Moon

- Earth
- Moon
- Sun
- Mercury
- Venus
- Mars
- Jupiter
- Saturn
- Uranus
- Neptune
- Earth, moon and sun moving at correct speed
- All the moon phases
- Interaction with the time scale (changing time)
- Ability to produce eclipse
- Choose if you want the weather texture and moon
- Interact with planet scale (enhancing planet size)

- Orbit markers (on or off)

## The Solar System

- A correct size relevance of the planets in the solar system
- The Sun
- The Earth
- The Moon
- Mercury
- Venus
- Mars
- Jupiter
- Saturn
- Uranus
- Neptune

## EARTH'S INTERIOR

### Earth's interior

- Planet earth without weather structure and with daylight all over
- Planet earth cut in half, visible inside
- Crust
- Mantle
- Outer core
- Inner core
- Comparing the thickness of the different layers
- Crust (0-100 km thick)
- Mantle (100-2900 km deep, 2000-3000°C)
- Outer core (2900-5100 km deep, 3800°C)
- Inner core (5100-6378 km deep, 6000°C)
- Planet earth cut in half and the different layers split apart

### Tectonic plates

- All tectonic plates, how the tectonic plates move, color separation to distinguish the different plates

### Strato Volcano

- Outside structure of a strato volcano, inside view, magma chamber, vent, blocked vent, cone, crater, ash and steam, eruption

## PHYSICS

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### FISSION AND FUSION

## Fission

- Nuclear chain reaction
- Uranium atoms
- Bromine atoms
- Krypton atoms
- Fission formula

## Nuclear power

- Nuclear reactor (BWR)
- Uranium atom
- Bromine atom
- Krypton atom
- Boron atoms
- Control rods
- Fuel rods
- Fission formula

## Nuclear reactor (Boiling water reactor)

- Boiling water reactor
- Control rods
- Fuel rods

## Nuclear reactor (Pressurized water reactor)

- Pressurized water reactor
- Control rods
- Fuel rods

## Fusion – The sun

- The sun
- Cut section of the sun
- Fusion reaction within the sun
- Hydrogen atoms
- Helium atoms
- Positron
- Neutrino
- Gamma ray

## RADIATION

### Alpha decay

- Uranium-238
- Alpha particle (Helium)
- Thorium-234

## Beta decay

- Carbon-14
- Beta particle (electron)
- Anti-neutrino
- Nitrogen-14

## Gamma decay

- Caesium-137
- Gamma ray

## Alpha, beta and gamma radiation

- Piece of paper
- Wooden plank
- Block of lead
- Alpha particle
- Beta particle
- Gamma ray

## NEWTON'S LAW

### Forces

- Block on a plane
- Interaction, change gravity and mass
- Arrows symbolizing force
- Equation for the action
- $F_g = m \times g$  (changes with input of force)

### Parallel Forces

- Block on a plane
- Interaction, change  $F_1$  (force one) and  $F_2$  (force two)
- Force arrows with labels ( $F_1$ ,  $F_2$ , Res)
- Resultant
- Equation for the action
- $F_{res} = F_1 + F_2$
- Show acceleration
- Show constant speed
- Show deceleration

## REFRACTION

## Refraction

- Light waves
- Light waves through concave lens
- Light waves through convex lens

## Human Eye

- Human eye
- Light waves through eye lens
- Light waves through concave lens and eye lens
- Light waves through eye lens
- Light waves through convex lens and eye lens

# CHEMISTRY

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## ISOTOPES

### Isotopes - Hydrogen

- Hydrogen-1
- Hydrogen-2 (Deuterium)
- Hydrogen-3 (Tritium)
- Designations

### Isotopes - Carbon

- Carbon-12
- Carbon-13
- Carbon-14
- Designations

### Isotopes - Lead

- Lead-204
- Lead-205
- Lead-206
- Lead-207
- Lead-208
- Designations

### Isotopes - Uranium

- Uranium-235
- Uranium-236
- Uranium-237
- Uranium-238

- Designations

## WATER

### Water molecule

- One H<sub>2</sub>O molecule
- Many H<sub>2</sub>O molecules

### Liquid

- Water molecules (liquid water)
- Hydrogen bonding with the molecules

### Solid

- Water molecules (solid water - ice)
- Hexagonal crystalline structure due to hydrogen bonding
- Interaction, from zero degrees Celsius to 273,15 degrees Celsius (absolute zero, zero degrees Kelvin)

## THE PERIODIC TABLE

### Periodic Table

- The periodic table
- All the elements as an atom (interaction choose any element)
- Electrons
- Neutrons
- Protons
- Atom numbers
- Mass numbers
- Electron shells for each atom
- Correct number of valence electrons for each atom

### Atomic structure

- Animated oxygen atom with electrons

## CHEMICAL BONDS

### Ionic bonds - NaCl

- Water, Na and Cl in water, the reaction, electrons, vaporation, change in polarization, structure of NaCl molecules, salt crystals, salt

### Covalent Bond – H<sub>2</sub>O

- Oxygen atom with protons, neutrons and electrons
- Hydrogen atom with proton and electron

- Bonding with shared electrons in valence shell
- Rejection of bonding when valence shell is full

## MATHEMATICS

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### GEOMETRY

#### Points

- Cross, visualizing a position in universe
- Point, interaction removing the cross
- Interaction, fill the space with points

#### Lines

- A line, visualizing a line with no beginning and no end
- A direction

#### Rays

- A ray, visualizing a line that begins in a point

#### Line Segment

- Two points
- Filling up the distance between the points

#### Angles

- Protractor
- Angle
- Interaction, choose angle
- Change the angle
- Angle degrees in numbers
- Graphic reference of angle

#### Corresponding angles

- Protractor
- Two parallel base lines
- Interaction, choose angles
- Change the angles
- Angles degrees in numbers
- Graphic reference of angles

#### Area

- Two points

- Line segment
- Break up into four other points
- Rectangle
- Filling of the square with small rectangles
- Twist to show that area has no height
- Empty the square (area is not physical)

## Volume

- Four points
- Two line segments
- Break up into four new points for each line segment
- Build up the walls
- Cube
- Fill the cube with smaller cubes

## Pythagorean Theorem

- Right angled triangle
- Right angle marked
- Length of sides marked
- The formula ( $3^2 + 4^2 = 5^2$ )
- Rectangles (areas) forming from each side of the triangle
- Visualization showing that the smaller areas are equal to the bigger area
- New right angled triangle with different composition
- Right angle marked
- Length of sides marked
- The formula
- Rectangles (areas) forming from each side of the triangle
- Visualization showing that the smaller areas are equal to the bigger area

## Circle

- Concept of area
- Radius
- Diameter
- Circumference
- Pi
- Circumference formula
- Area formula

## Pyramid and cone

- Cube
- Base
- Height
- Formula:  $V=Bxh$

- Pyramid
- Different pyramid configurations
- Three pyramids inside one cube
- Formula:  $V=(Bxh)/3$
- Three cones
- Cylinder

#### Rectangle area

- Rectangle's shape, use the slider to change the opacity of the grid
- Base and height
- Formula:  $A=b*h$

#### Triangle area

- Triangle's shape, use the slider to change the opacity of the grid
- Base and height
- Duplicate the triangle to form a square
- Formula:  $A=(b*h)/2$
- Show that a rectangular triangle has the same shape as a square that has been divided along the diagonal

#### Triangle area (non-isosceles)

- Triangle's shape, use the slider to change the opacity of the grid
- Base and height
- Duplicate the triangle to form a parallelogram
- Formula:  $A=(b*h)/2$
- Show that the triangle is half of a parallelogram

#### Kite area

- Kite's shape, use the slider to change the opacity of the grid
- Diagonal 1 and 2
- Duplicate the kite and rotate each part to form a rectangle
- Formula:  $A=(d1*d2)/2$
- Show that the kite is half of a rectangle

#### Parallelogram area

- Parallelogram's shape, use the slider to change the opacity of the grid
- Base and height
- Show that the parallelogram has the same area as a rectangle
- Formula:  $A=b*h$
- Overview of the process

#### Trapezoid area (rectangle)

- Trapezoid's shape, use the slider to change the opacity of the grid

- Base 1, base 2, and height
- Duplicate the trapezoid and flip it over
- The two trapezoids are joined to form a parallelogram
- Show that the parallelogram forms a rectangle
- Formula:  $A = ((b_1 + b_2) * h) / 2$
- Overview of the process

#### Trapezoid area (triangle)

- Trapezoid's shape, use the slider to change the opacity of the grid
- Base 1, base 2, and height
- The trapezoid is cut from the upper left corner down to half the height
- The cut-out part is joined to form a triangle. The base is now  $b_1 + b_2$  and the height is the same
- Formula:  $A = ((b_1 + b_2) * h) / 2$
- Overview of the process

#### 2D shapes

- Circle
- Square
- Rectangle
- Ellipse
- Triangle
- Parallelogram
- Kite
- Trapezoid
- Pentagon
- Hexagon
- Octagon
- Decagon

#### 3D shapes

- Tetrahedron
- Pyramid
- Hexagonal pyramid
- Cube
- Cuboid
- Octahedron
- Triangular prism
- Pentagonal prism
- Hexagonal prism
- Octagonal prism
- Decagonal prism
- Dodecahedron
- Icosahendron

- Torus
- Sphere
- Hemisphere
- Ellipsoid
- Cone
- Cylinder
- Tesseract cube

## LINEAR EQUATIONS

### Connection and Change

- Coordinate system with x and y axis
- Line (Graph)
- Interaction, change the k (b) and the m value
- The equation
- The equation and graph equals

## MATHEMATICS

### Negative numbers

- Thermometer, number line
- Formula, reacting with input
- Interact with starting point
- Interact with adding positive or negative input
- Interact with subtracting positive or negative input

### Fractions

- Value
- Integer
- Fraction
- Pie charts
- Percentage
- Decimals
- Number line

## ENGINEERING

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### ELECTRICITY

#### Basic DC

- Schematic view of a circuit
- Cables
- Light bulb
- Battery
- Interaction, click on battery to engage or disengage current

## AC/DC

- Cable
- Switch
- Light bulb
- Battery
- Electric outlet (AC socket)
- Both AC and DC circuit in schematic and with real objects
- Interaction, click the switch to engage or disengage current
- Interaction, show circuit in schematic view
- Interaction, show current view

## LEVERS

### The Golden Rule

- Lever
- Fulcrum (pivot point)
- Weight
- Force (arrow that changes in size with changes in force)
- Interaction, change the fulcrum position
- Interaction, change the force

### Human Arm

- Moving human arm
- All the muscles
- All the bones from hand to shoulder
- Transparent skin
- Dumbbell
- Schematic view with fulcrum (pivot point) force and weight, graphic
- Interaction, turn off skin
- Interaction, turn on biceps view

## HYDRAULICS

### Pascal's law

- Interact with a pressure sphere, drag the force slider to show how the pressure is distributed in the sphere to the rest of the pistons

### Basic hydraulics

- Simulate how the area and force work together in hydraulics. The force amplitude slider will change the amount of force that is applied to the left piston. This slider will affect the two force indicators. The force slider will move the pistons up and down. The radius slider will change the area of the right piston
- If you set the force amplitude to 1.0 and the radius to 2.0 the right piston will have twice the area as the left. Now you can see that you get four times the force from the right piston. If you drag the force slider, you will see that you only get a fourth of the distance

#### Force distribution – simple

- When dragging the force slider, you will see how four of the pistons only move one fourth of the distance. From here, we can start describing how a braking system in a car works with hydraulics

#### Force distribution – brake system

- Static overview of a car's braking system. Brake using the toggle
- A closer look at the braking system, when you brake you'll see how the force from the brake pedal is distributed in the brake line

#### Disc brake

- Close-up view of a disc brake. When using the brake toggle you will see the hydraulics in action, how the parts in the disc brake move to brake the car
- Static overview of a car's braking system. Brake using the toggle

#### Drum brake

- Close-up view of an old drum brake. When using the brake toggle you will see the hydraulics in action, how the parts in the drum brake move to brake the car
- Static overview of a car's braking system. Brake using the toggle