BioMight Technical Spec

Version 1.0

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1. Introduction

This specification lays out the details for implementing BioMight, an enterprise class software application that allows an Internet user to build biological simulations. Rather than contracting the work out a professional medical animation firm, a novice can build life-like, custom-made animations in a few hours utilizing BioMight's intuitive interface and modeling engine.

BioMight's engine will serve the needs of a few hundred thousand simultaneous users. They will interact with BioMight via a web browser using the industry standard OpenGL graphics engine. BioMight's core processor is built on J2EE technology and is capable of running on Application Servers such as IBM's WebSphere, Oracle's WebLogic or open source JBoss.

The J2EE application components running on application servers will add knowledge and context to the objects being rendered on the integrated UI. This knowledge will be used to set parameters and behaviors on the objects portraying their physical and logical properties.

The J2EE application will also maintain one's orientation in the BioMight virtual world. What one views is based ones perception. For instance, if I were to look at calcium and potassium ions interacting with the muscle cells of the heart, I would only see other atoms, ions, and macromolecules as they circle as behemoths about me.

The first release of BioMight will encompass the human model. It will provide all the basic anatomical features of the human body.

BioMight does not portend to create a completely 100% accurate simulation. BioMight's goal is communication. It is to show, to teach, to explain and elaborate. The model is built around these principals.

Drug companies are interested in animations that show their medication entering the body, traveling the route with the body, and acting on the disease. They want to show the consumer in an easy to explain way how the drug works.

When one wants to run an animation, they select the characters, such as the white blood cells, a pill, etc. They then set the path that the object of perception takes through the BioMight model. For instance, if a drug works on cancer tumors and the medication is injected intravenously then the path it will take is through the bloodstream to and then it will coalesce around the site of the tumor maybe interacting in angiogenesis.

BioMight will compute the pathway and display it for the user. They will have the ability to skip through the points of the model and add finer grain of detail whey they desire. BioMight will see that the drug will travel by through the bloodstream.

The Simulation could show the drug moving through a 3D representation of a vein. The perspective would give on the perception of riding in a roller coaster bloodstream. A hallow tube filled with erythrocytes, platelets, white blood cells, and antibodies. In this view, one would be able to select from the libraries various representations to add uniqueness to their simulation, and to personalize it to their liking.

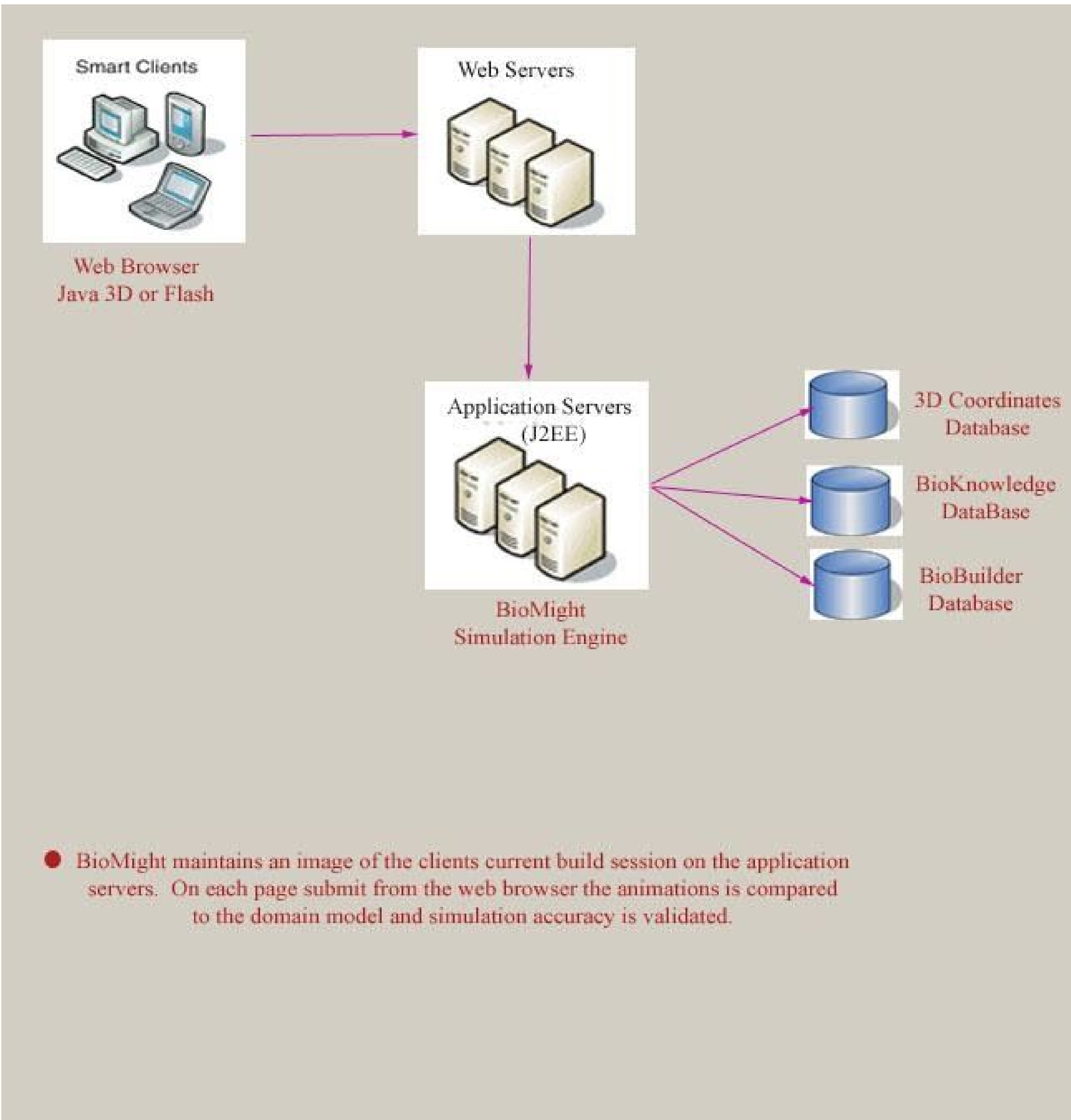
One could set the erythrocyte count higher or lower, select the color and texture of the platelets, the white blood cells, from the many models stored in the BioMight database. One could also wish to view the drug working its way through a transparent body, looking as you would see a person in real perspective. The model could zoom in when the drug reaches its target

Future Release
The BioMight engine has the ability to visualize normal human body processes, as well as portray the body under the attack from injury and disease. The engine has the ability to inflict, and it knows how pharmacological agents act upon repressing or curing.

Users will be able to set the background colors and patterns, lighting, etc. thereby customizing their animations. BioMight will never generate duplicate content. One can program the same simulation, but chaos and chance will produce subtle differences in the model. For example, the program could use the position of the Sun and Moon to produce gravitational effects on the molecules in your body as in day to day life processes.

Deployment Diagram

Appearing below is a simplified deployment diagram. It portrays the basic system architecture minus firewalls, redundancy, etc.



1.1 BioMight 3D Modeling

To build a precise model of the human body, we would have to replicate it atom by atom, process by process, and essentially we would end up with such an exact simulation that it would be a replica. Fortunately, for BioMight to be successful, it will only need to generate displays that are aesthetically pleasing to the perceptibility of the human eye.

This domain limitation makes the BioMight engine feasible. No human really knows what an atom really looks like, but scientists have presented the abstraction in a meaningful way that allows us to understand. This is one of BioMight's core competencies in that it abstracts biological data such that the average internet user can utilize and understand.

In real life, everything in our body is comprised of subcomponents, decomposing from layer to layer down to the atom. BioMight's models will also be comprised of subcomponents. If one uses the decomposition tool to look at the lining of the stomach, one will see the grouping and layers of stromal and endothelial cells that comprise it.

Mapping BioMight to Pixels

Consider that in BioMight, one will be able to represent an atom as a single pixel, or if desired blow it up billions of times its theoretical size and display it in an 8x10 inch frame. BioMight also displays an organ as complex and intricate as the liver realistically in an 8x10 as well. And all of this is rendered using a few million pixels.

When one considers this contradiction, one understands that BioMight only need simulate, not replicate. By abstracting the processes into layers, BioMight makes the solution of generating realistic graphics and simulations technically feasible. An image or animation filling a 17 inch computer display using a resolution of 1400w X 1050h pixels would equate to 1,470,000 pixels. A 1x1 pixel area appears as a small spot of color on the page. The pixel is BioMight's basic building block.

A string of 1x1 pixel blocks, the thinnest possible line on a monitor, would be used, for instance, to detail a cellular membrane surface, viewing the composition of chromatin. A 5x5 pixel block could represent the smallest square whereas a 10x10 pixel image would be needed to create a barely recognizable cell membrane lacking any detail. Looking at current and future display technologies in the next five years, BioMight will need produce representations from a 4x4 inch up to 20 x 20 inch viewing area

Underlying each of BioMight's models is a definition of coordinates in 3D space. These coordinates are the key points that comprise the BioMight object. For instance to construct a nose, one needs the start of the bridge, the apex of the bridge, the height projecting from the bridge outward.

Each component in BioMight contains algorithms that describe how the cells that comprise the nose "grow" to make it. These algorithms are encoded in BioMight's version of DNA. Adjusting the sequences of ACTG combinations contained on chromosome 11, allele 121, may cause a proturbance to grow.

BioMight renders its images using parameters specified by its user. Say, for the example, the user wishes to present a layer of the intestinal wall. Based on their defined viewing area, one can specify parameters such as the number of visible cells, individual cell size, color patterns, etc.

These parameters are then used by BioMight to render the image. BioMight does this by taking the core element, computing the dimensional surface area available, and then figuring out how many elements it can draw in a given view. The perception of the eye is that which must be achieved, not trueness on an atomic scale.

The repeating pattern in the biological model is a container within a container paradigm. Everything is in a container of another. Our skin is the outer container, the muscle underneath is another container, the veins and arteries that pass through it are other containers, all hallowed, allowing other elements to occupy its innards symbiotically.

BioMight maintains this container to container relationship. When BioMight constructs the digestive system, from the pharynx, to the esophagus, to the stomach, to the intestines, it basically creates a hallow tube with each component completely connected which transitions smoothly from end to end.

1.2 BioMight's Virtual World

BioMight assembles its representations using many interrelated three dimensional models. For instance to generate the high-level external view of the vascular system, each of the arteries and veins within the system are gathered from the BioMight library, assembled like pieces in a puzzle, and then rendered.

BioMight's models are designed and created as a whole from the component parts, and as component parts from the whole. The component parts are maintained as separate entities but each understands its interrelationship through the BioMight genetic code algorithm. Thus, BioMight contains the gestalt view as well as a precise view if the individual subcomponents. BioMight provides basic shape building blocks which allow one to assemble components in their totality, much like pre-manufactured panels when assembling superstructures

BioMight has mapped the human body into assemblies of virtual 3D worlds. As one traverses the various models, a map icon appearing at the top of the BioMight page will display one's position in the human body, similar to how position information is provided to players of video games showing their coordinates in the 3D world in which they play. BioMight will always be aware of one's position in the model.

BioMight begins by mapping the human body onto a 3D grid. Based on medical data, BioMight allows it extend up to 9 feet or 2.7m, have depth of 2 feet or .6m, and have a width up to 3 feet (.85m). These are the dimensions of the BioMight virtual world.

Divide this world it by feet or meters and it is easy for a computer to represent. Section it by inches or centimeters and a fast computer will have to work real hard to keep track of the entire model. Sectioning the model into 1/16th's of an inch, and you'd be heading out for a long lunch while it crunches the results. To get a really accurate model, one would have to divide it into atomic cubes. BioMight may live long enough to see it, but I will not.

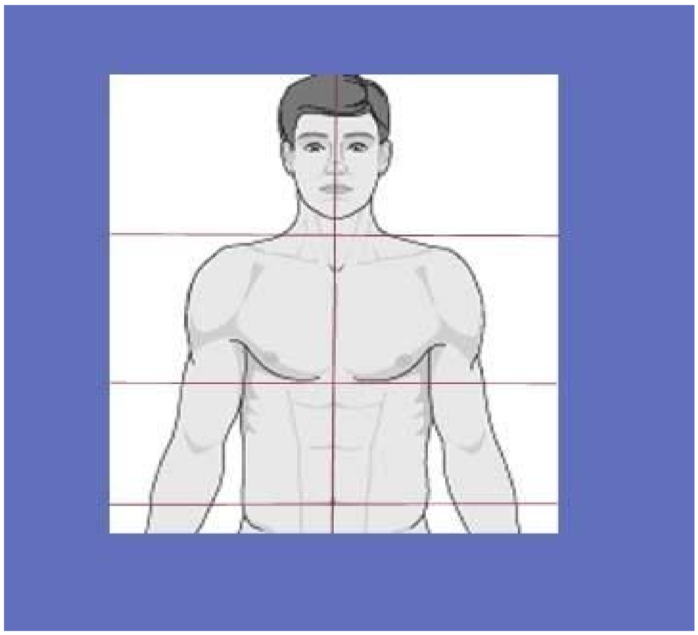
BioMight's simulations do not need to focus on the entire virtual world to illustrate biological inner workings. Imagine again, the 3D grid above, sectioned by feet or meters. Roughly, each of the cubes contains a component of the human body. Now, we will label each cube according to an XYZ vector system; X11, X12, X13...Y11, Y12, Y13…, etc. Each piece knows its position in the BioMight virtual world, and it can query the virtual world or other components to find out who is living next door. At this level of detail we are abstracting the human body.

Say we focus on the BioMight's model of a left torso. This would be held in cube position X5, Y30, and Z2. When this viewing area is selected, BioMight brings that portion of the Virtual world under view. It takes the selected cube, and sections it into inches and centimeters, and labels each section according to its position. Within this cube, we are abstracting at the Organ and Gland level.

In BioMight, everything is built from blocks inside blocks. BioMight is always working with one block at a time, even though the given box is comprised of a number of smaller boxes. These logical constructs limit the domain of the virtual world, by breaking it into smaller upon smaller worlds, with each world readily managed.

1.3 Abstracting the Human Body

When working at the abstraction level of the human body, BioMight's default configuration shows the body encased with skin. One can use the transparency tool to apply a translucent color scheme if desired, allowing on to view the muscles and organs underneath



When the transparency tool is applied, the BioMight engine recalculates the display exposing the 3D representations underlying the top level. At this level of abstraction, will be about 150 x 150 pixels.

Using the view window, one can also use reveal/un-reveal tool to allow one to see deeper into the model. For instance, one can turn off the muscle detail, and that portion of the model will not be rendered.

The human body model will allow for human models from 1 foot in length to 11 feet tall.

The center point is the bridge of the nose, where it meets the forehead.

Specifications for Me

Face 9 inches (4 forhead, 2 nose, 1 to lips, 2 to chin)

Neck is 2.5 inches

Clavicle rests at 10.5

Bottom part of chest at 17.0

Chest to Pelvis span is 11 inches

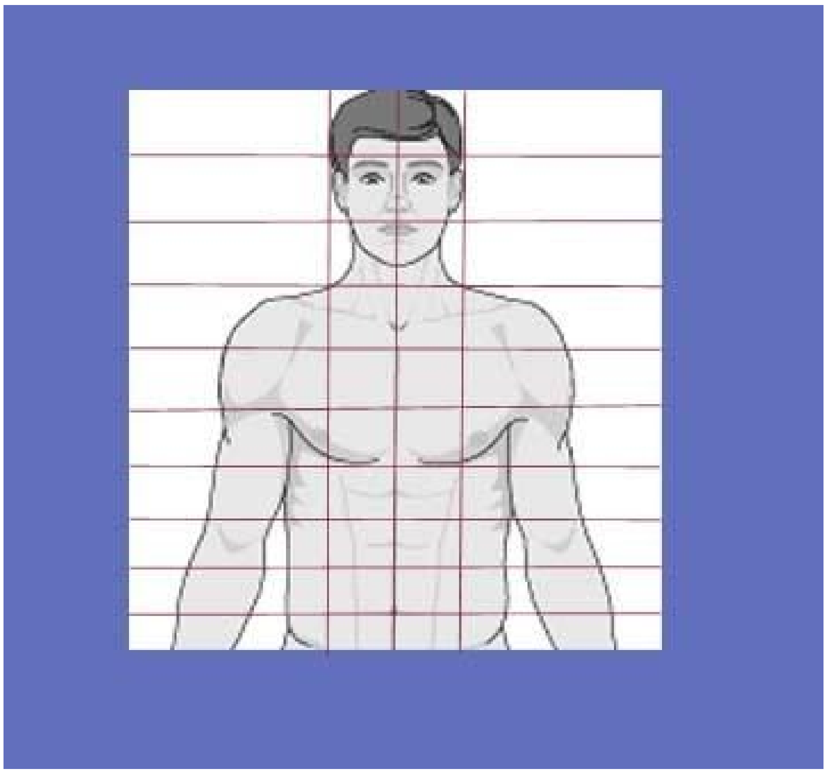
Hip runs from 28 to 44 to top of knee

44 to 48 is knee

48 to 63 takes me from lower knee to ankle

1.4 Abstracting the System Level

When one drills down to the System level of abstraction, one can view components such as the organs such as the stomach or liver, and be able to make out the larger arteries, folds, ridges, and other surface structures that comprise it.

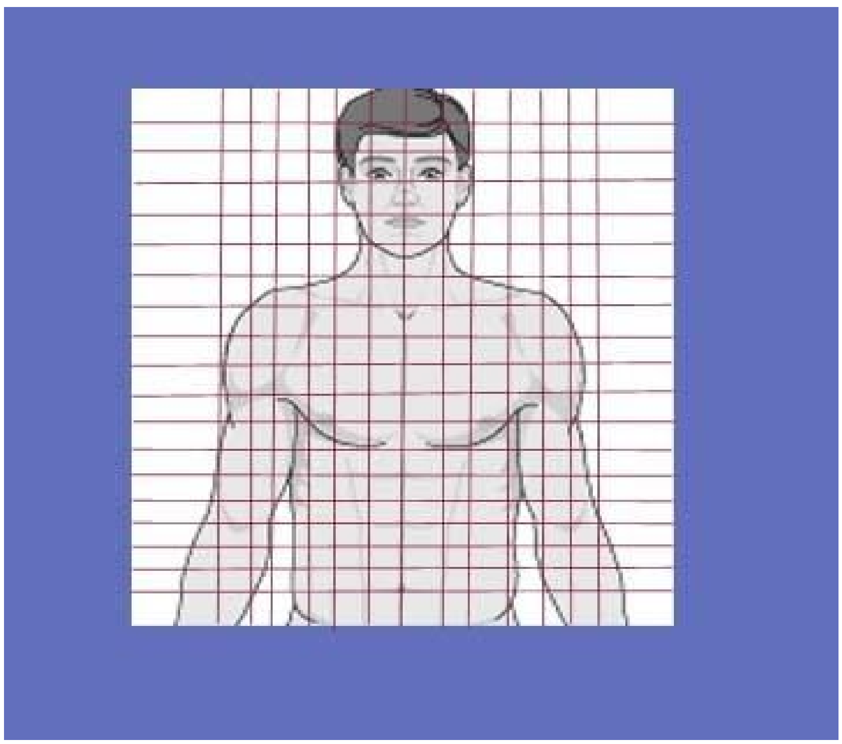


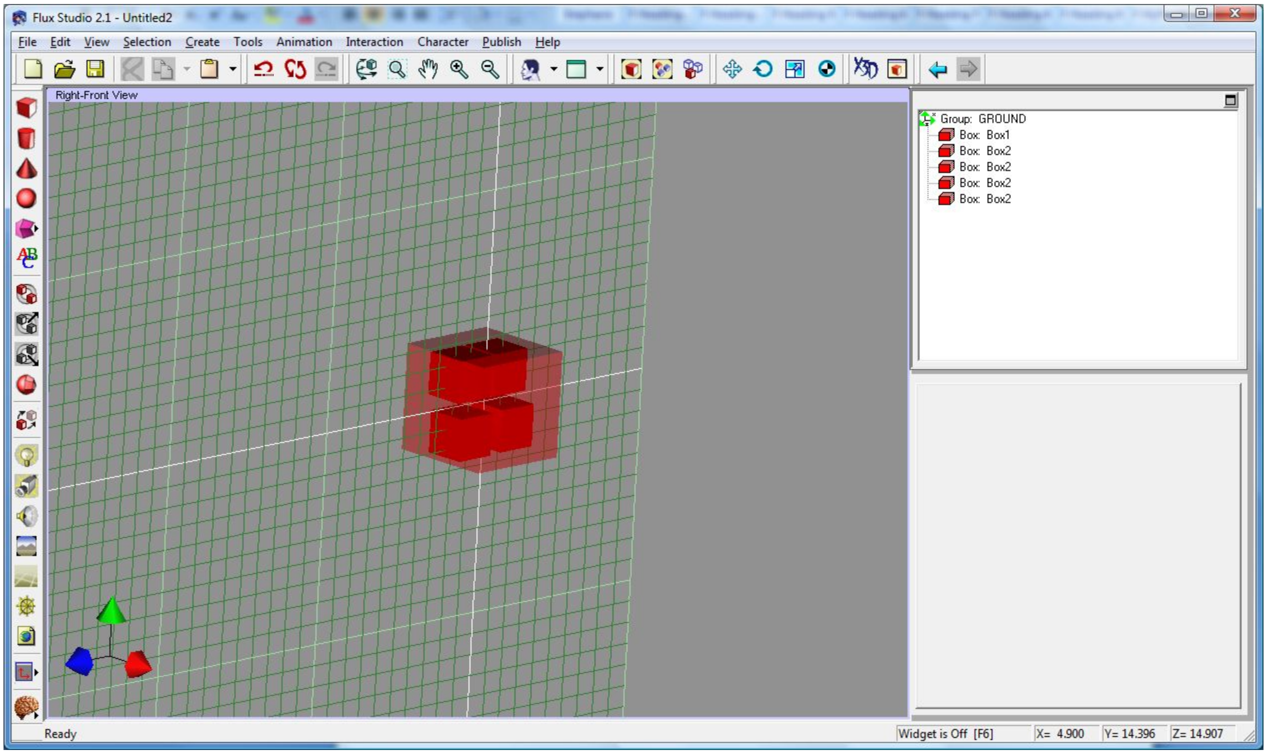
If one applies the translucent tool at this level, the view one receives depends upon the organ one is viewing. In the case of the digestive system, where many of organs are hallow tubes, one will see the inside wall of the respective organ. When one is looking a solid structure such as the liver, one will receive a cross sectional view.

From this System level of modeling and abstraction, one is not able to discern the details in the individual cells, but one is able to clearly distinguish between the various tissue types based on appearance and histology.

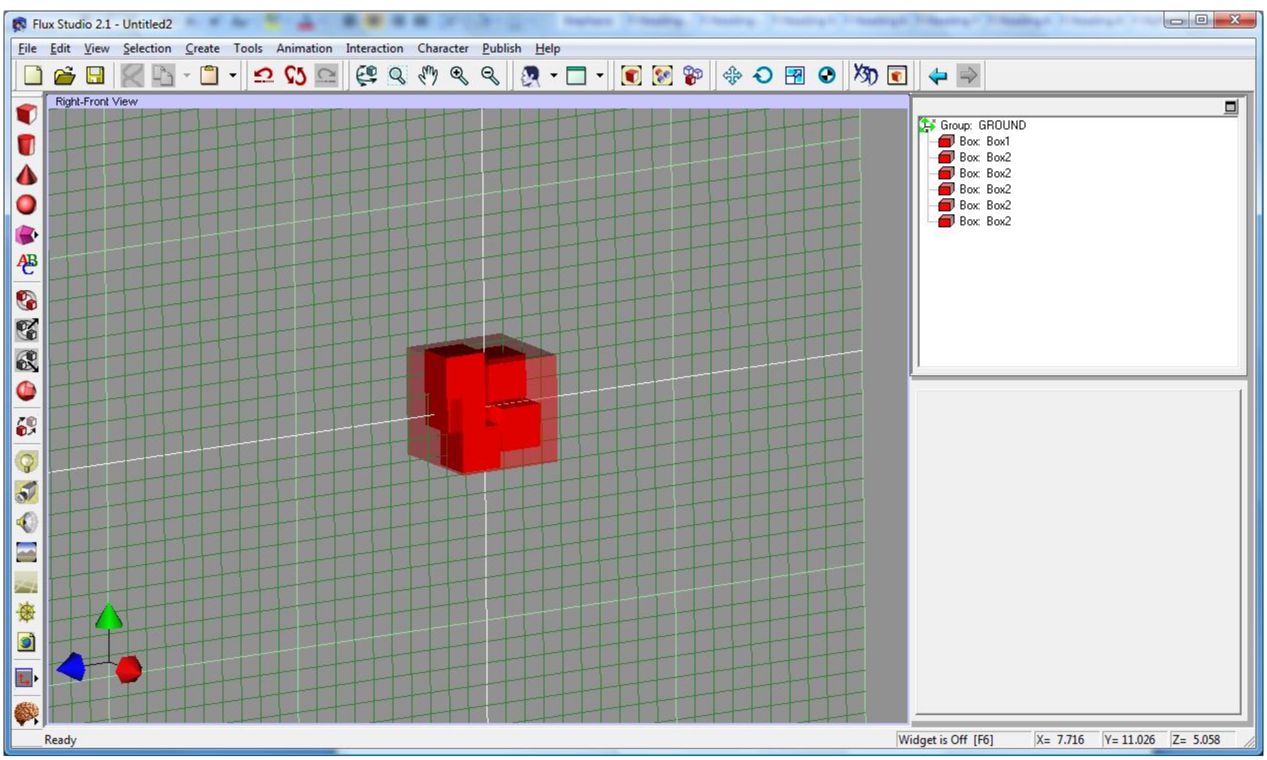
1.5 Abstracting the Tissue Level

When one zooms into the tissue level, one can view variations on the four basic tissue types; Epithelial, Connective, Muscle and Nerve. At the maximum level of detail, one can make out the collection of cells that comprise the tissue. When one is working in the Systems model, one can also abstract to the Tissue level in order to see the details of how an organ is comprised. BioMight will not have a single representation of a Stomach wall; it will on the other hand dynamically create representations based on configuration parameters. It will use a genetic model to create a balance and structure that flows through the organ as invivio.





Flux Studio 2.1 - Untitled2
File Edit View Selection Create Tools Animation Interaction Character Publish Help
Right-Front View
Group: GROUND
Box: Box1
Box: Box2
Box: Box2
Box: Box2
Box: Box2
Ready
Widget is Off [F6]
X= 4.900
Y= 14.396
Z= 14.907



Flux Studio 2.1 - Untitled2
File Edit View Selection Create Tools Animation Interaction Character Publish Help
Right-Front View
Group: GROUND
Box: Box1
Box: Box2
Box: Box2
Box: Box2
Box: Box2
Box: Box2
Ready
Widget is Off [F6]
X= 7.716
Y= 11.026
Z= 5.058

1.6 Abstracting the Cells

At the cellular level, one can view a cell and the larger constituent components that comprise it in detail. When viewed in non-translucent mode, one can shade the cell in various colors to suite the animation one is building.

Applying the translucent tool will allow one to view cellular components such as the nucleus, mitochondria, and the golgi apparatus. The translucent tool can further be applied these components revealing the building blocks that comprise these cellular substructures.

Based on the method of accessing the cellular abstraction mode, BioMight will offer present its information tailored to the user's needs. For instance, if one zooms into the cellular level by clicking on a specific tissue type, the cells offered will model the tissue selected. A grouping of hepatocytes will be presented if one is viewing the tissue in the liver, where osteoclasts will be displayed when is zooming into the cellular level through the bone tissue.

1.7 Abstracting the Molecular Assemblies

BioMight provides a toolset that is similar to the functionality found in RasMol and Chime, the shareware applications that render atoms, proteins, and small molecules. It will allow one to display as; wireframe, backbone, stick, spacefill, and ball & stick. As RasMol also does with proteins, one can view as ribbons, strands, and cartoons.

1.8 Abstracting the Basic Elements

BioMight can render each of the basic periodic elements that are part of the human conglomerate; Nitrogen, Oxygen, Carbon, Hydrogen, Iron, Magnesium, Calcium, Potassium, Phosphorous, Zinc. BioMight does not provide a cross section, or decomposition tool for the Basic elements. The application stops at the atom, leaving the world of quarks and antiprotons in the hands of the physicists.

1.9 Assembling and Traversing the Models

"Just picking objects from a palette does not an animation make." Even though BioMight will offer a database pack full of representations from which one can build their custom animations, it will also be intelligent enough to assist the user in assembling accurate animations. It will use its underlying knowledge base and expert system awareness to put all the BioMight objects into the proper context.

Each of the layers of abstraction will have several models for a component depending up the current size, resolution and distance (camera distance from actual objects being viewed) parameters. As the zoom tool is used, BioMight will respond by selecting the set of 3D mesh coordinates, that satisfy the view parameters. Each of these models will be very similar to each other due to the fact that they are materializing the same object. The difference is in the

Say we put hundred of these pieces in a database. Each one will have a scale associated with it. For instance, the stomach will be able to be seen a different magnifications and levels.

The elements that render on the Flash UI must be able to have some intelligence in the way they interact. As the user constructs their model, the workspace state will be maintained on the application servers running at the central hub.

Upon each submit (server trip) the images that are appearing on the Flash UI will have their consistency checked against BioMight's model to render accurate depictions.

From a technical perspective, the UI can only present data. From a Flash or Java 3D perspective, these objects are just a bunch of coordinates, nothing more. To add intelligence to these objects would not be technically infeasible in Flash. Each object in the simulation has an intelligent object behind it running on the application server, keeping everything in check.

BioMight also allows one artistic expression. For instance, if one wishes to create a scene of a virus attaching to the cellular membrane, one has the freedom to make the virus 100 times larger than the cell, by overriding BioMight's integrity mechanism.

To construct a model of an eye, do we need to construct the entire virtual world? Each layer under makes solidity so eventually you fill every data point with something. Based on where you are the model, BioMight will have a rendering based on the viewings camera position.

We cannot create any of the models in the human body based on mathematical formulas. Each object will have to hand plotted.

The human body is a composite. Nerves, blood vessels, and lymph course throughout the body, interlacing soft tissue and following the canals laid out by the hard tissue.

Determine the number of cubes BioMight will have, and then you'll know the scope.

Body by 1	Body Level of Abstraction
Body by 10	Organ Level of Abstraction
Body by100	Tissue Level of Abstraction
Body by 100,000	Cellular Level of Abstraction
Body by 100,000,000	Molecular Level of Abstraction
Body by 100,000	

Rather than building by a mesh of triangles, we should build from the base. First assemble a cell and replicate. If one wants a stomach, we need several hundred million cells. Several hundred million cells will not fit on the screen, so must compress down to their size, and then it basically looks like the color of all the cells, appearing as a dot.

We have to apply a biological rendering model rather than rely on that used for commercial purposes. BioMight should be able to assemble the cells into patterns, which present the distinct features of the organ based on a DNA pattern, as in humans. Let the DNA assemble the organism rather than drawing the model based on predefined coordinates. Changes in the BioMightic DNA reflect changes in the model.

During Construction BioMightic DNA defines;

- the size of the component.
- the shape of the component
- the location of the component

During Activation BioMightic DNA defines;
- the components function
- the components that are associated with

BioMightic DNA defines that a capillaries pass through tissue and that a vein and arterial network exist in a lymph node.

Why do trees that branch up into the sky resemble the patterns of our nerves and arteries? Everything reaches into space but fills it delicately. It reaches to fill the cavities likes an artists brush on canvas. BioMight has an AI algorithm that uses the patterns in a way

Basically we are just looking at color. The models wire mesh coordinates will have to overlayed with a pattern. The mesh work defines the shape and the color overlays it. In the real world of flat computer screens, there is no three dimensional shape only an illusion of. BioMight translates the real object into a bunch of pixels. As you ascend upon an object, more and more detail is revealed as your range of vision decreases.

The BioMightic DNA will dictate that the thalamus grows and then shrinks with age, practically disappearing when one makes it to their seventies.

How do I show attachment?
There is side by side attachment as in epidermal layers. There is attachment between muscles and bones, and there is attachment between the spleen and

Does every object extend an attachment object? Or do I create an attachment object when working with unified pieces. Or do I use the coordinate positions and see if one object comes in contact with another in 3D? The program could look for common vectors and vertices and actually compute the intersection of the two objects.

How does BioMight do disease?
Does the disease have the intelligence to seek its host and reservoir? Or does the body know where the disease? Does the Lung know it can get cancer, or does cancer know it can permeate the lungs?

How do I show secretion?
Do I create a secretion object? Or do I place the property right into the cell that creates it?

How do I do name aliasing?
If there are several names for a component, then BioMight should be able to recognize them as one as the same. They are not subclasses, they are one in the same.

How do I distinguish Tissue & Cells, and Layers & Membranes
A group of cells form tissue. So does my collection of cells satisfy the equation? Not really, because tissues are usually stratified and contain cartilages, various cell types,

Every BioMight object will have the ability to be inspected and manipulated from the user interface. For instance, when one instantiates a Nervous System object, the user interface will list the components such as the brain, spinal chord, thoracic nerves, the various plexuses.. The user will have the ability to turn on or off pieces in the model by clicking on checkboxes to enable or disable features.

The user will also be able to dynamically change the model through the interface as well.
kr-v5560

Map Questing/Body Questing
This system must be able to traverse from point to point. And one can pick the vehicle and methods for traversal. For instance, one should be able to; traverse the digestive tract, should be able to traverse the nervous system, traverse the circulatory system; traverse through tissue and bone. If one is using one system, the start and end points can be easily defined.

They need to set the zoom such that they see cells, or tissues, or assemblies.

People will want to show injections. BioMight must have a collection of tools, hypodermic needles, scapulas, cotton balls, and representations of a number of popular medical devices. The tools can be manipulated and moved around the in the 3D representation.

Deliver a shot
- Subcutaneous
- Intraveneous
- Epidural

Take a pill
- Set size and shape of the pill
- Define the pills properties

Take a liquid medication
- Set the color and density of the liquid

Take ones Temperature

Show a pill traversing the digestive tract

Show Medicine Saturating various systems

****

This system must be message driven. It will communicate by nervous system, chemical messengers, pressure, heat, etc. If I poke a needle into someone's arm, then the cells that get destroyed emit pain as they die or are injured, and this message travels to the nervous system, which forwards the messages along the axons until it reaches the brain, where the pain message is received and registered. Every message will spawn multiple messages.
Not yet, dude, let the interface set the parameters.

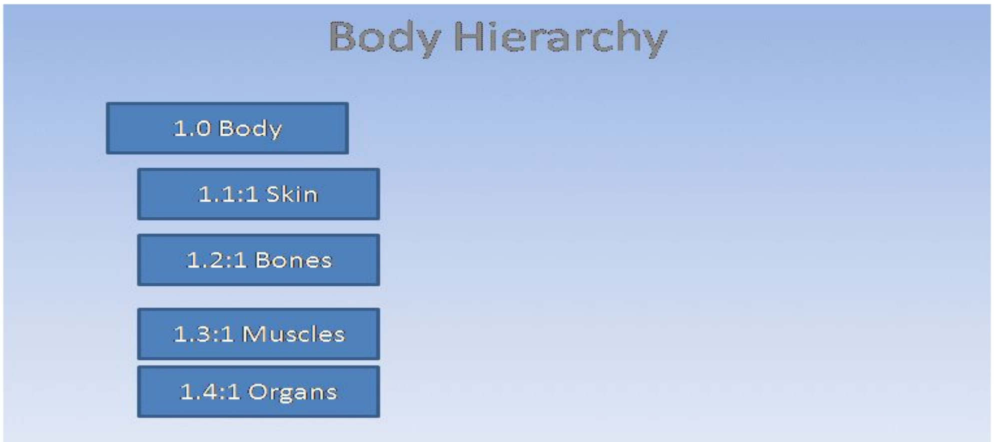
Property Data vs Database Data?
When does BioMight store a property rather than place in a database? If its in the object it is readily usable . Once it's in a database the system becomes more complex to use. Storing the data in the objects especially vertices, chemical formulas, maybe best take a place in the DB.

The focus is always on the object one is looking at. If we are looking at a drug, one will see the drug pass the where it entered the body albeit from a patch, a shot, nasal, or oral medication. The model will use the size of the object that you are looking at to render the scene based on the size of perception. If taken orally, it will pass through the digestive tract, until it is absorbed into the body and migrates to its site of action.

If I am looking at acetlycholine as in interacts in a nerve cell, then I am working at a macromolecule size. I will want to see atoms, and everything in my word will be comprised of similar sized objects.

We just need a number of different sized renderings for each level of the conceptualizations and we will be golden

To create the pinna, one has to place cells side by side, and top on top, stacking them into a shape that makes the pinna a pinna. In the DNA, there must be a mechanism for determining how many cells to create, and into which position to place them. Is this done by distance, as cells are stacked, do they create an ohm circuit between them.


Body Hierarchy
1.0 Body
1.1:1 Skin
1.2:1 Bones
1.3:1 Muscles
1.4:1 Organs

Is the nose the skin, bones and arteries, or are the skin, bones, and arteries the nose. Everything we see , we see a wrapped up conglomerate.

For creating the intestine-
We just can't let it go random. It has to be directed randomness. It needs to go to certain places, and it cannot go others. It has a box in which it can play, and in that box there are rules. We can lay down templates, general constructs that allow for improvisation, sometimes rarely, we can flip the world and survive.

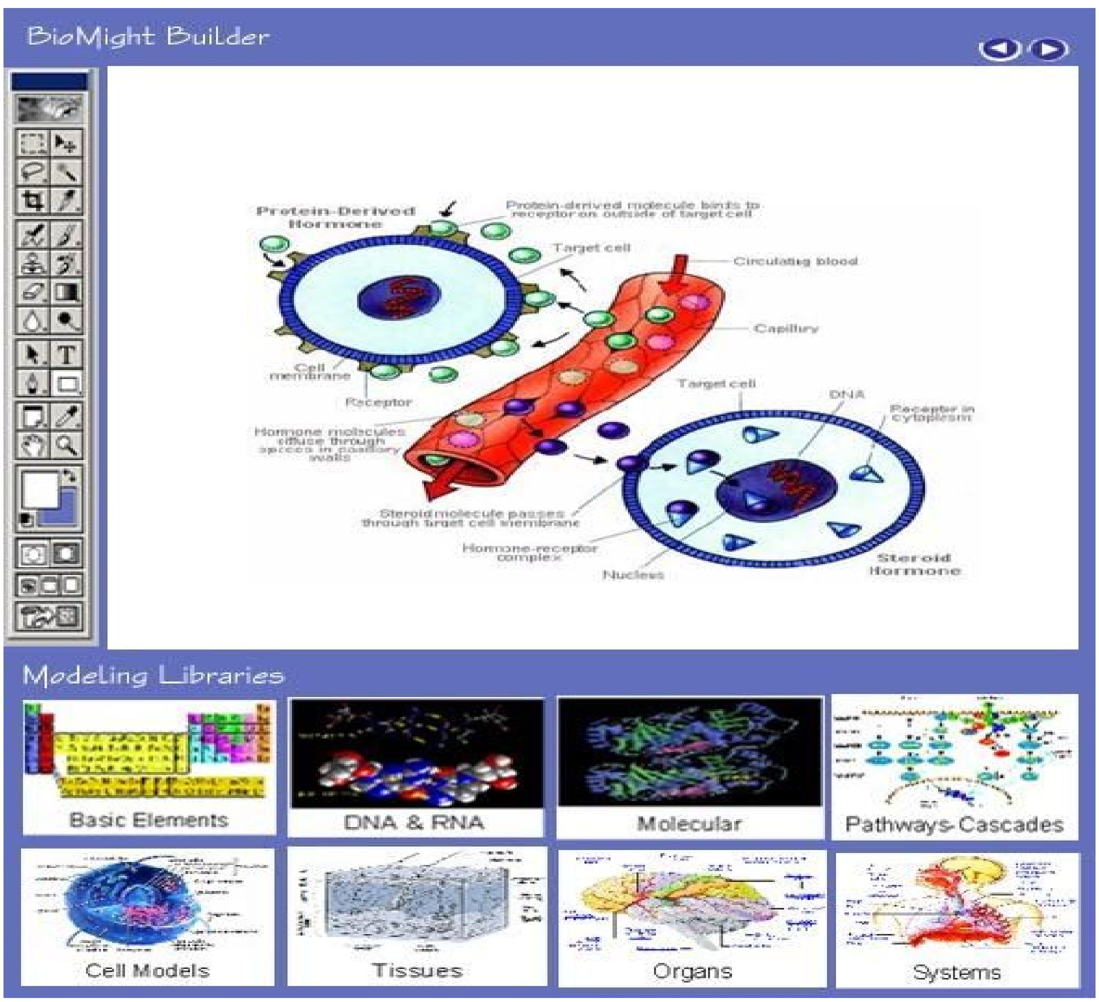
X2 + y2 = r2

2. BioMight Builder

The BioMight Builder provides users with the ability to construct graphics, slideshows, and animations. Each frame in an animation is stored in the **BioFrame** object. This object maintains a composite of all the BioMight images arranged in 3D space.

From the BioMight Builder workspace, one can work with objects individually, or apply an operation across a group of objects. Associated with each of the renderings in the **BioFrame** will be a set of attributes contained in configuration mode that define how the object is to be presented. These values allow one to define color, shade, texture, overlapping characteristics, etc.

Shown below is a representation of hormone interaction in a compartmentalized view of basic elements. At the base of the slide appear images, when clicked; take one into one of BioMight's Systems libraries.

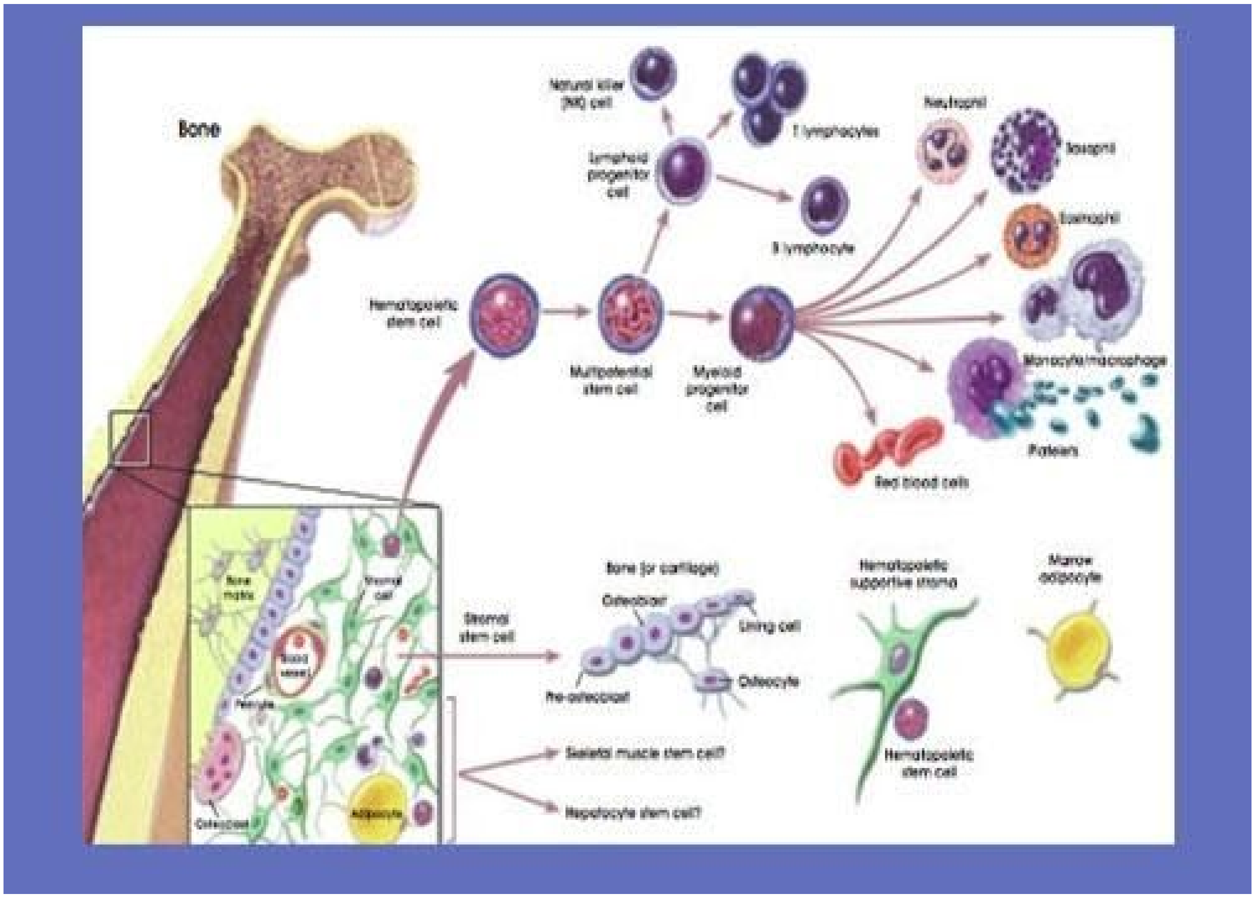


2.1 Building in BioMight

BioMight is capable of building a variety of renditions simulating biological elements and processes. Shown below is an example graphic that could be produced utilizing BioMight. This graphic displays the how our red and white blood cells are manufactured in the marrow of a bone.

To build this animation, one would start with a blank slate choosing their desired background color, dimensions, etc. The bone appearing at the left would be selected from BioMight's Skeletal System models. The user would then apply the Cross section tool to open the model to reveal the details within the bone.

The various cells; Neutrophil, Basophil, Red Blood Cells, etc would be selected from the Cellular Library. The user will have the option to set the configuration parameters for each of the cells, such as color, dimension, level of detail, etc that determine the how the components will be rendered. Lastly, the user will access the basic images toolset allowing them to connect the elements through arrows, lines, etc.

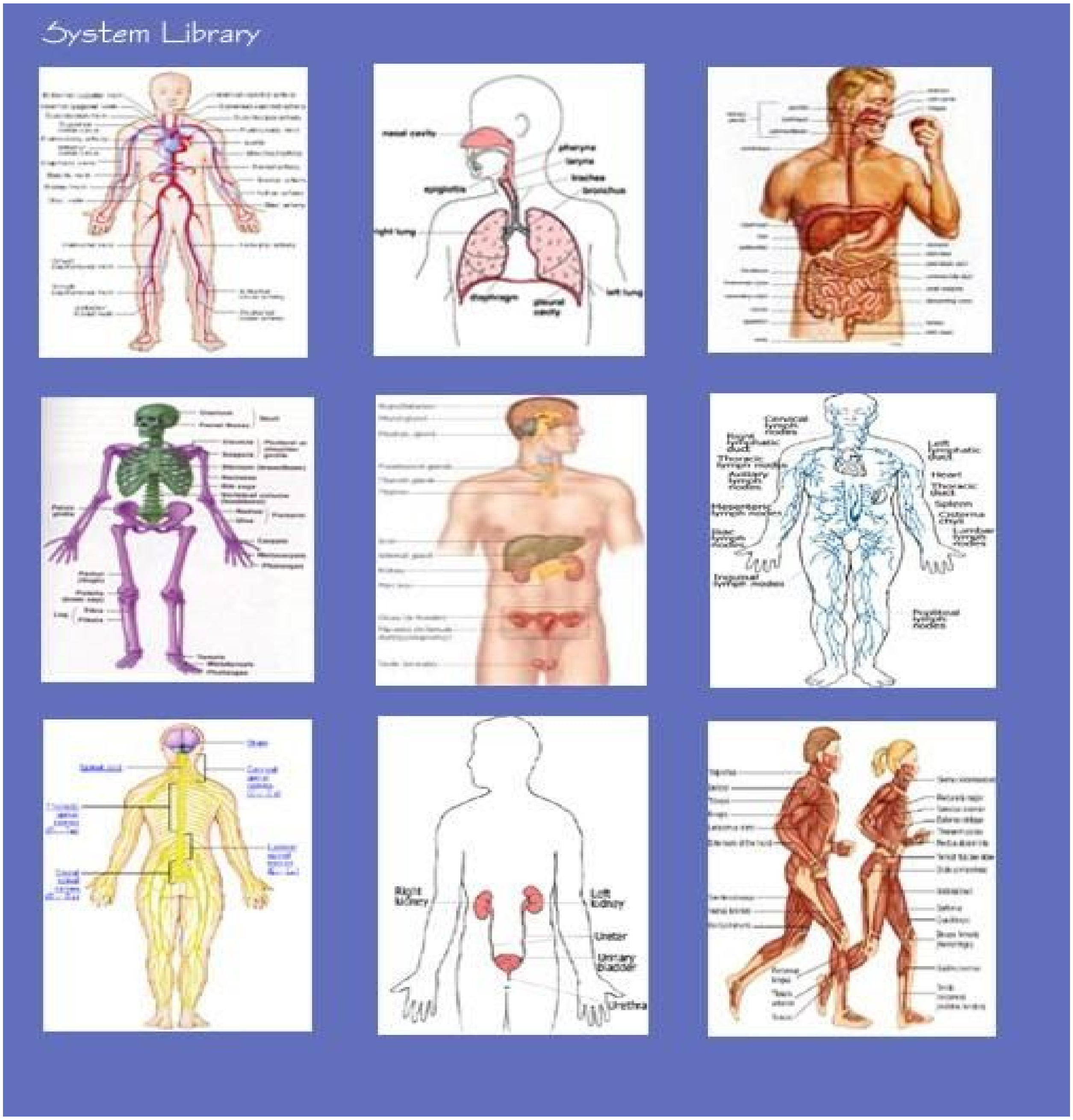


Bone
Natural killer (NK) cell
T lymphocytes
Lymphoid progenitor cell
B lymphocyte
Neutrophil
Eosinophil
Hematopoietic stem cell
Multipotential stem cell
Myeloid progenitor cell
Monocyte/macrophage
Red blood cells
Bone (or cartilage)
Hematopoietic supportive stroma
Marrow adipocyte
Osteoblast
Lining cell
Osteocyte
Stromal stem cell
Skeletal muscle stem cell?
Hepatocyte stem cell?
Adipocyte
Hematopoietic stem cell

Each image that appears in BioMight will have its height and width coordinates for rendering such that it does not distort under view and so it can be displayed as it should be

3. Systems Library

The Systems Library offers one a view into the body's major life support systems. Each library offers a variety of pre-built templates that one can pick and choose from to build their animations. Each of the images appearing the Systems Library top-level view can be activated from this page with the animate option. If one were to select the respiratory system and click animate, the associated model would be loaded and an animation would spawn to life detailing a working model.



System Library
nasal cavity
pharynx
larynx
trachea
bronchus
epiglottis
left lung
diaphragm
pleural cavity
Right kidney
Left kidney
Ureter
Urinary bladder
Urethra

Technical Details:

Each System is defined by a **BioSystem** object. A **BioSystem** object is comprised of a collection of **BioOrgan**, **BioGland, or BioStructure** objects. For example the Respiratory system would be comprised of the nose, trachea, lungs, etc. If one were to release a pathogen into any part of the BMSystem, it would adversely effect the collection, not just the component for which it initially bound.

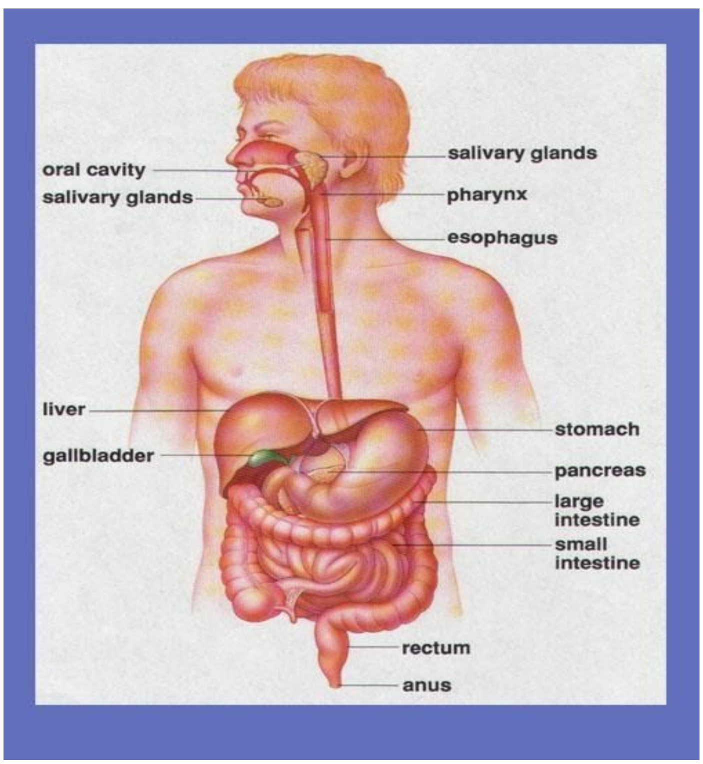
3.1 Digestive System

BioMight's Digestive System model contains elements such as the trachea, esophagus, stomach, gall bladder, and intestines. BioMight will have the ability to render images of the system in its entirety with each organ or gland occupying their designated 3D position within the human form, as presented below, and will also allow one to zoom into the independent components.

At the System Level of abstraction, BioMight presents a 3D working system that bends, stretches, and mimics the movements of the actual system correlated from biological data. BioMight's engine maintains the positions of the heart, stomach, intestine, gall bladder, and other component in 3D virtual world.

Configuration parameters such as body type, weight, hair color, gender, and even genetic factors can be applied to the model using the phenotype tool. This allows BioMight to create a wide variety of representations.

BioMight will be able to render biological events such as a pill being swallowed and absorbed into the body, or an event such a food being digested and transported through the digestive channel. The Disease and Pathogen tools can also be applied at this level such that one can observe the effects on the system and render customized images.

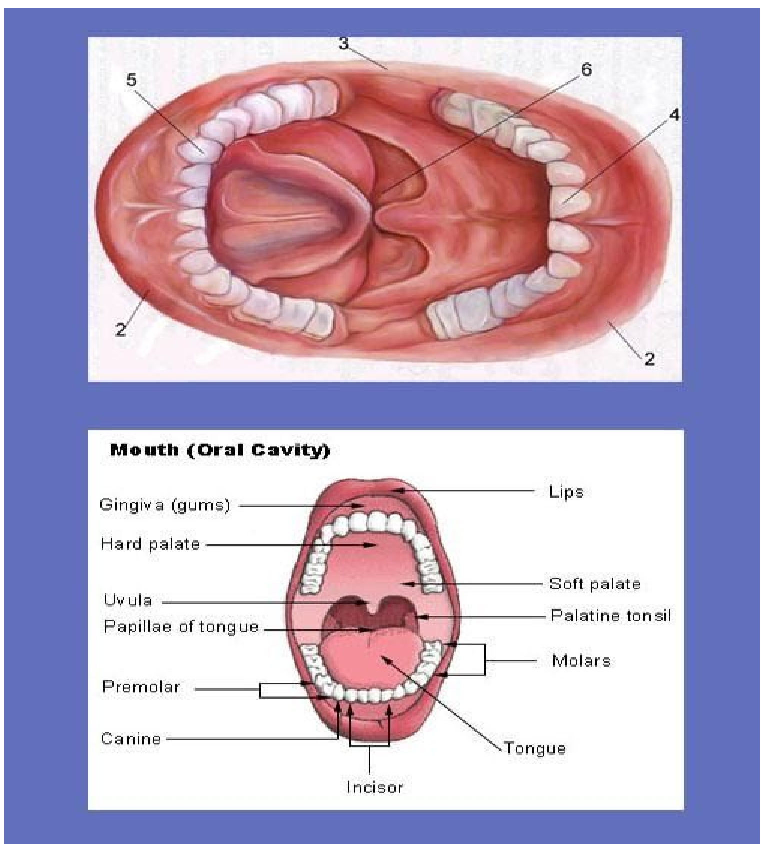


3.1.1

Decomposition Tool – Mouth

Food enters the digestive system via the mouth, which is mucous membrane lined. The lips protect its outer opening, cheeks form lateral walls, hard palate and soft palate form anterior/posterior roof. Floor is muscular tongue. Tongue has bony attachments (styloid process, hyoid bone) attached to floor of mouth by frenulum. Posterior exit from mouth guarded by a ring of palatine/lingual tonsils.

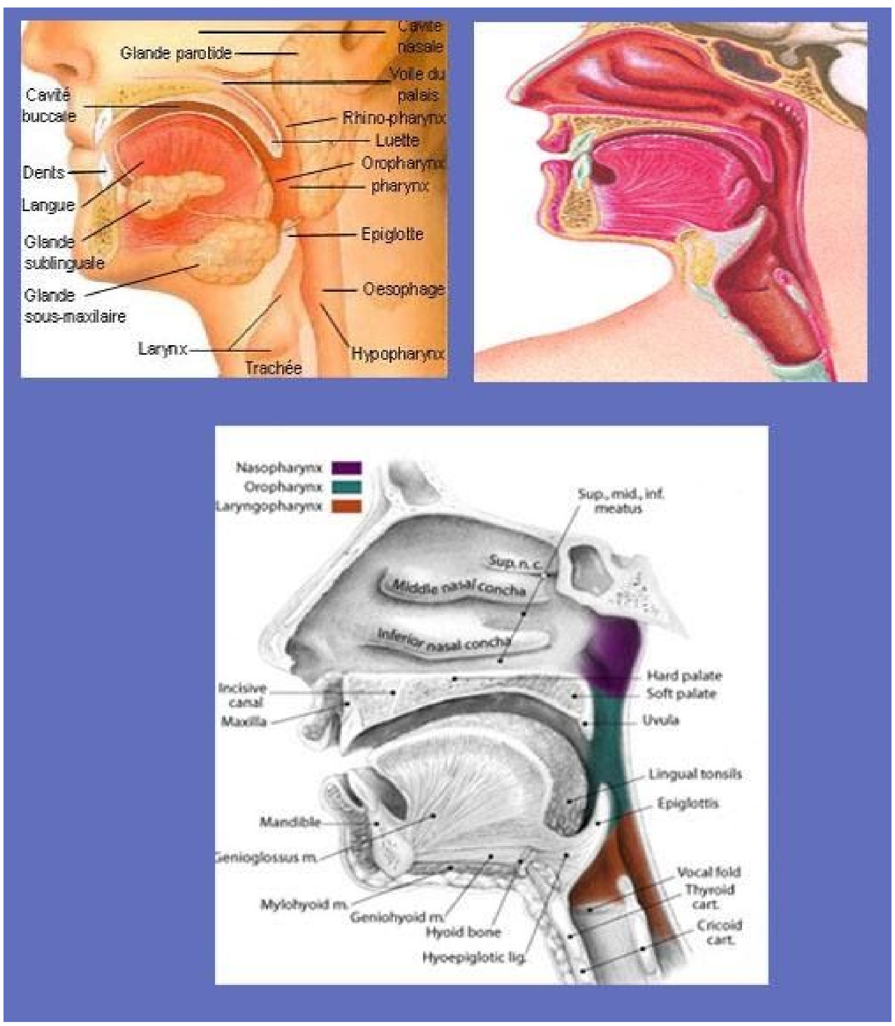
Food is first processed (bitten off) by teeth, especially the anterior incisors. Suitably sized portions then retained in closed mouth and chewed or masticated (especially by cheek teeth, premolars, molars) aided by saliva Ducted salivary glands open at various points into mouth. This process involves teeth (muscles of mastication move jaws) and tongue (extrinsic and intrinsic muscles). Mechanical breakdown, plus some chemical (ptyalin, enzyme in saliva). Taste buds allow appreciation, also sample potential hazards (chemicals, toxins)



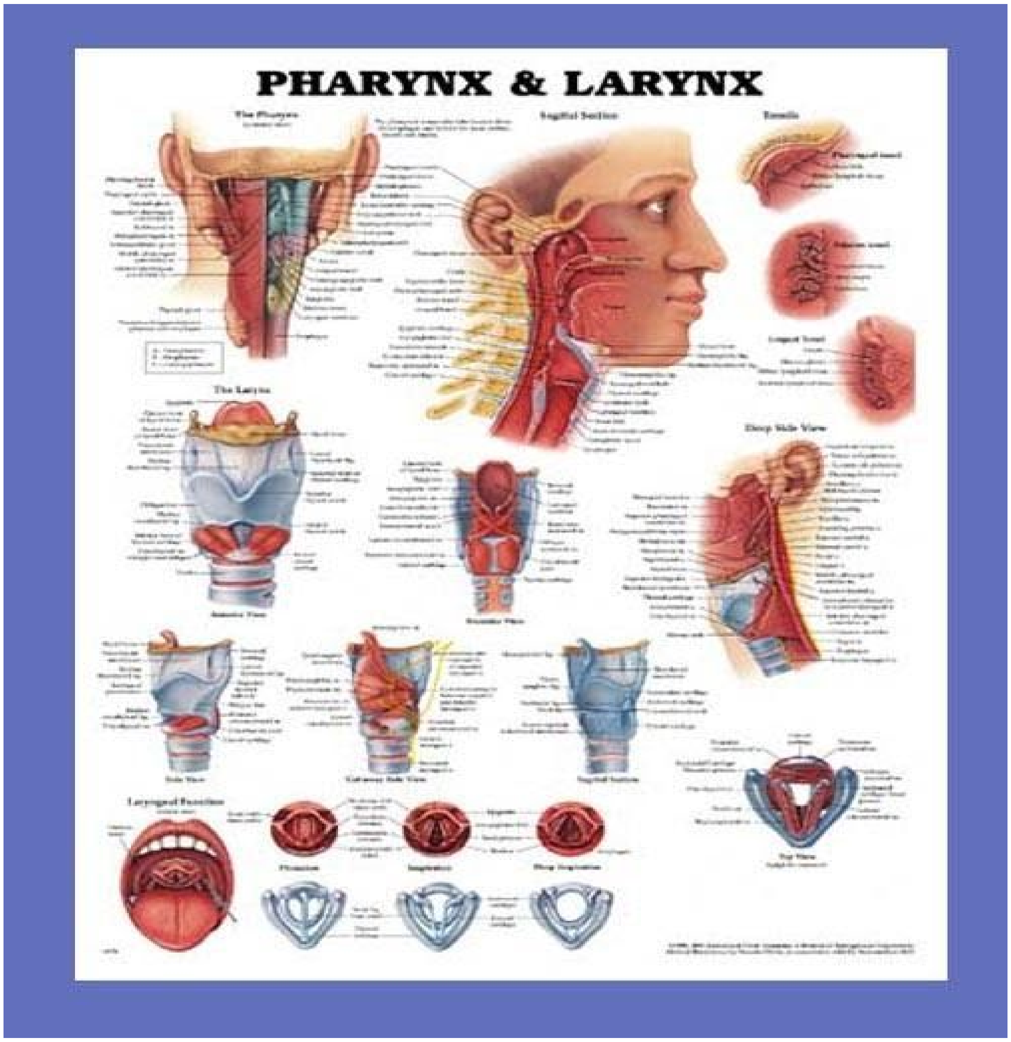
3.1.2 Decomposition Tool - Pharynx

BioMight's Pharynx model is assembled from the subcomponents such as; the Langue, Larynx, Epiglottis, nasal conchae, etc. Each model is generated based on the phylogeny of the individual as well as other configurable elements.

The **pharynx** is that part of the digestive tube which is placed behind the nasal cavities, mouth, and larynx. It is a musculomembranous tube, somewhat conical in form, with the base upward, and the apex downward, extending from the under surface of the skull to the level of the cricoid cartilage in front, and that of the sixth cervical vertebra behind. The cavity of the pharynx is about 12.5 cm. long, and broader in the transverse than in the antero-posterior diameter.



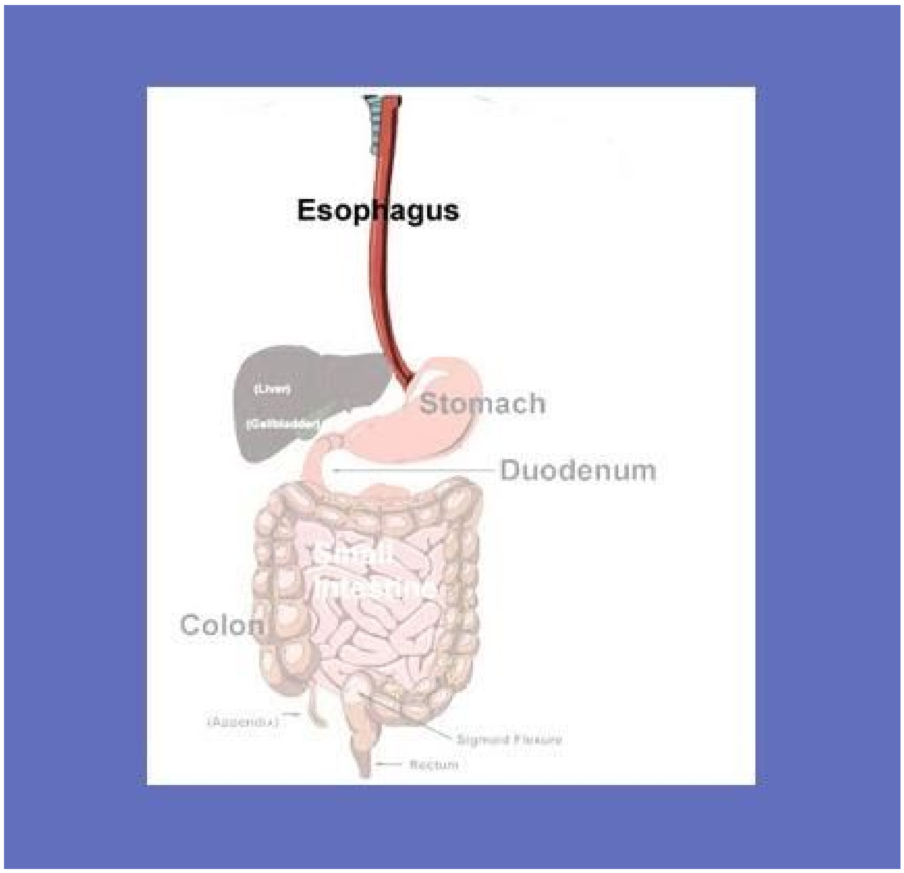
BioMight will allow one to view the model of the Pharynx as a whole, or separate it into it views of the constituent components.



3.1.3

Decomposition Tool – Esophagus Organ

The **esophagus** is a muscular canal, about 23 to 25 cm. long, extending from the pharynx to the stomach. It begins in the neck at the lower border of the cricoid cartilage, opposite the sixth cervical vertebra, descends along the front of the vertebral column, through the superior and posterior mediastina, passes through the diaphragm, and, entering the abdomen, ends at the cardiac orifice of the stomach, opposite the eleventh thoracic vertebra.



The general direction of the esophagus is vertical; but it presents two slight curves in its course. At its commencement it is placed in the middle line; but it inclines to the left side as far as the root of the neck, gradually passes to the middle line again at the level of the fifth thoracic vertebra, and finally deviates to the left as it passes forward to the esophageal hiatus in the diaphragm. The esophagus also presents antero-posterior flexures corresponding to the curvatures of the cervical and thoracic portions of the vertebral column. It is the narrowest part of the digestive tube, and is most contracted at its commencement, and at the point where it passes through the diaphragm.

3.1.3.1 Virtual Coordinates

Abstracting at the Organ Level the Esophagus resides in blocks {{X1,Y1,Z1}, {X1,Y1,Z1},… },

3.1.3.2 Mesh Coordinates

3.1.3.3 Hues & Saturation

Abstracting

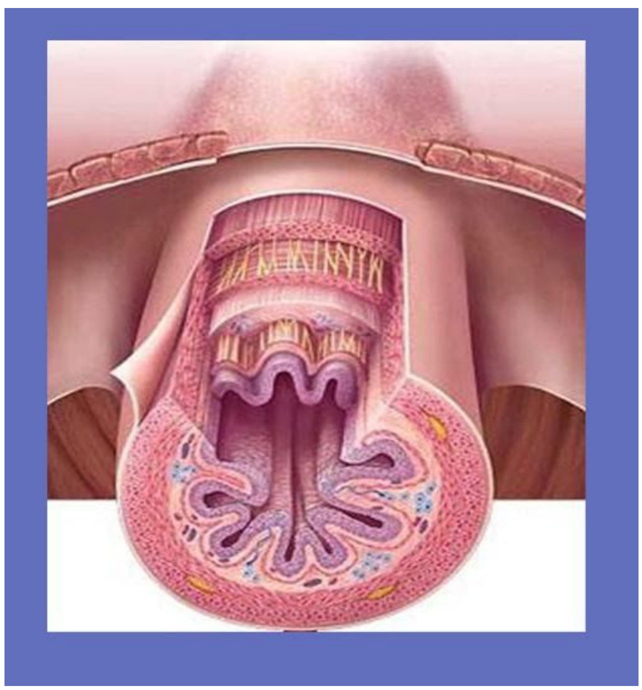
3.1.4

Decomposition Tool – Esophagus Tissue

BioMight's Esophagus model allows one to abstract to the tissue level, where one can view the layers within the model. The esophagus consists of several distinct layers. Covering the outside is a thin fibrous covering, followed by a coat made of divided fibers of longitudinal muscle. A layer of transverse or circular muscular fibers follow.

Next, is the submucous coat or areolar layer which connects loosely the mucous and muscular coat. It contains blood vessels, nerves, and mucous glands. The *e*Muscularis mucosæ follows. At the commencement of the esophagus, the *e*Muscularis mucosæ are absent, or only represented by a few scattered bundles; lower down it forms a considerable stratum.

The Mucous membrane follows and has vessels and part of lymphoid nodules. The **esophageal glands** (*glandulæ æsophageæ*) are small compound racemose glands of the mucous type: they are lodged in the submucous tissue, and each opens upon the surface by a long excretory duct. Lastly, on the innermost layer, one finds Striated muscular fibers



When BioMight constructs a representation of the layers, it works by "growing" the layers from sections and then assembling them into a working whole. For instance, BioMight does not maintain a model of each individual cell that comprises the longitudinal muscle layer. BioMight, upon analyzing the dimensions of the slide one is constructing, and taking into the considerations the user's viewpoint, constructs the tissue as a collection of cells glued together, each dynamically generated based on the configuration parameters for the given model.

3.1.4.1 Virtual Coordinates

Abstracting at the Organ Level the Esophagus resides in blocks {{X1,Y1,Z1}, {X1,Y1,Z1},… },

3.1.4.2 Mesh Coordinates

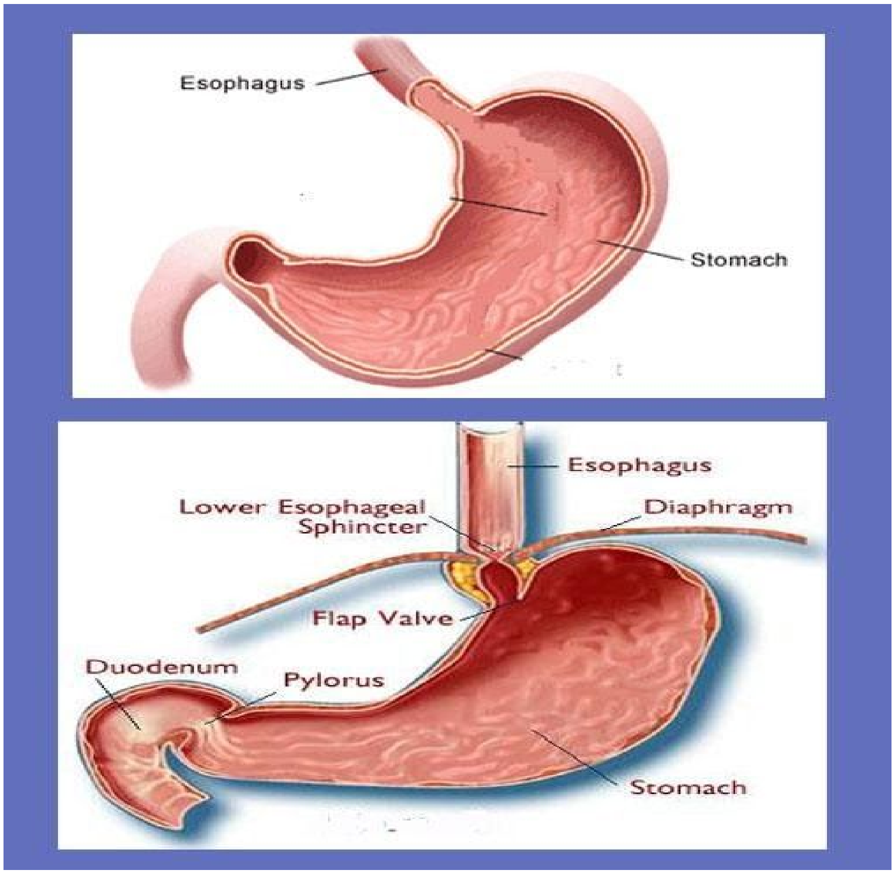
3.1.4.3 Hues & Saturation

Abstracting

3.1.5 Decomposition Tool – Stomach

The stomach is the most dilated part of the digestive tube, and is situated between the end of the esophagus and the beginning of the small intestine. It lies in the epigastric, umbilical, and left hypochondriac regions of the abdomen, and occupies a recess bounded by the upper abdominal viscera, and completed in front and on the left side by the anterior abdominal wall and the diaphragm.

The shape and position of the stomach are so greatly modified by changes within itself and in the surrounding viscera that no one form can be described as typical. The chief modifications are determined by (1) the amount of the stomach contents, (2) the stage which the digestive process has reached, (3) the degree of development of the gastric musculature, and (4) the condition of the adjacent intestines. It is, however, possible by comparing a series of stomachs to determine certain markings more or less common to all models.



Esophagus
Stomach
Esophagus
Lower Esophageal Sphincter
Diaphragm
Flap Valve
Duodenum
Pylorus
Stomach

3.1.5.1

The lesser Curvature

The **lesser curvature** extends between the cardiac and pyloric orifices and forms the right or posterior border of the stomach.

3.1.5.2 The Greater Curvature

The **greater curvature** is directed mainly forward, and is four or five times as long as the lesser curvature. Starting from the cardiac orifice at the incisura cardiaca, it forms an arch backward, upward, and to the left; the highest point of the convexity is on a level with the sixth left costal cartilage.

3.1.5.3 Lower Esophageal Sphincter

The lower esophageal sphincter is directed

3.1.5.4 Pylorus

The pylorus is where the stomach and the duodenum meet

3.1.5.5 Virtual Coordinates

Abstracting at the Organ Level the Stomach occupies grid blocks {{X1,Y1,Z1}, {X1,Y1,Z1},… },

3.1.5.6 Mesh Coordinates

3.1.5.7 Natural Hues

3.1.5.8 Virtual Coordinates

Abstracting at the Organ Level the Esophagus resides in blocks {{X1,Y1,Z1}, {X1,Y1,Z1},… },

3.1.5.9 Mesh Coordinates

3.1.5.10Hues & Saturation

Abstracting

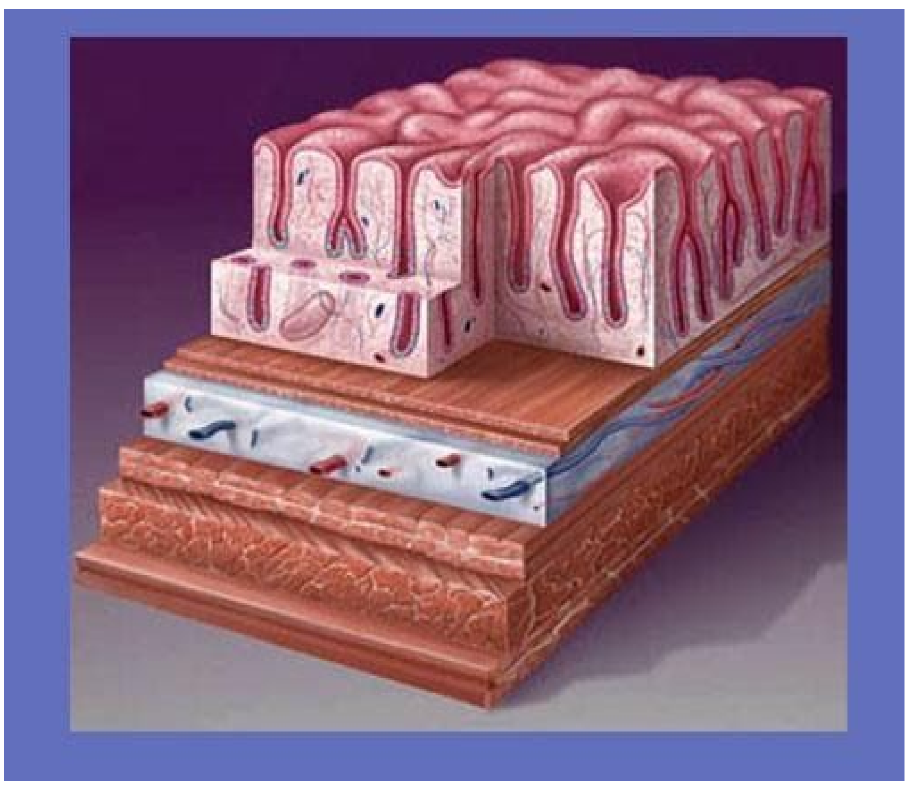
3.1.6 Decomposition Tool – Stomach Tissue

BioMight's stomach lining is comprised of a mixture of tissues just as in a real life. The three major muscular layers; the longitudinal, the circular, and the oblique, as well as the detail in the gastric folds are renderable by BioMight.

The layers of in a rendering are created based on parameters defined for the Stomach model. By default, BioMight creates the layers based on anatomical data. The user has the ability to adjust the configuration parameters such that the walls thickness can be increased or reduced as is seen when afflicted with disease or a genetic mutation.

Each layer in the stomach model is created as a separate unit. The association between the layers is maintained by the Stomach object. The dimensions and position is computed by looking at the base coordinates of the stomach to be rendered, and then using anatomical data on the layers' depth, to construct them.

The stomach's surface is thrown into some 3.5 million gastric pits.



3.1.6.1 Virtual Coordinates

Abstracting at the Organ Level the Esophagus resides in blocks {{X1,Y1,Z1}, {X1,Y1,Z1},… },

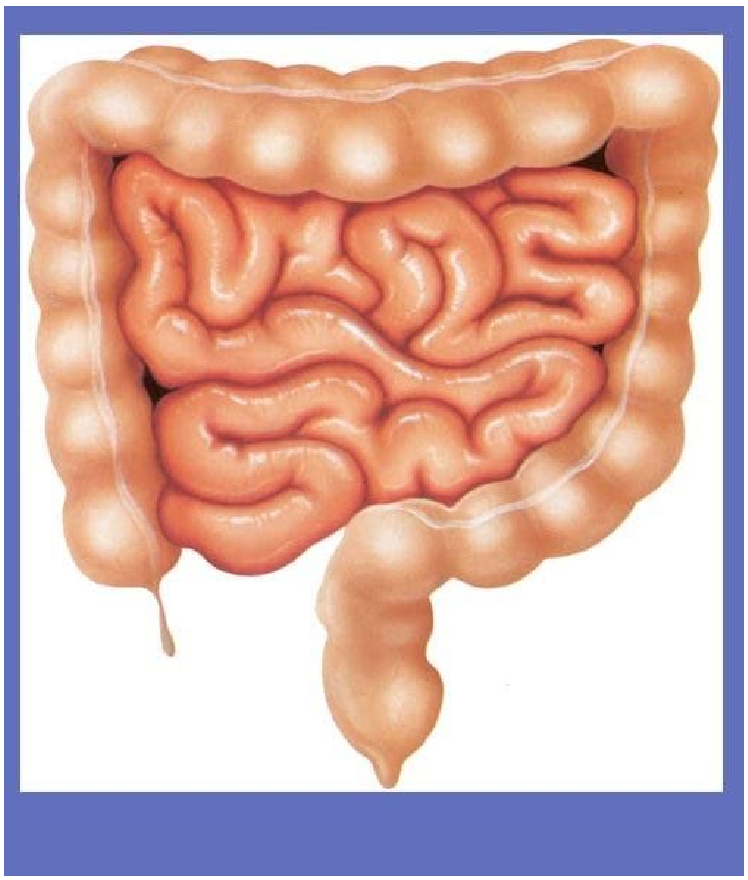
3.1.6.2 Mesh Coordinates

3.1.6.3 Hues & Saturation

Abstracting

3.1.7 Decomposition Tool – Small Intestine

The small intestine is a convoluted tube, extending from the pylorus to the colic valve, where it ends in the large intestine. It is about 7 meters long and gradually diminishes in size from its commencement to its termination. It is contained in the central and lower part of the abdominal cavity, and is surrounded above and at the sides by the large intestine; a portion of it extends below the superior aperture of the pelvis and lies in front of the rectum. It is in relation, in front, with the greater omentum and abdominal parietes, and is connected to the vertebral column by a fold of peritoneum, the mesentery. The small intestine is divisible into three portions: the duodenum, the jejunum, and the ileum.



3.1.7.1 The duodenum

The **Duodenum** has received its name from being about equal in length to the breadth of twelve fingers (25 cm.). It is the shortest, the widest, and the most fixed part of the small intestine, and has no mesentery, being only partially covered by peritoneum. Its course presents a remarkable curve, somewhat of the shape of an imperfect circle, so that its termination is not far removed from its starting-point.

3.1.7.2 The jejunum

The Jejunum is wider, its diameter being about 4 cm, and is thicker, more vascular, and of a deeper color than the ileum, so that a given length weighs more. The circular folds (*valvulæ conniventes*) of its mucous membrane are large and thickly set, and its villi are larger than in the ileum. The aggregated lymph nodules are almost absent in the upper part of the jejunum, and in the lower part are less frequently found than in the ileum, and are smaller and tend to assume a circular form. By grasping the jejunum between the finger and thumb the circular folds can be felt through the walls of the gut; these being absent in the lower part of the ileum, it is possible in this way to distinguish the upper from the lower part of the small intestine.

3.1.7.3 The ileum

The ileum is narrower, its diameter being 3.75 cm., and its coats thinner and less vascular than those of the jejunum. It possesses but few circular folds, and they are small and disappear entirely toward its lower end, but aggregated lymph nodules (Peyer's patches) are larger and more numerous. The jejunum for the most part occupies the umbilical and left iliac regions, while the ileum occupies chiefly the umbilical, hypogastric, right iliac, and pelvic regions.

The remainder of the small intestine from the end of the duodenum is named jejunum and ileum; the former term being given to the upper two-fifths and the latter to the lower three-fifths. There is no morphological line of distinction between the two, and the division is arbitrary; but at the same time the character of the intestine gradually undergoes a change from the commencement of the jejunum to the end of the ileum, so that a portion of the bowel taken from these two situations would present characteristic and marked differences.

3.1.7.4 Virtual Coordinates

Abstracting at the Organ Level the Esophagus resides in blocks {{X1,Y1,Z1}, {X1,Y1,Z1},… },

3.1.7.5 Mesh Coordinates

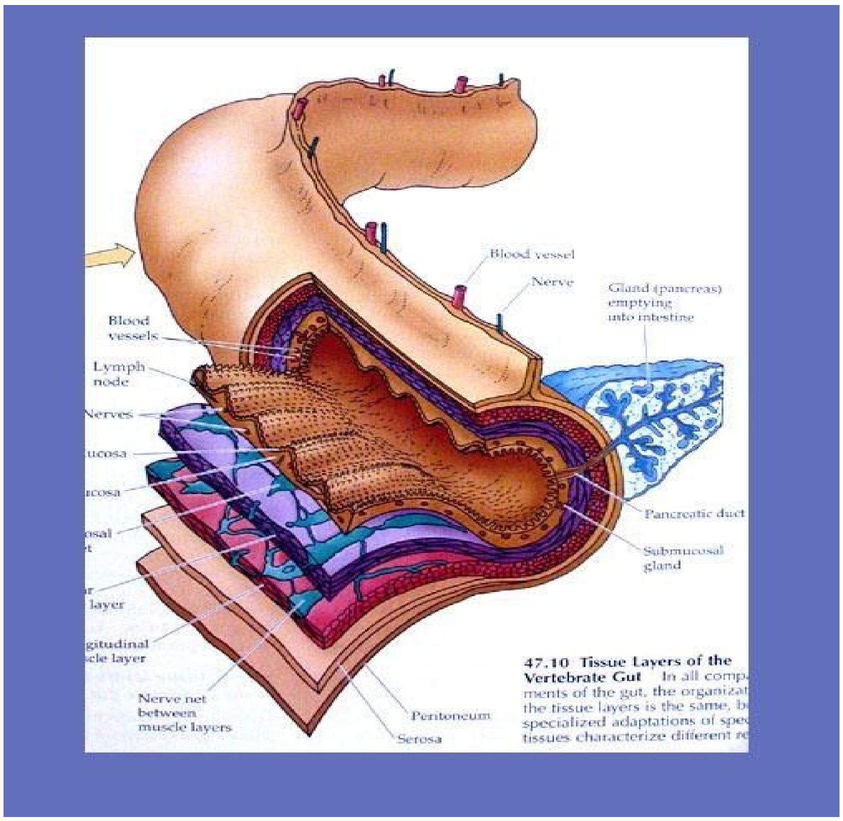
The Stomach model consists of ------------- data points….

3.1.7.6 Hues & Saturation

Abstracting

3.1.8 Cross Section Tool – Intestine Tissue

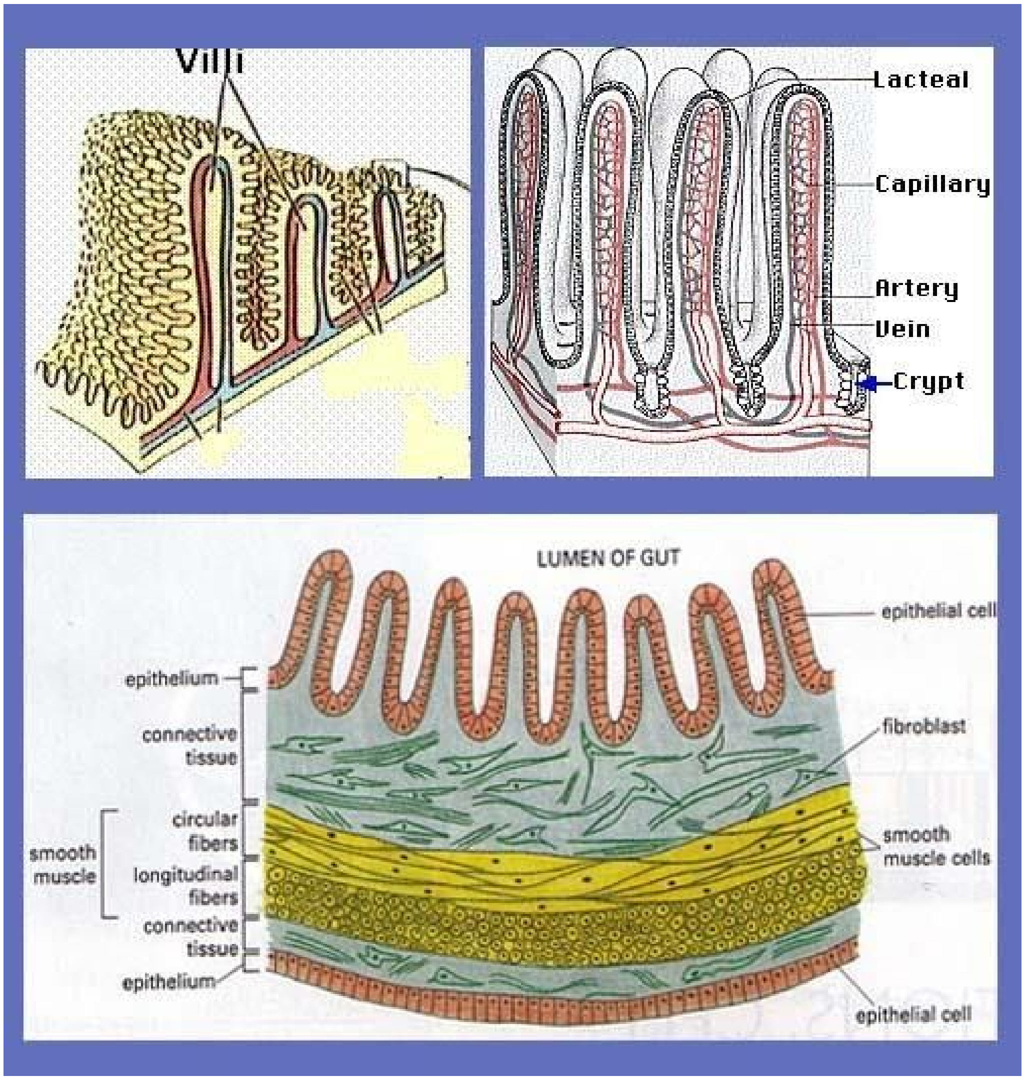
Diving into BioMight's intestinal model at the substructure layer of abstraction reveals the five layers of tissue wound together just as in the human body.



3.1.9

Decomposition Tool – Intestine Tissue

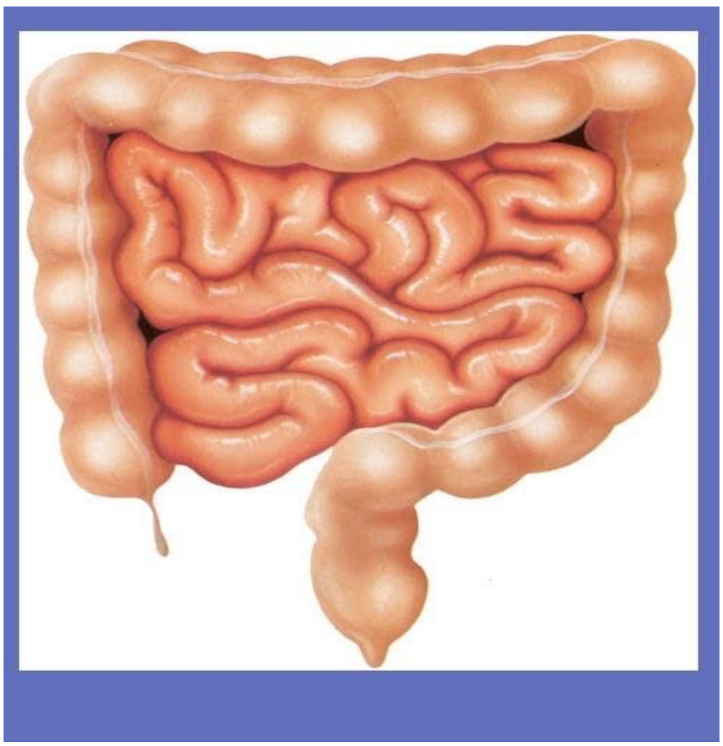
Diving into BioMight's intestinal model



3.1.10

Decomposition Tool – Large Intestine

The large intestine extends from the end of the ileum to the anus. It is about 1.5 meters long, being one-fifth of the whole extent of the intestinal canal. Its caliber is largest at its commencement at the cecum, and gradually diminishes as far as the rectum, where there is a dilatation of considerable size just above the anal canal. It differs from the small intestine in its greater caliber, its more fixed position, its sacculated form, and in possessing certain appendages to its external coat, the appendices epiploicæ. Further, its longitudinal muscular fibers do not form a continuous layer around the gut, but are arranged in three longitudinal bands or tæniæ.



3.1.10.1

The Cecum

The Duodenum has

3.1.10.2The Colon

The Duodenum has

3.1.10.3The Rectum

The Duodenum has

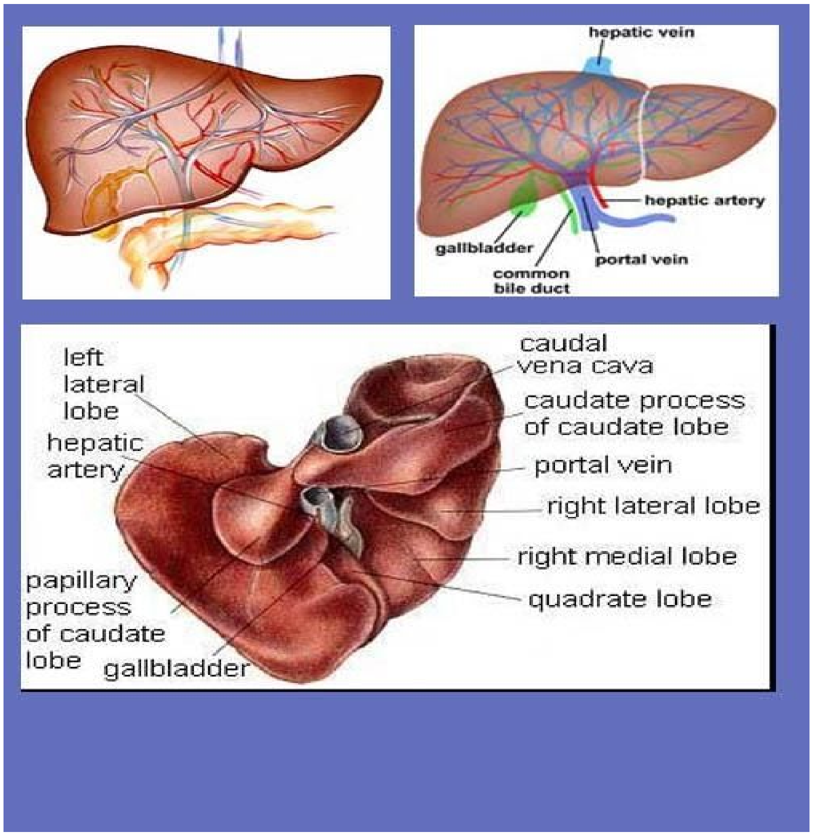
3.1.10.4The Anal Canal

The Duodenum has

3.1.11 Decomposition Tool – Liver

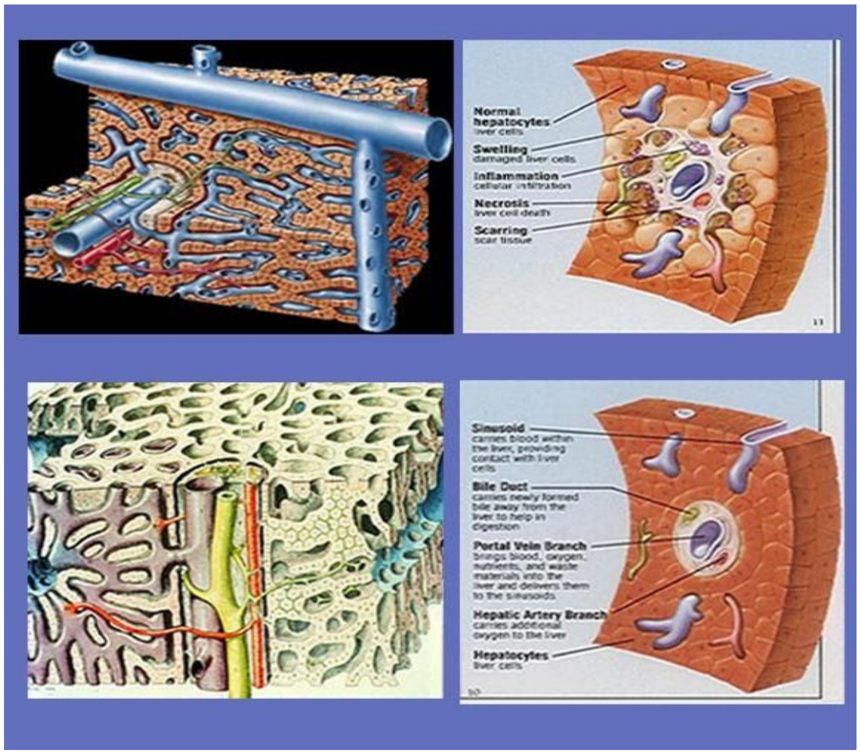
The liver is the largest gland of the body, weighing 1200 -1600 g, it is wedge-shaped, and covered by a network of connective tissue (Glisson's capsule). Situated in the upper right portion of the abdominal cavity, the liver is divided by fissures (*fossae*) into four lobes: the right (the largest lobe), left, quadrate and caudate lobes.

It is connected to the diaphragm and abdominal walls by five ligaments: the membranous falciform (also separates the right and left lobes), coronary, right and left triangular ligaments, and the fibrous round ligament (which is derived from the embryonic umbilical vein).



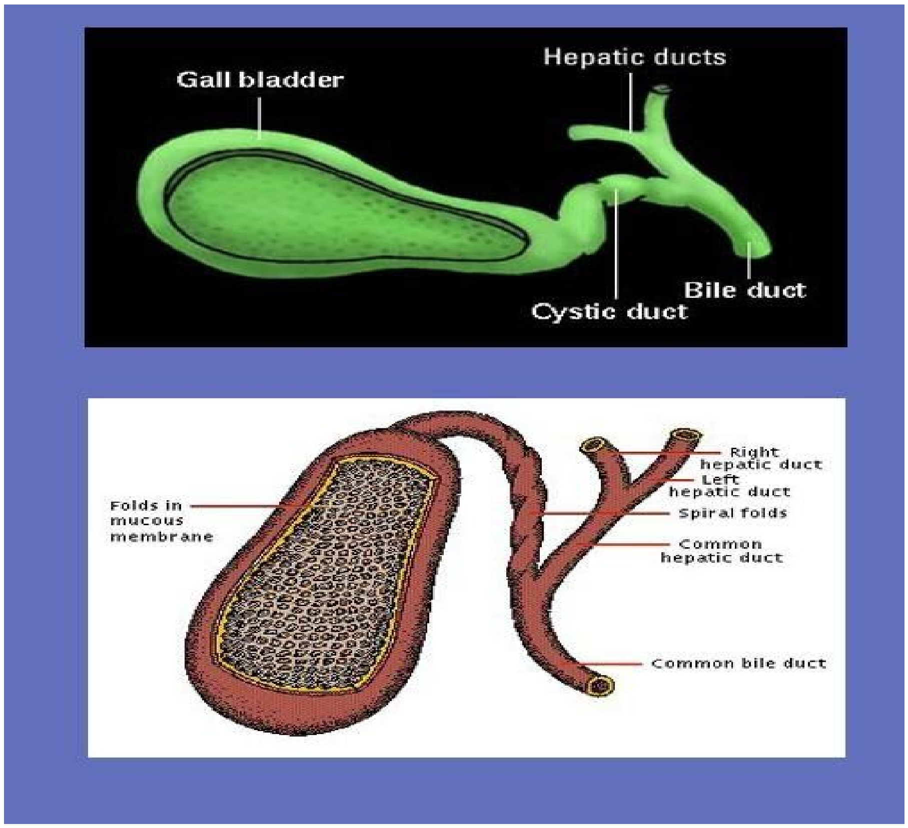
3.1.12 Decomposition Tool – Liver Tissue

Abstracting to the tissue layer, one can see the substructures that make up the organ such as; the Bile Duct, the Portal vein branch, the hepatic artery branch, and hepatic tissue. BioMight uses the patterns that occur in nature to generate its renderings.



Decomposition Tool – Gall Bladder

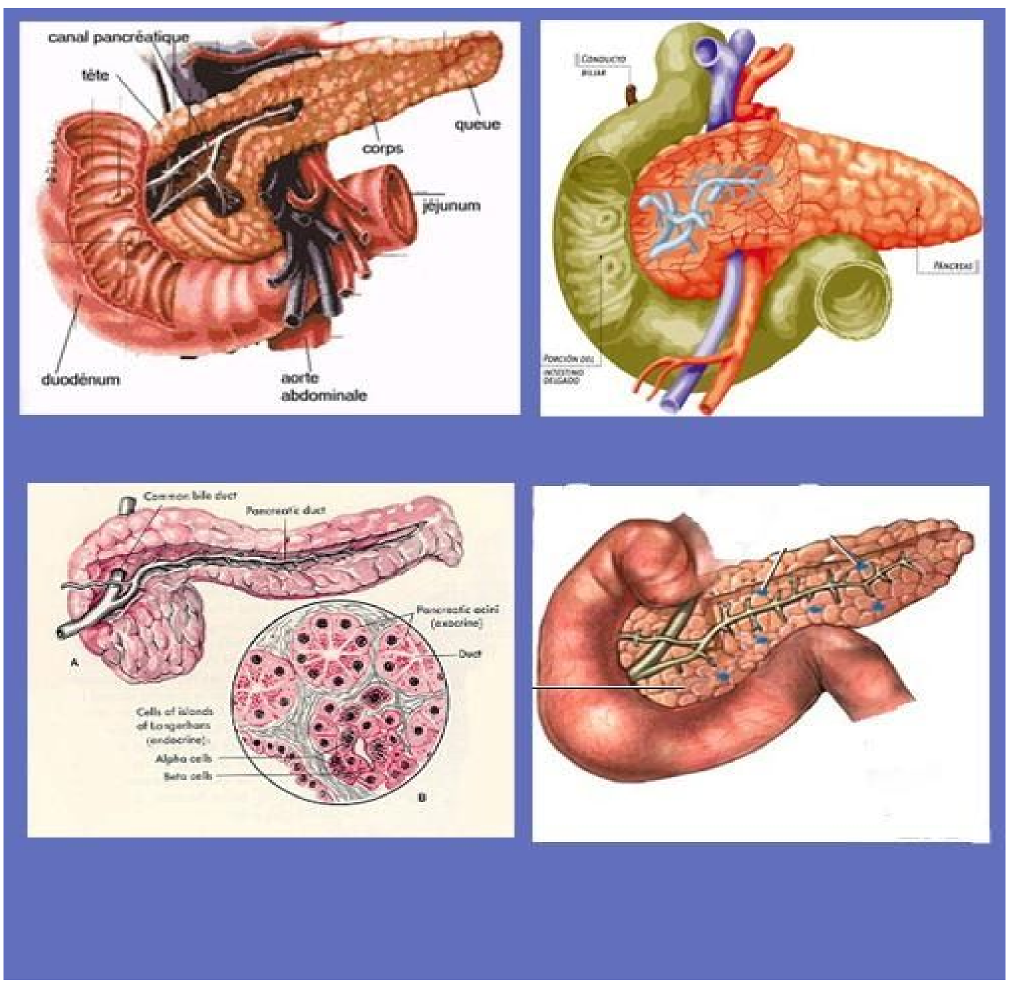
BioMight’s Gall Bladder is comprised of



3.1.13 Decomposition Tool – Pancreas

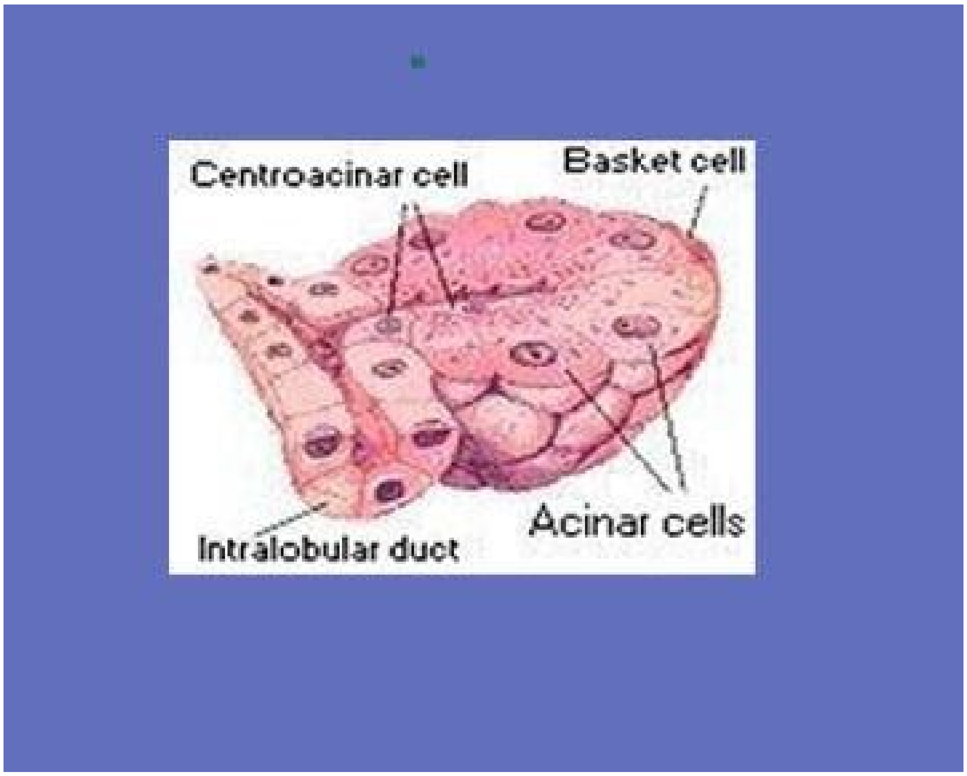
The pancreas is a compound racemose gland, analogous in its structures to the salivary glands, though softer and less compactly arranged than those organs. Its secretion, the pancreatic juice, carried by the pancreatic duct to the duodenum, is an important digestive fluid. In addition the pancreas has an important internal secretion, probably elaborated by the cells of Langerhans, which is taken up by the blood stream and is concerned with sugar metabolism.

It is long and irregularly prismatic in shape; its right extremity, being broad, is called the head, and is connected to the main portion of the organ, or body, by a slight constriction, the neck; while its left extremity gradually tapers to form the tail. It is situated transversely across the posterior wall of the abdomen, at the back of the epigastric and left hypochondriac regions. Its length varies from 12.5 to 15 cm., and its weight from 60 to 100 gm.



Decomposition Tool – Pancreas Substructures

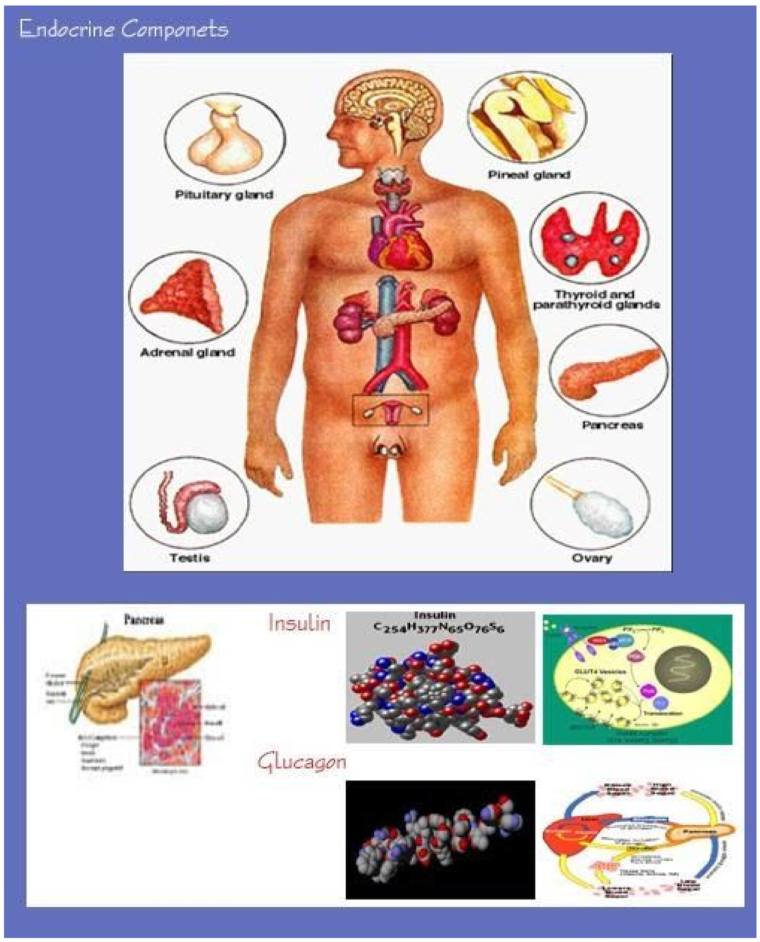
Going even deeper into the pancreas, we see the underlying structures called acini. As the pancreas is an exocrine organ, it is exuding various chemicals out of its innards.



3.2 Endocrine System

For our example, one wishes to work with Endocrine System library. A view will appear that displays the components of selected system. From here, one can further drill down into the individual organs and glands or interact with the entire model.

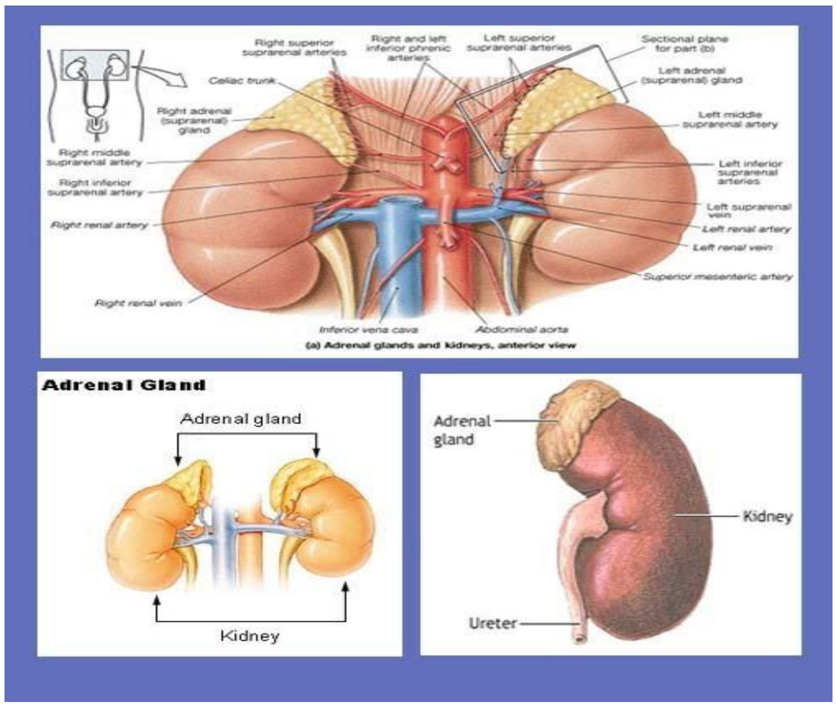
Here, one is examining pancreatic functioning. As one scrolls over the parts, the details associated with each appears in the details window appearing at the base of the page providing access to the next level of abstraction.



3.2.1

Decomposition Tool – Adrenal Gland

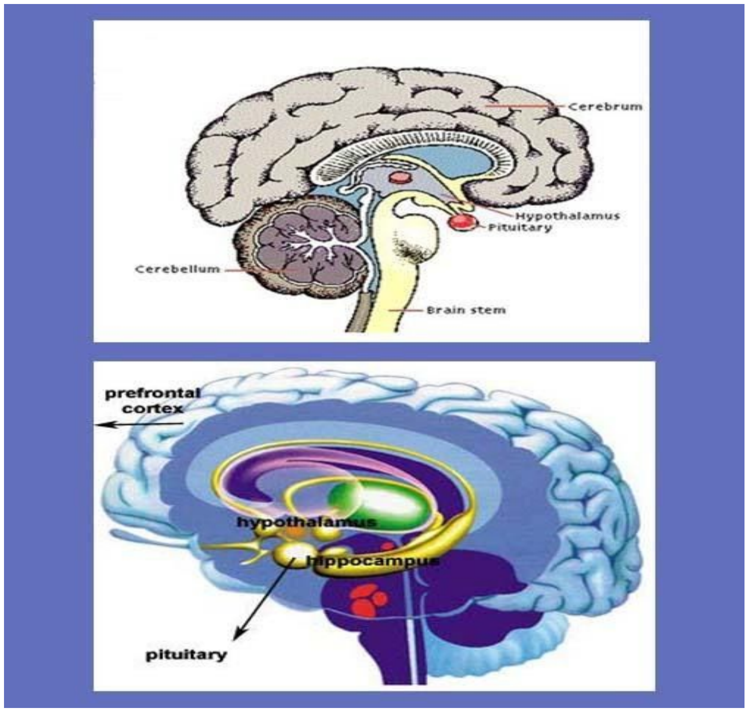
The pair of adrenal glands are located on top of both kidneys. Adrenal glands work hand-in-hand with the hypothalamus and pituitary gland.



**** can we scan the images in? Apply an algorithm to render them? Grab the Biological data points from the Adam project.

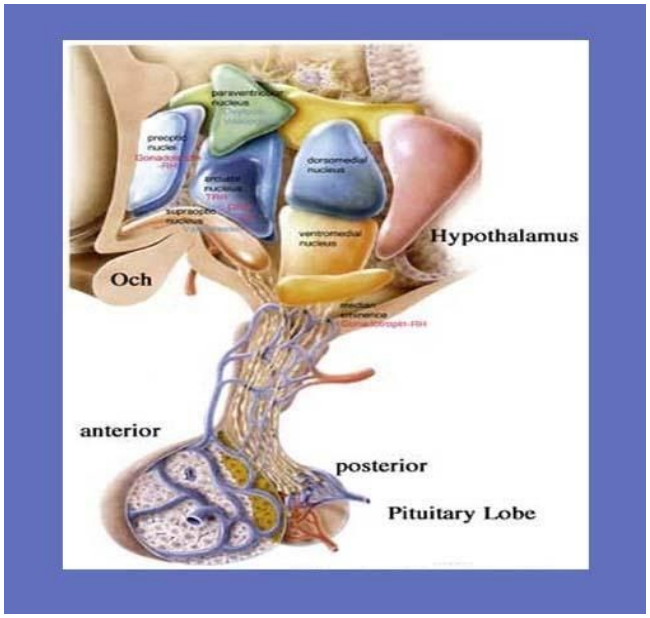
3.2.2 Decomposition Tool –Hypothalamus

BioMight's



3.2.3 Decomposition Tool –Hypothalamus Structures

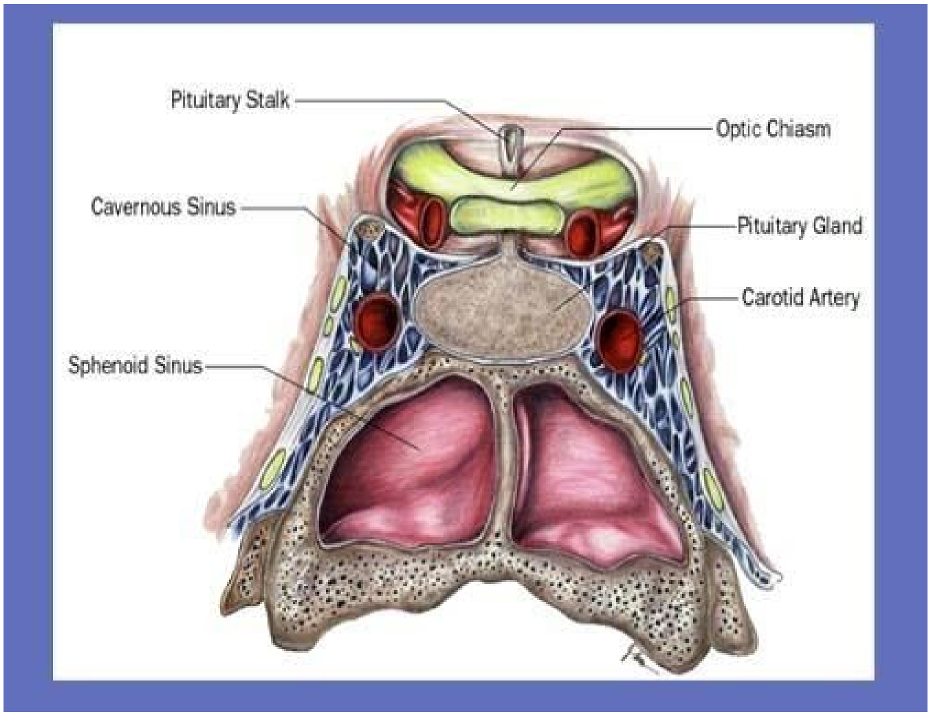
BioMight's



3.2.4

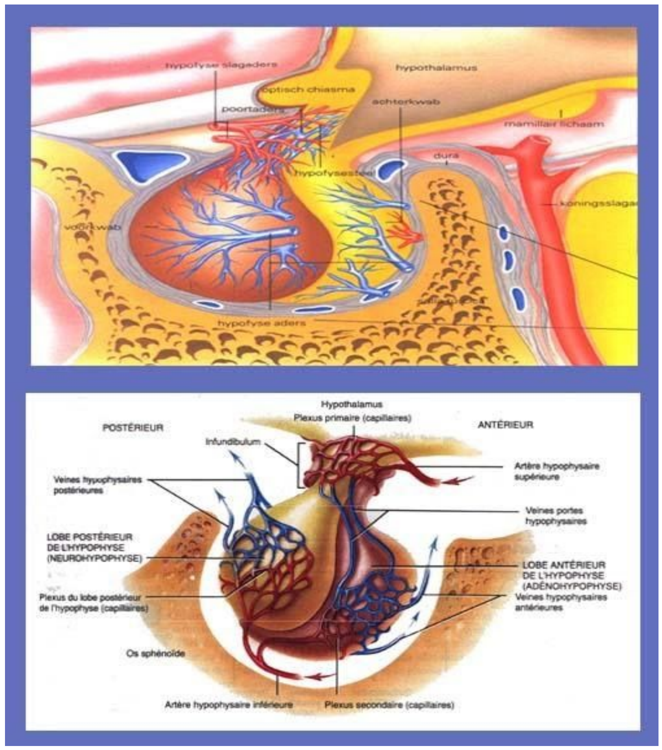
Decomposition Tool –Pituitary

BioMight's



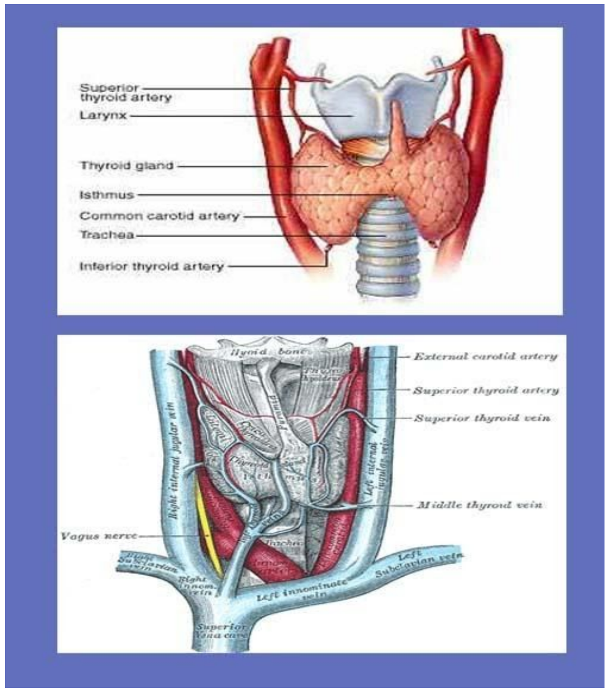
3.2.5 Decomposition Tool –Pituitary Structures

BioMight's



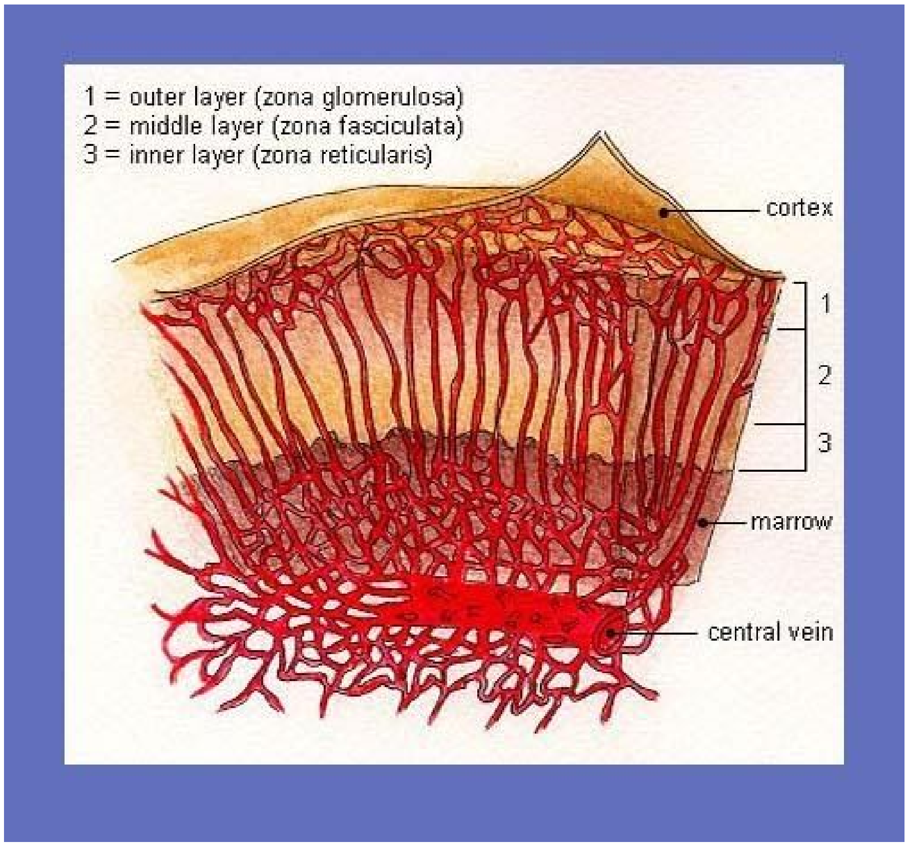
3.2.6 Decomposition Tool – Thyroid

BioMight's



3.2.7 Decomposition Tool – Thyroid Tissue

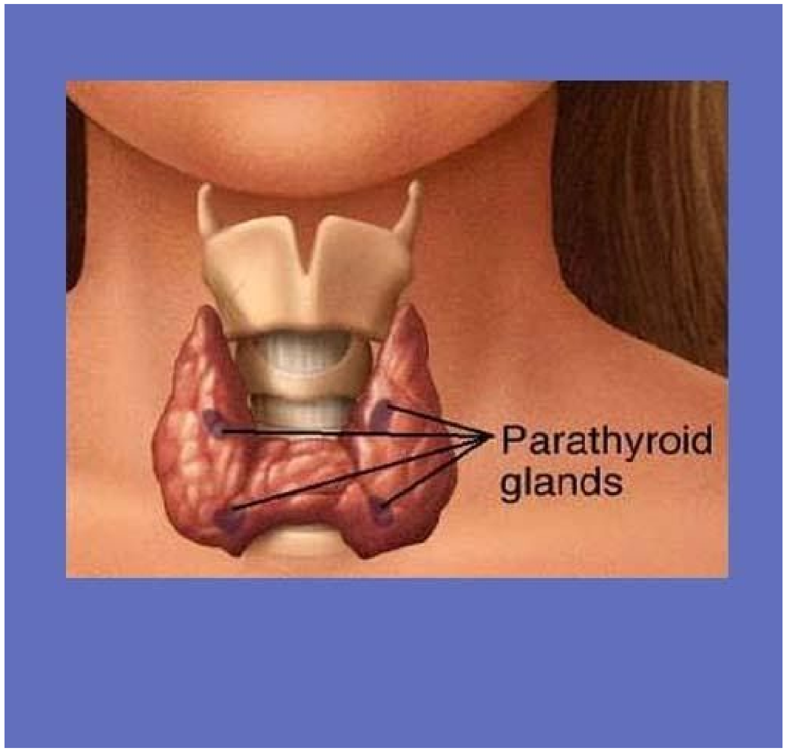
BioMight's



3.2.8

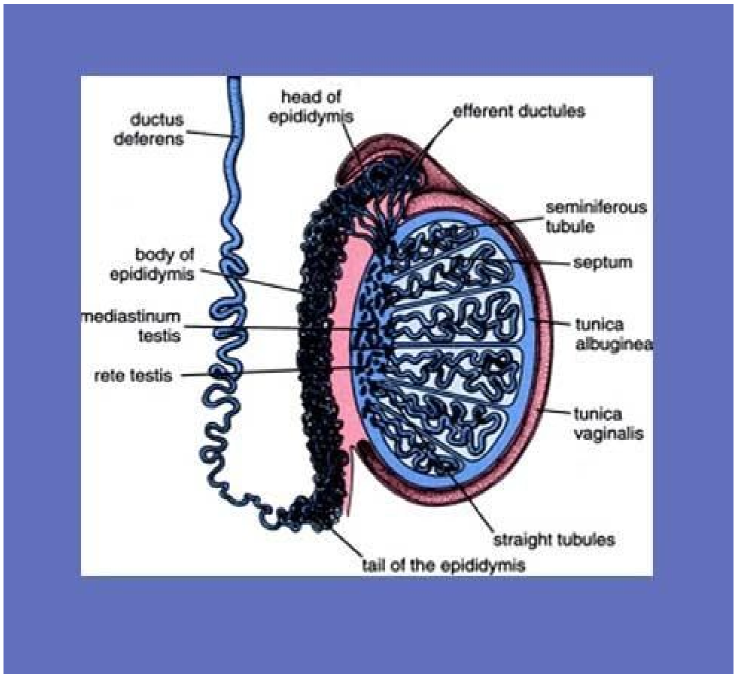
Decomposition Tool – ParaThyroids

BioMight's



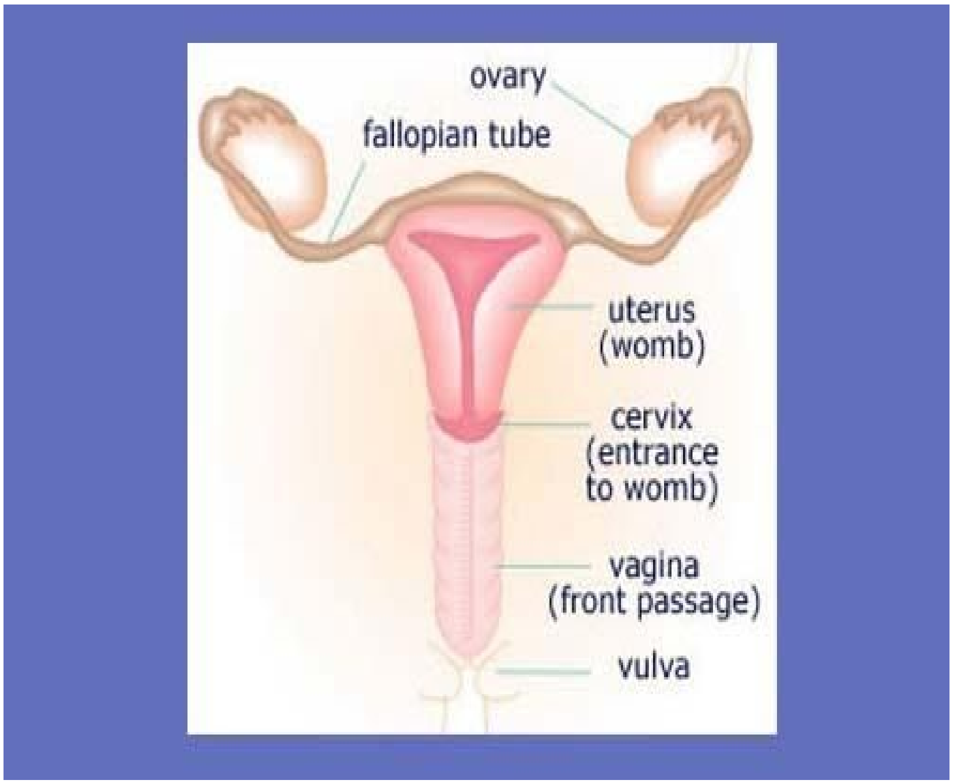
3.2.9 Decomposition Tool – Testis Gland

BioMight's

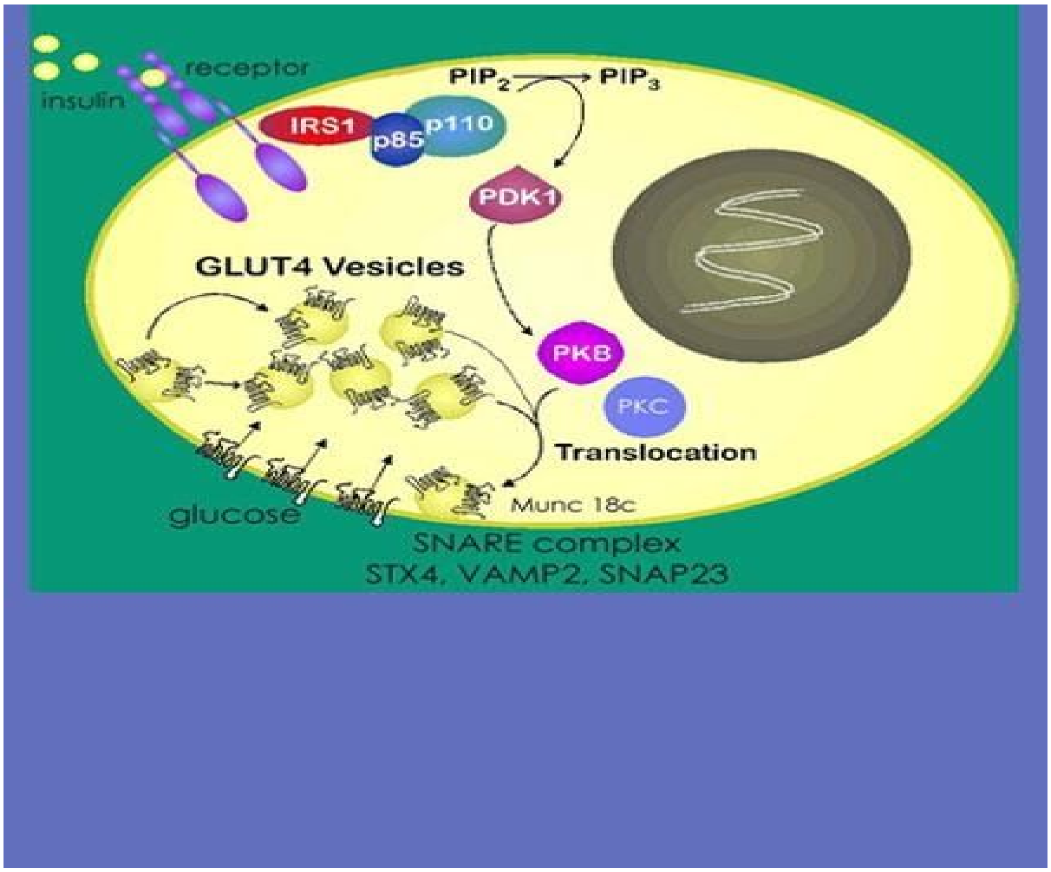


3.2.10 Decomposition Tool – Ovary

BioMight's



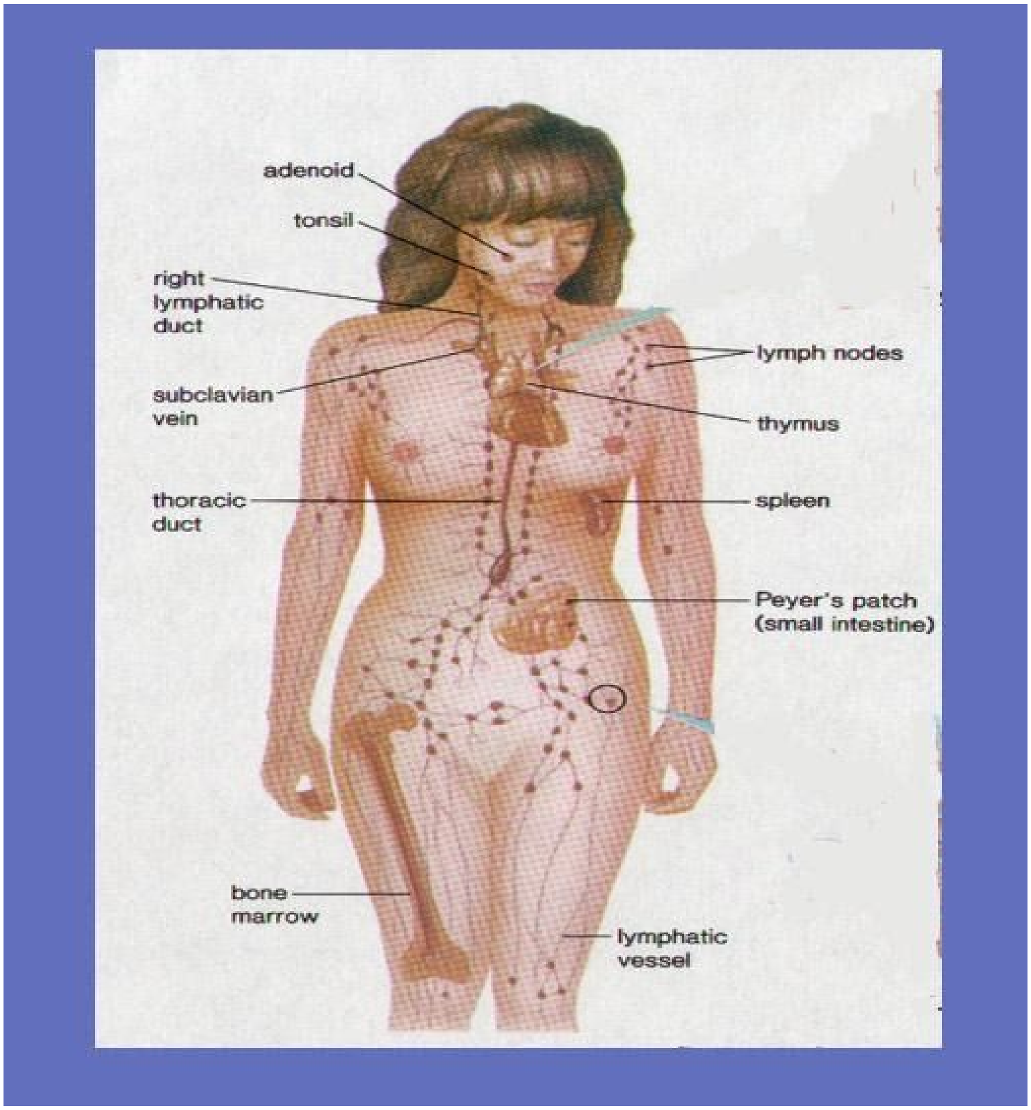
3.2.11 Pathways, Processes and Cascades



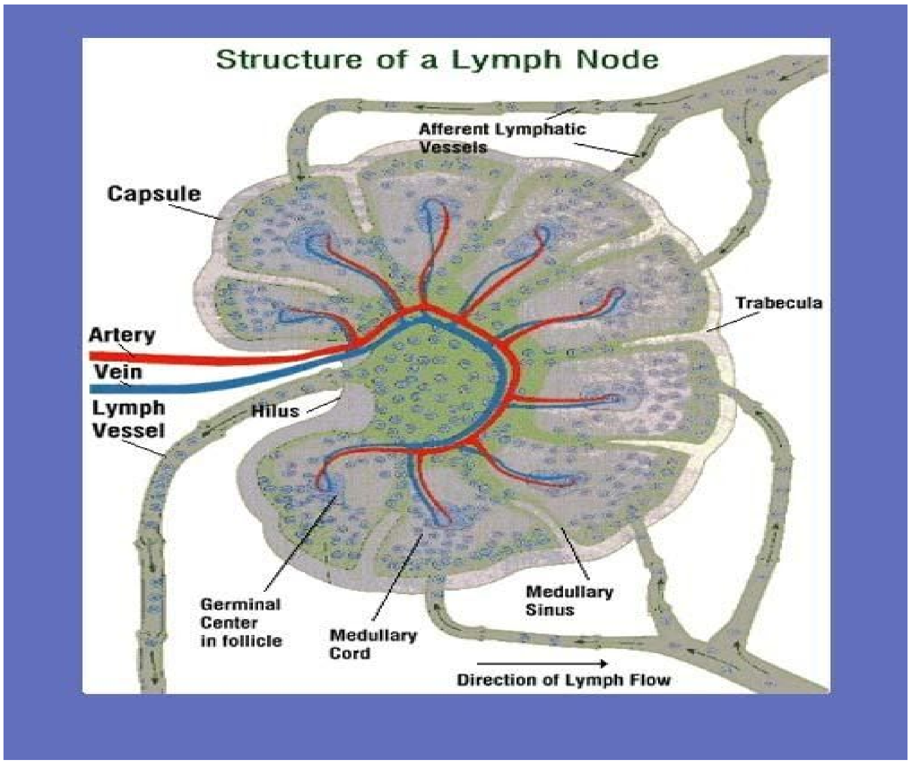
3.3

Lymphatic System

BioMight's Lymphatic system top-level view allows one to see the major components of the system. Shown below is a presentation of BioMight's ------ theme. Also, in this theme, the user has applied BioMight's Phenotype tool to select a middle aged Caucasian woman, with dark brown hair. The Phenotype tool allows one to select items such as gender, age, ethnicity, body type, metabolism, etc.



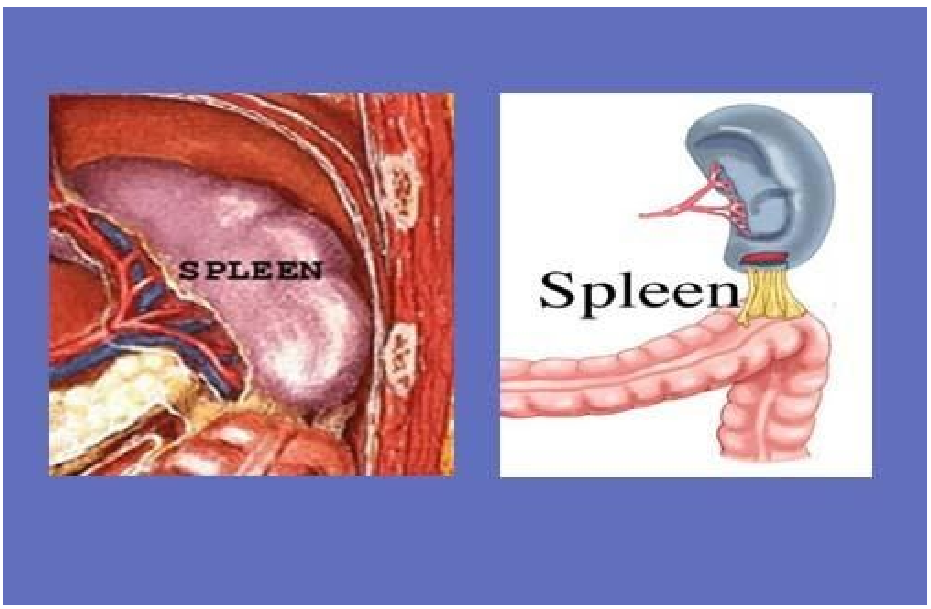
3.3.1 Decomposition Tool - Lymph Node



3.3.2 Decomposition Tool - Spleen

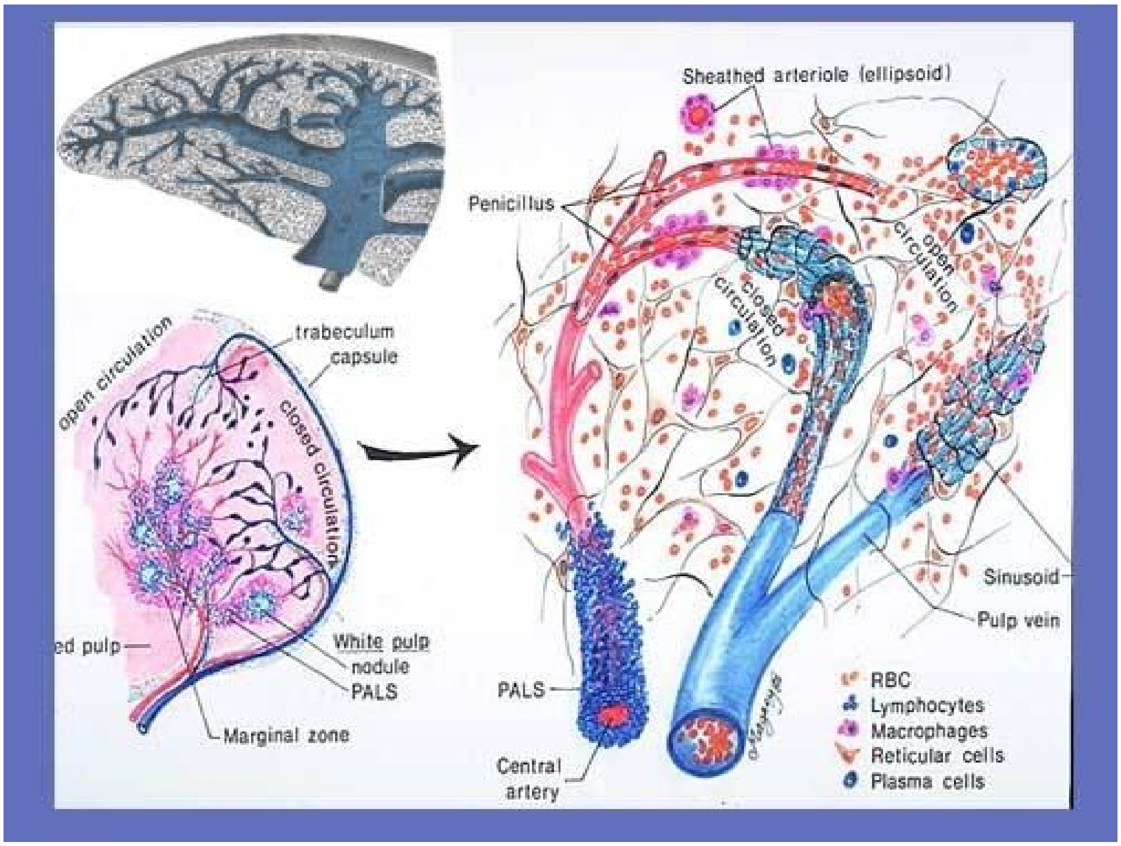
The spleen is situated principally in the left hypochondriac region, but its superior extremity extends into the epigastric region; it lies between the fundus of the stomach and the diaphragm. It is the largest of the ductless glands, and is of an oblong, flattened form, soft, of very friable consistence, highly vascular, and of a dark purplish color.

The size and weight of the spleen are liable to very extreme variations at different periods of life, in different individuals, and in the same individual under different conditions. *In the adult* it is usually about 12 cm. in length, 7 cm. in breadth, and 3 or 4 cm. in thickness, and weighs about 200 grams



3.3.3 Decomposition Tool – Spleen Tissue

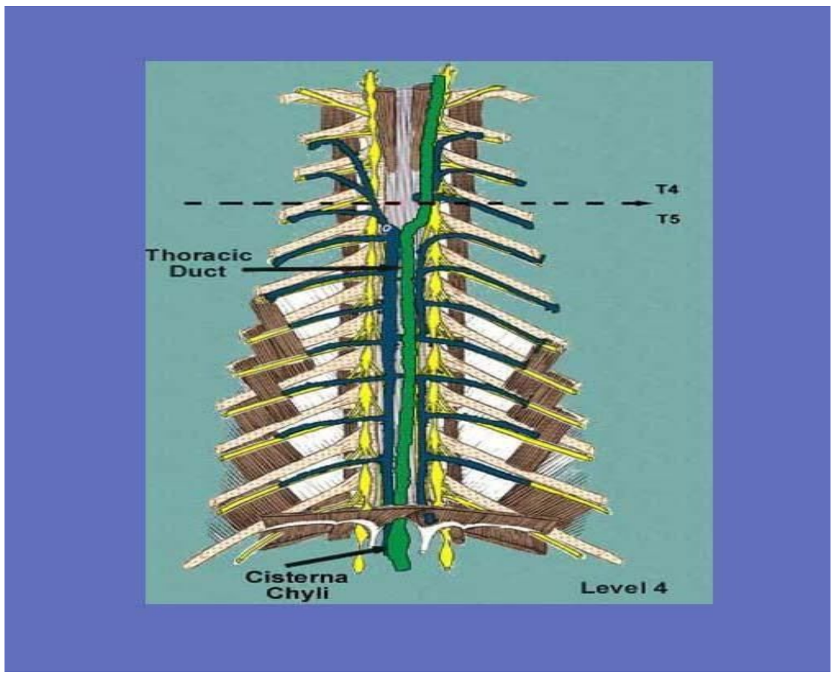
The Spleen



3.3.4

Decomposition Tool – Thoractic Duct

The thoracic duct conveys the greater part of the lymph and chyle into the blood. It is the common trunk of all the lymphatic vessels of the body, excepting those on the right side of the head, neck, and thorax, and right upper extremity, the right lung, right side of the heart, and the convex surface of the liver. In the adult it varies in length from 38 to 45 cm. and extends from the second lumbar vertebra to the root of the neck. It begins in the abdomen by a triangular dilatation, the cisterna chyli, which is situated on the front of the body of the second lumbar vertebra, to the right side of and behind the aorta, by the side of the right crus of the diaphragm.



3.3.5 Decomposition Tool – Thymus

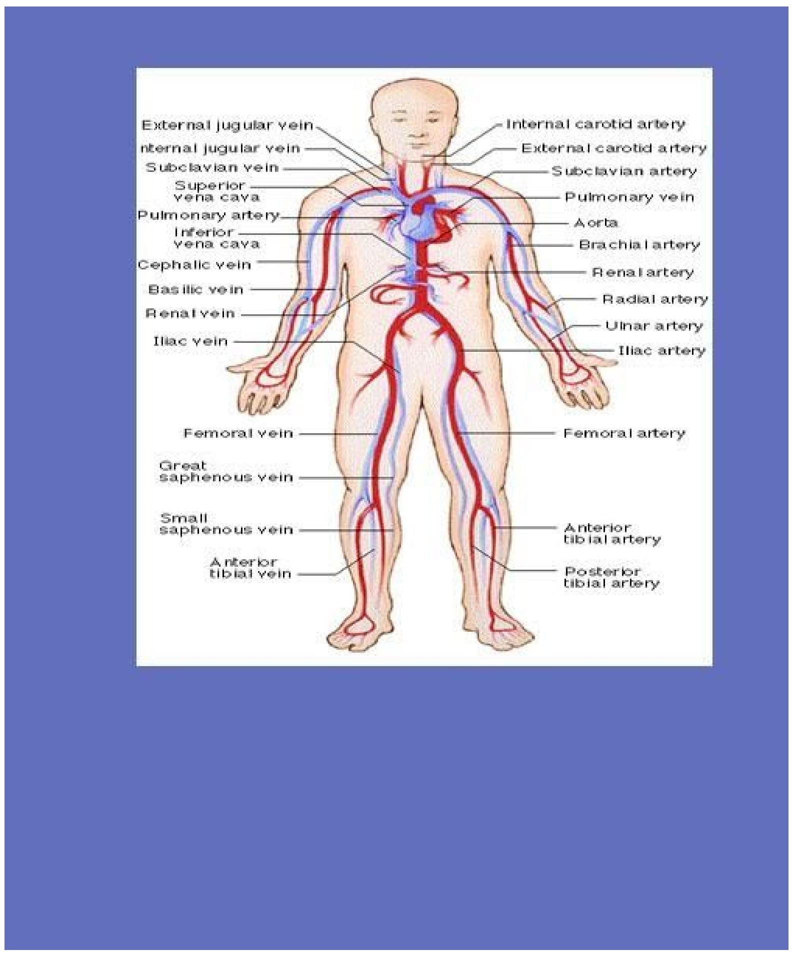
The **thymus** is a temporary organ, attaining its largest size at the time of puberty, when it ceases to grow, gradually dwindles, and almost disappears. If examined when its growth is most active, it will be found to consist of two lateral lobes placed in close contact along the middle line, situated partly in the thorax, partly in the neck, and extending from the fourth costal cartilage upward, as high as the lower border of the thyroid gland.

It is covered by the sternum, and by the origins of the Sternohyoidei and Sternothyreoidei. Below, it rests upon the pericardium, being separated from the aortic arch and great vessels by a layer of fascia. In the neck it lies on the front and sides of the trachea, behind the Sternohyoidei and Sternothyreoidei. The two lobes generally differ in size; they are occasionally united, so as to form a single mass; and sometimes separated by an intermediate lobe. The thymus is of a pinkish-gray color, soft, and lobulated on its surfaces. It is about 5 cm. in length, 4 cm. in breadth below, and about 6 mm. in thickness. At birth it weighs about 15 grams, at puberty it weighs about 35 grams; after this it gradually decreases to 25 grams at twenty-five years, less than 15 grams at sixty, and about 6 grams at seventy years.

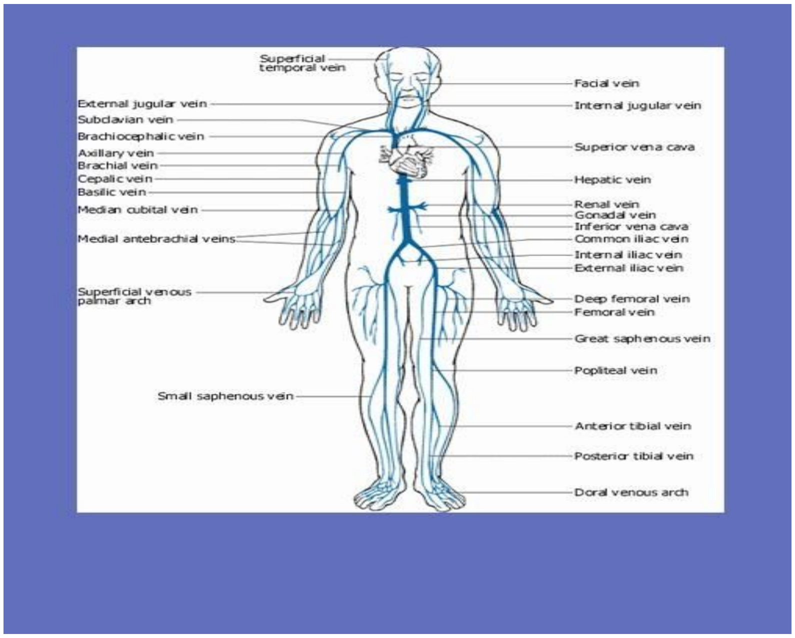
3.4 Vascular System

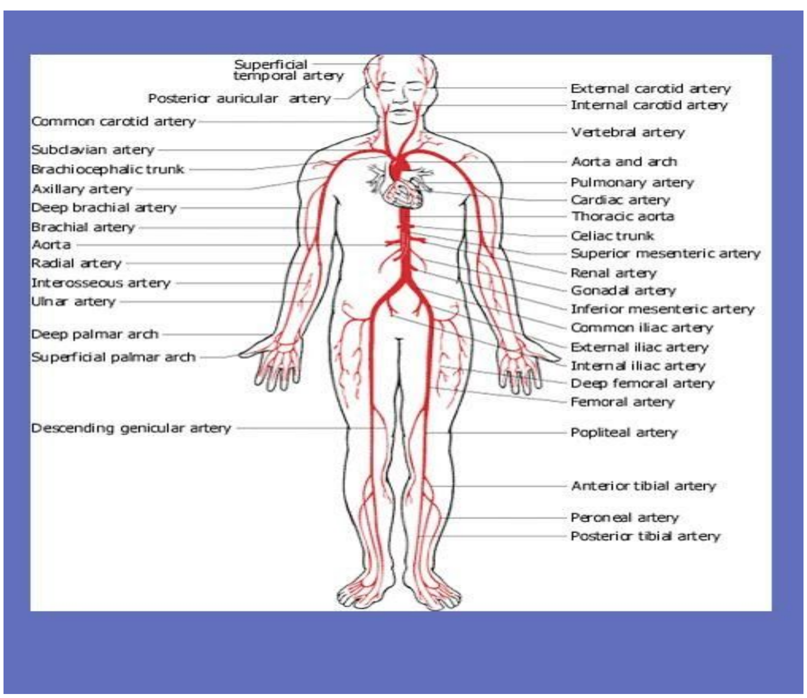
From the top-level vascular system view, one can observe the major components that comprise the system. Below, one can see that the notation property of BioMight enabled. When turned on, text descriptions and connecting lines are shown depicting the respective parts of the diagram.

From this view, one can also animate the model using the animate tool, or manipulate its orientation in 3D space, or even use the Sizing tool to affect the representations dimensions.



For each of the components, the user will be able to enable, disable, or accent their view. For instance, if one wishes to view only the veins, the artery view can be disabled. If one wishes to accent a certain component, they can choose from a range of graphic effects in which one attention can be drawn.

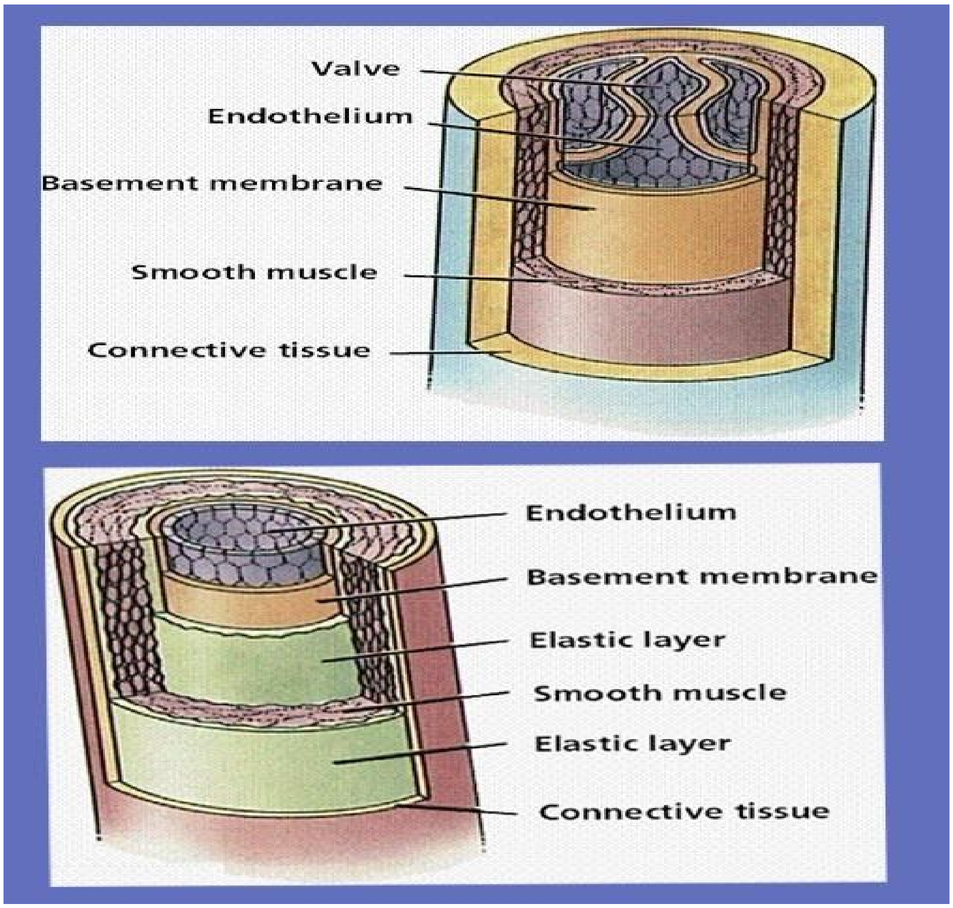




3.4.1

Decomposition Tool (Arteries/Veins)

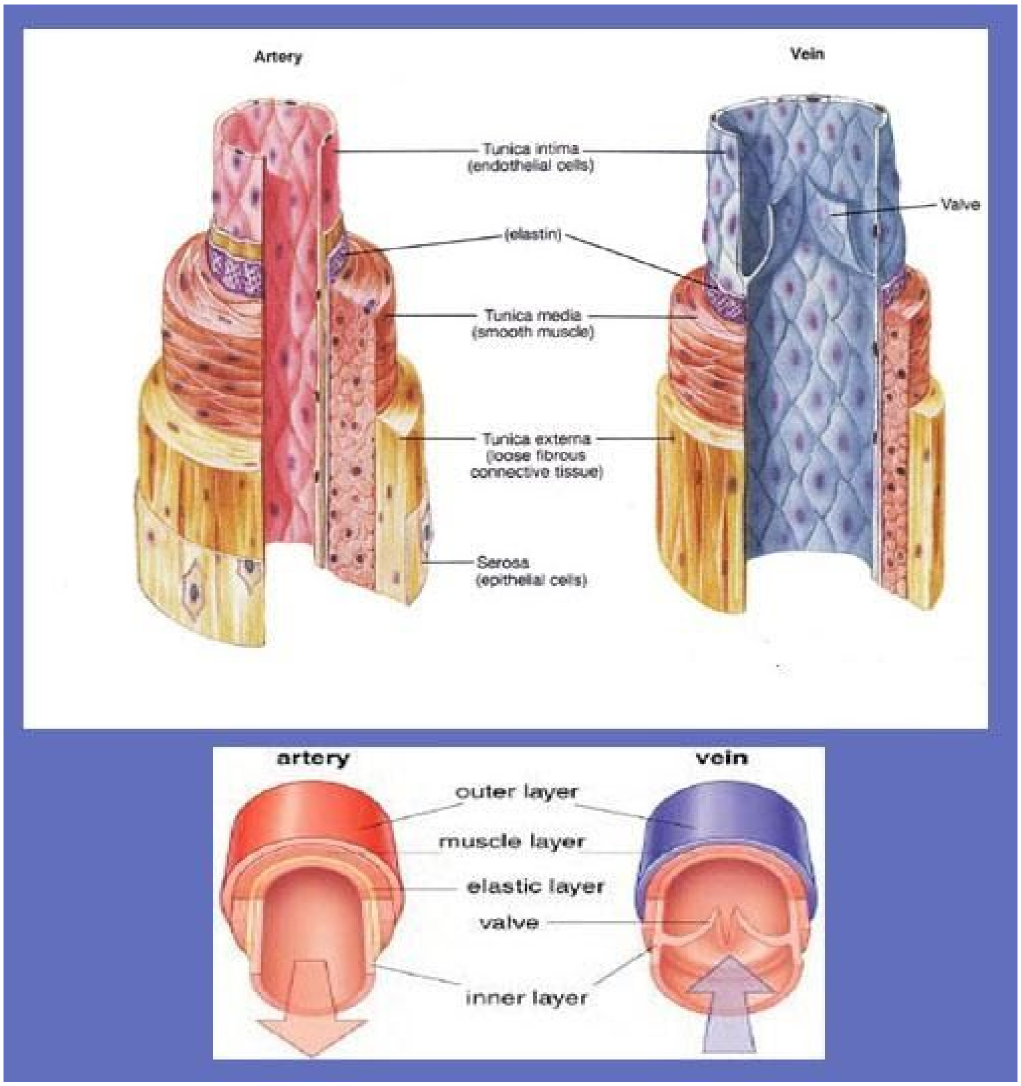
If the user was to click on one of the arteries or veins in the model using the Decomposition Tool, an illustration presented below may be displayed, based on the theme configuration parameter.



In addition, one can apply effects to the model. For instance, one can use a puncture tool to punch a hole in an artery and observe the effects. From this detail level, one would be able to see the seepage of blood into the surrounding fluids, obviously, based on the configuration of the current model.

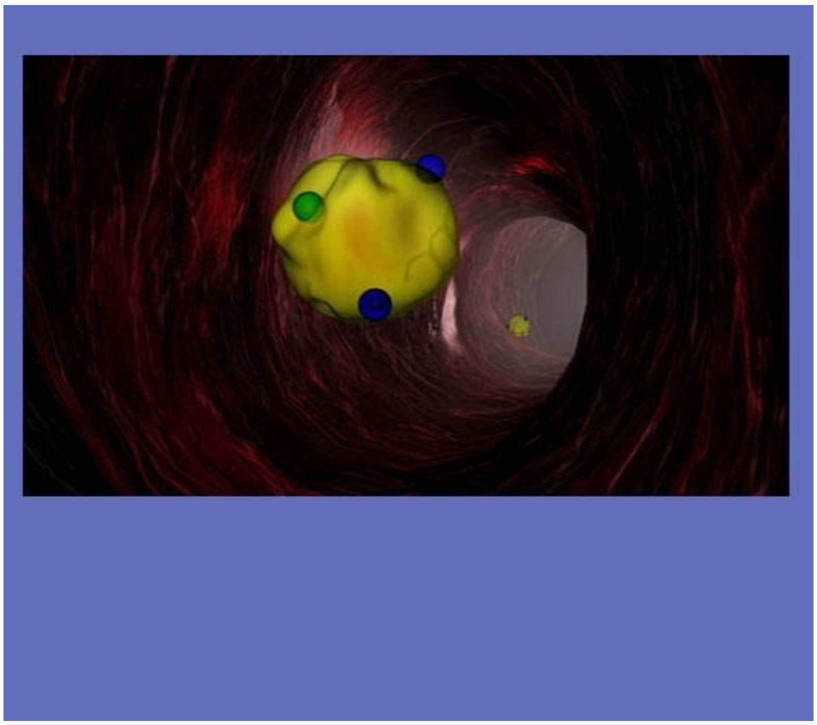
Using the syringe tool, one can also affect the working model by injecting substances into the model. Whether these, be poisons, toxins, medicines, pharmaceuticals.

By choosing another theme in combination with the Decomposition tool and Cross Section tool, one can get also get a view similar to the one depicted below.



3.4.2 Fly Through Tool

Using the FlyThrough Tool, one can dynamically change the view perspective. Activating this tool and then clicking on the artery or vein subsystems will changing the perspective from outside to within, allowing one enter the vessel assembly and traverse the system.



Travel the Vascular System

Every component knows where it is
The cell will know where it is.
The Component should keep its semantic tree within it
Just as DNA is carried everywhere, it needs to keep track where everything else is
Maybe that's why we carry the whole copy

When a body is loaded into BioMight;
- The Vascular channel will be created based upon the data in the model

1.) Determine the Vein/Artery in which it resides
- recurse up the chain?
- use a location algorithm.
- run through Arteries and Veins in that Body part to see where it is.
- It will need to be within the bounding box
- there is not much space that needs to be scanned as the arteries are a small tree

2.) After location is determined
Determine the current coordinate and see where you are in the tube
Determine the speed of the blood flow based upon the heart
Determine how far you can move with each tick of the clock
Create a bounding box around the component
Pick a random spot in the bounding box and move to it

There will be a section of endothelium cells that surround the cell
Get the, previous section, current section, and the forward section

3.4.3

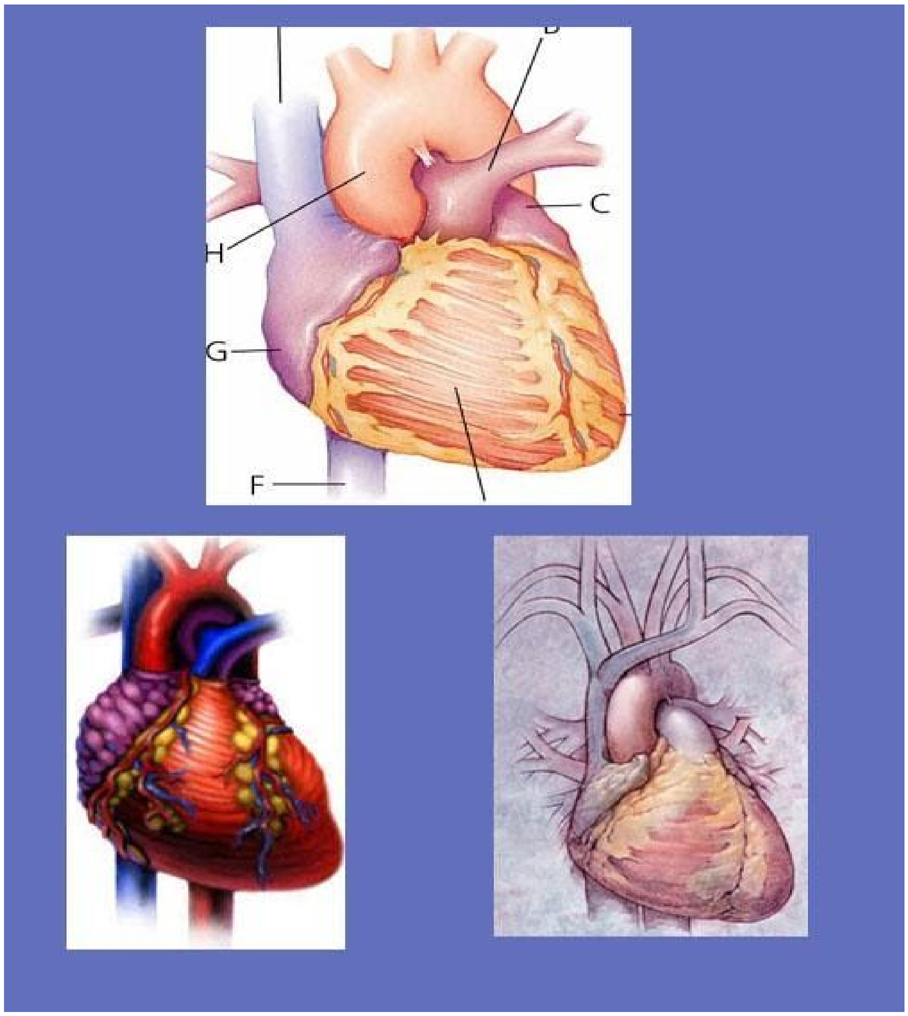
The Pericardium

The inner sac, or serous pericardium, is a delicate membrane which lies within the fibrous sac and lines its walls; it is composed of a single layer of flattened cells resting on loose connective tissue. The heart invaginates the wall of the serous sac from above and behind, and practically obliterates its cavity, the space being merely a potential one.

3.4.4

The Heart

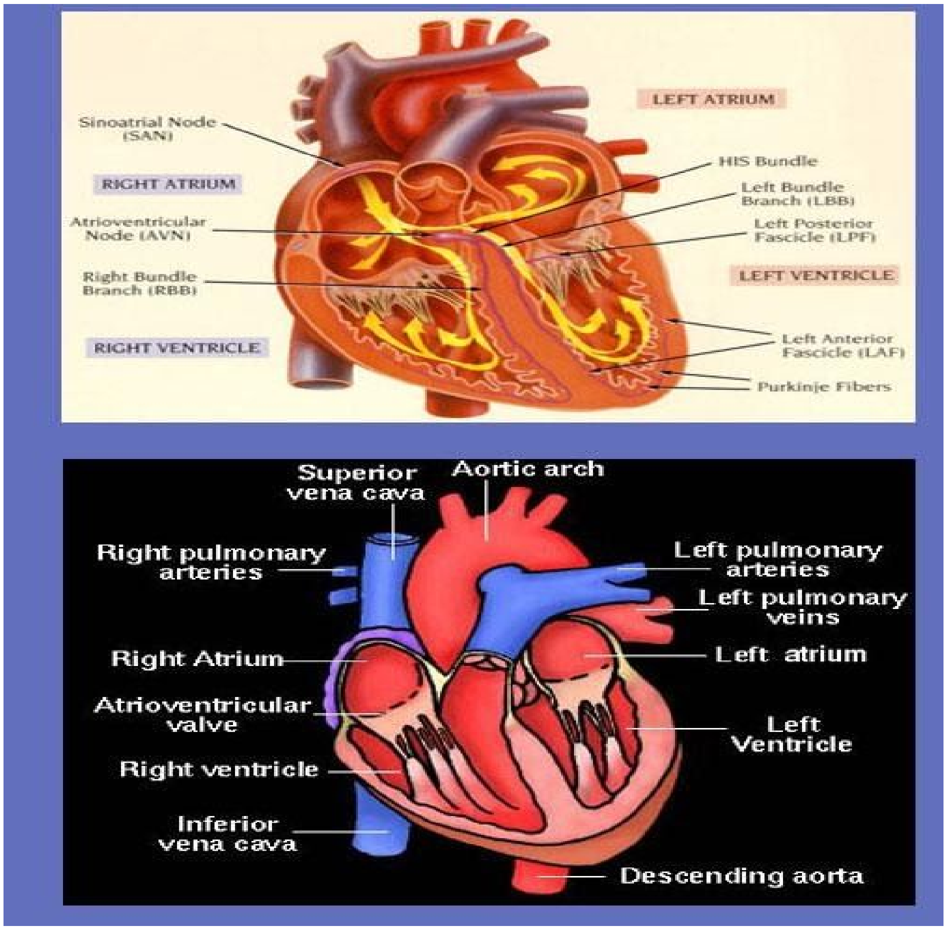
Clicking on the heart with the zoom tool opens a variety of illustrations produced through the application of various BioMight's themes.



3.4.5

Cross Section Tool (Heart)

While viewing the heart in detail mode, one can use the cross section tool to open a window to the organs inner workings.



3.4.5.1

Coronary Arteries

The coronary arteries are the network of blood vessels that carry oxygen- and nutrient-rich blood to the cardiac muscle tissue. The blood leaving the left ventricle exits through the aorta, the body's main artery. Two coronary arteries, referred to as the "left" and "right" coronary arteries, emerge from the beginning of the aorta, near the top of the heart.

The initial segment of the left coronary artery is called the left main coronary. This blood vessel is approximately the width of a soda straw and is less than an inch long. It branches into two slightly smaller arteries: the left anterior descending coronary artery and the left circumflex coronary artery. The left anterior descending coronary artery is embedded in the surface of the front side of the heart. The left circumflex coronary artery circles around the left side of the heart and is embedded in the surface of the back of the heart.

Just like branches on a tree, the coronary arteries branch into progressively smaller vessels. The larger vessels travel along the surface of the heart; however, the smaller branches penetrate the heart muscle. The smallest branches, called capillaries, are so narrow that the red blood cells must travel in single file.

3.4.5.2 Superior Vena Cava

The superior vena cava is one of the two main veins bringing de-oxygenated blood from the body to the heart. Veins from the head and upper body feed into the superior vena cava, which empties into the right atrium of the heart.

3.4.5.3 Inferior Vena Cava

The inferior vena cava is one of the two main veins bringing de-oxygenated blood from the body to the heart. Veins from the legs and lower torso feed into the inferior vena cava, which empties into the right atrium of the heart.

3.4.5.4 Aorta

The **aorta** is the main trunk of a series of vessels which convey the oxygenated blood to the tissues of the body for their nutrition. It commences at the upper part of the left ventricle, where it is about 3 cm. in diameter, and after ascending for a short distance, arches backward and to the left side, over the root of the left lung; it then descends within the thorax on the left side of the vertebral column, passes into the abdominal cavity through the aortic hiatus in the diaphragm, and ends, considerably diminished in size (about 1.75 cm. in diameter), opposite the lower border of the fourth lumbar vertebra, by dividing into the right and left common iliac arteries. Hence it is described in several portions, viz., the **ascending aorta,** the **arch of the aorta,** and the **descending aorta,** which last is again divided into the **thoracic** and **abdominal aortæ.**

3.4.5.5 Pulmonary Artery

The pulmonary artery is the vessel transporting de-oxygenated blood from the right ventricle to the lungs. A common misconception is that all arteries carry oxygen-rich blood. It is more appropriate to classify arteries as vessels carrying blood away from the heart.

3.4.5.6 Pulmonary Vein

The pulmonary vein is the vessel transporting oxygen-rich blood from the lungs to the left atrium. A common misconception is that all veins carry de-oxygenated blood. It is more appropriate to classify veins as vessels carrying blood to the heart.

3.4.5.7 Right Atrium

The right atrium receives de-oxygenated blood from the body through the superior vena cava (head and upper body) and inferior vena cava (legs and lower torso). The sinoatrial node sends an impulse that causes the cardiac muscle tissue of the atrium to contract in a coordinated, wave-like manner. The tricuspid valve, which separates the right atrium from the right ventricle, opens to allow the de-oxygenated blood collected in the right atrium to flow into the right ventricle.

3.4.5.8 Right Ventricle

The right ventricle receives de-oxygenated blood as the right atrium contracts. The pulmonary valve leading into the pulmonary artery is closed, allowing the ventricle to fill with blood. Once the ventricles are full, they contract. As the right ventricle contracts, the tricuspid valve closes and the pulmonary valve opens. The closure of the tricuspid valve prevents blood from backing into the right atrium and the opening of the pulmonary valve allows the blood to flow into the pulmonary artery toward the lungs.

3.4.5.9 Left Atrium

The left atrium receives oxygenated blood from the lungs through the pulmonary vein. As the contraction triggered by the sinoatrial node progresses through the atria, the blood passes through the mitral valve into the left ventricle.

3.4.5.10 Left Ventricle

The left ventricle receives oxygenated blood as the left atrium contracts. The blood passes through the mitral valve into the right ventricle. The aortic valve leading into the aorta is closed, allowing the ventricle to fill with blood. Once the ventricles are full, they contract. As the left ventricle contracts, the mitral valve closes and the aortic valve opens. The closure of the mitral valve prevents blood from backing into the left atrium and the opening of the aortic valve allows the blood to flow into the aorta and flow throughout the body.

3.4.5.11 Papillary Muscles

The papillary muscles attach to the lower portion of the interior wall of the ventricles. They connect to the chordae tendineae, which attach to the tricuspid valve in the right ventricle and the mitral valve in the left ventricle. The contraction of the papillary muscles opens these valves. When the papillary muscles relax, the valves close.

3.4.5.12 Chordae Tendineae

The chordae tendineae are tendons linking the papillary muscles to the tricuspid valve in the right ventricle and the mitral valve in the left ventricle. As the papillary muscles contract and relax, the chordae tendineae transmit the resulting increase and decrease in tension to the respective valves, causing them to open and close. The chordae tendineae are string-like in appearance and are sometimes referred to as "heart strings."

3.4.5.13 Tricuspid Valve

The tricuspid valve separates the right atrium from the right ventricle. It opens to allow the de-oxygenated blood collected in the right atrium to flow into the right ventricle. It closes as the right ventricle contracts, preventing blood from returning to the right atrium; thereby, forcing it to exit through the pulmonary valve into the pulmonary artery.

3.4.5.14 Mitral Value

The mitral valve separates the left atrium from the left ventricle. It opens to allow the oxygenated blood collected in the left atrium to flow into the left ventricle. It closes as the left ventricle contracts, preventing blood from returning to the left atrium; thereby, forcing it to exit through the aortic valve into the aorta.

3.4.5.15 Pulmonary Valve

The pulmonary valve separates the right ventricle from the pulmonary artery. As the ventricles contract, it opens to allow the de-oxygenated blood collected in the right ventricle to flow to the lungs. It closes as the ventricles relax, preventing blood from returning to the heart.

3.4.5.16 Aortic Valve

The aortic valve separates the left ventricle from the aorta. As the ventricles contract, it opens to allow the oxygenated blood collected in the left ventricle to flow throughout the body. It closes as the ventricles relax, preventing blood from returning to the heart.

3.4.6

Decomposition Tool – Pericardium

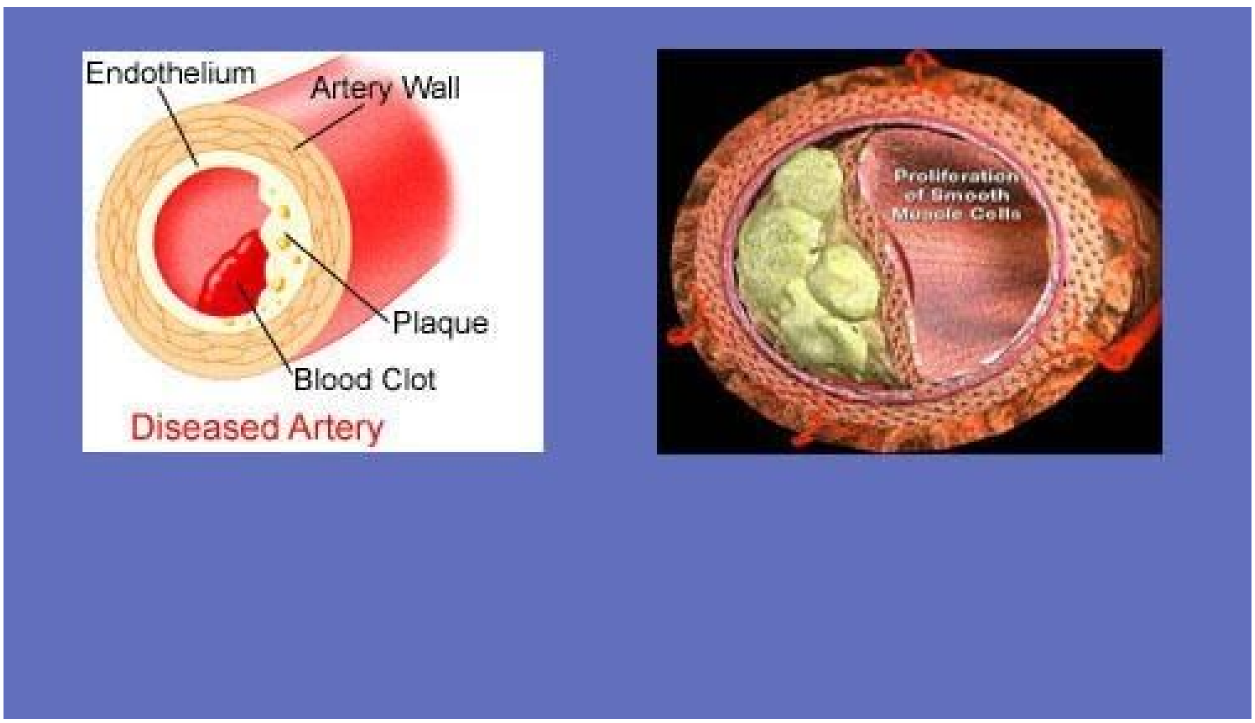
The pericardium is a conical fibro-serous sac, in which the heart and the roots of the great vessels are contained. It is placed behind the sternum and the cartilages of the third, fourth, fifth, sixth, and seventh ribs of the left side, in the mediastinal cavity.

The Blood Composition Tool

When the user drills into the vascular assembly, the Blood Composition Tool will be enabled. Here, one can specify through configuration parameters, the concentration of the blood, from the serum albumin, to white and red blood cells.

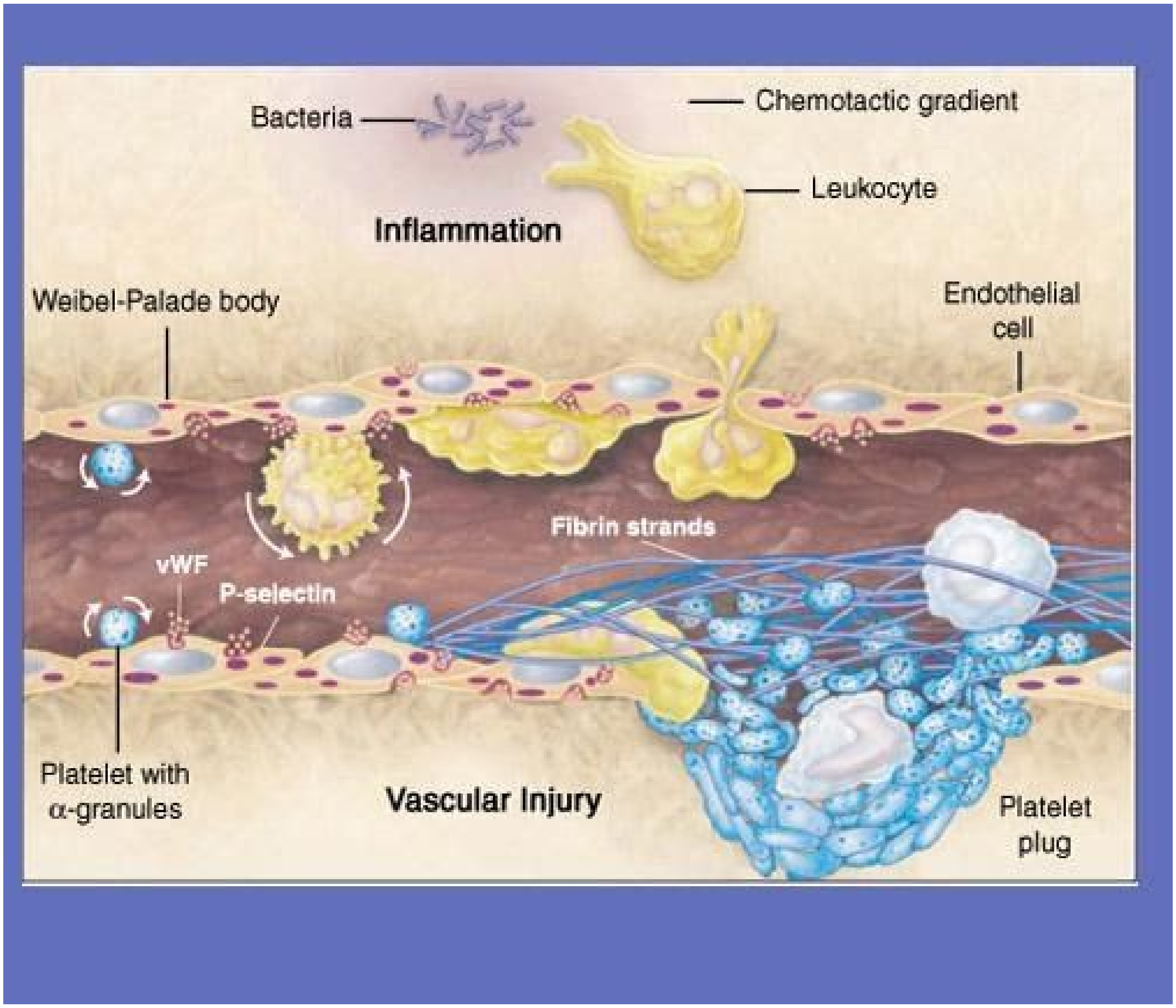
3.4.7 The Disease Tool

There are several diseases that plague the vascular system, the number one being heart disease. Using BioMight's disease tool, one can clog an artery with plaques, wear down the heart muscles from a Staph infection, and apply a number of aliments.



3.4.8 Cross Section Tool (Vascular)

Shown below is a cross section representation of a vascular channel. The user has annotated the channel with various elements from BioMight's libraries to show what happens when an injury occurs. Using the Pathogen tool, bacteria has been added and from the Cellular library, leukocytes have been added. From the structure library, fibrin strands have been incorporated as well.

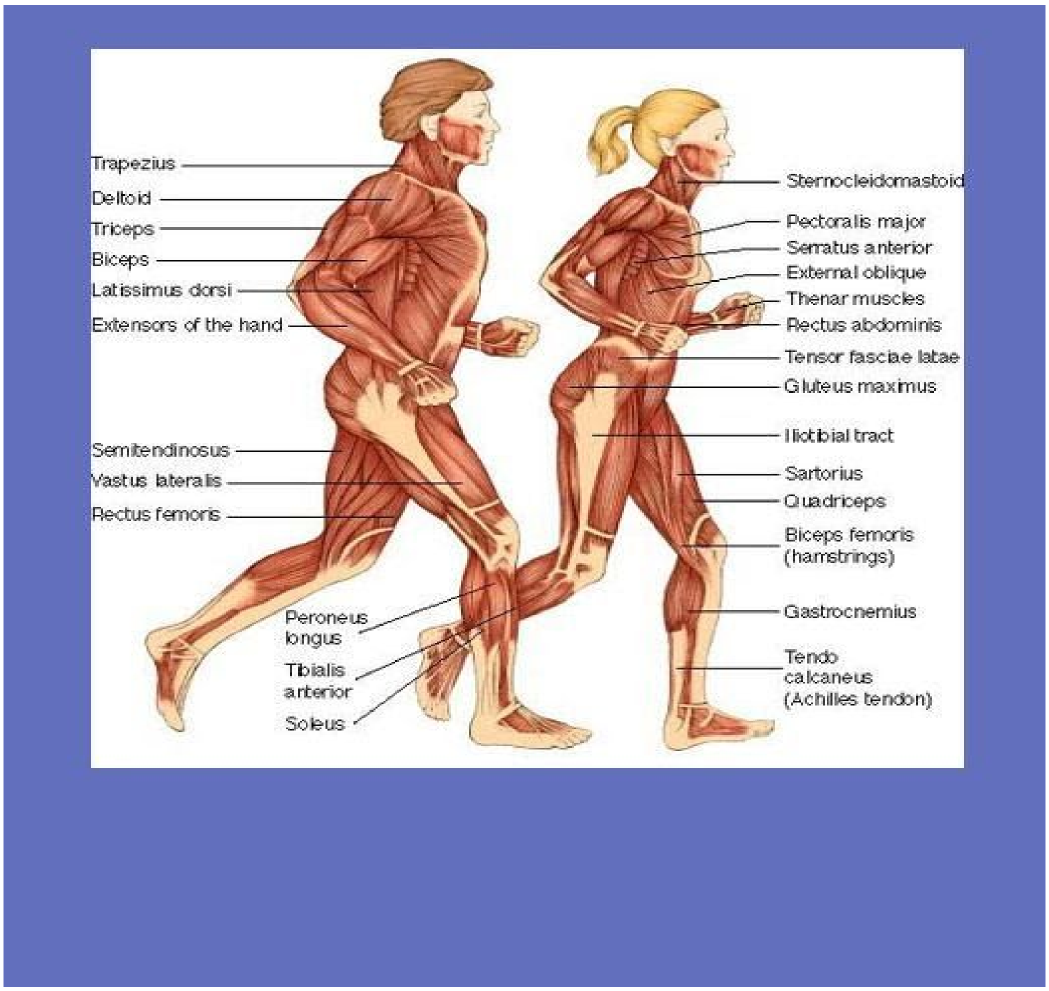


Vessel Assembler

For our example, the user would select smooth muscle tissue and then drill down to the Vessels Assembler library. From here, they can select the components they wish to include in their animation.

3.5 Muscular System

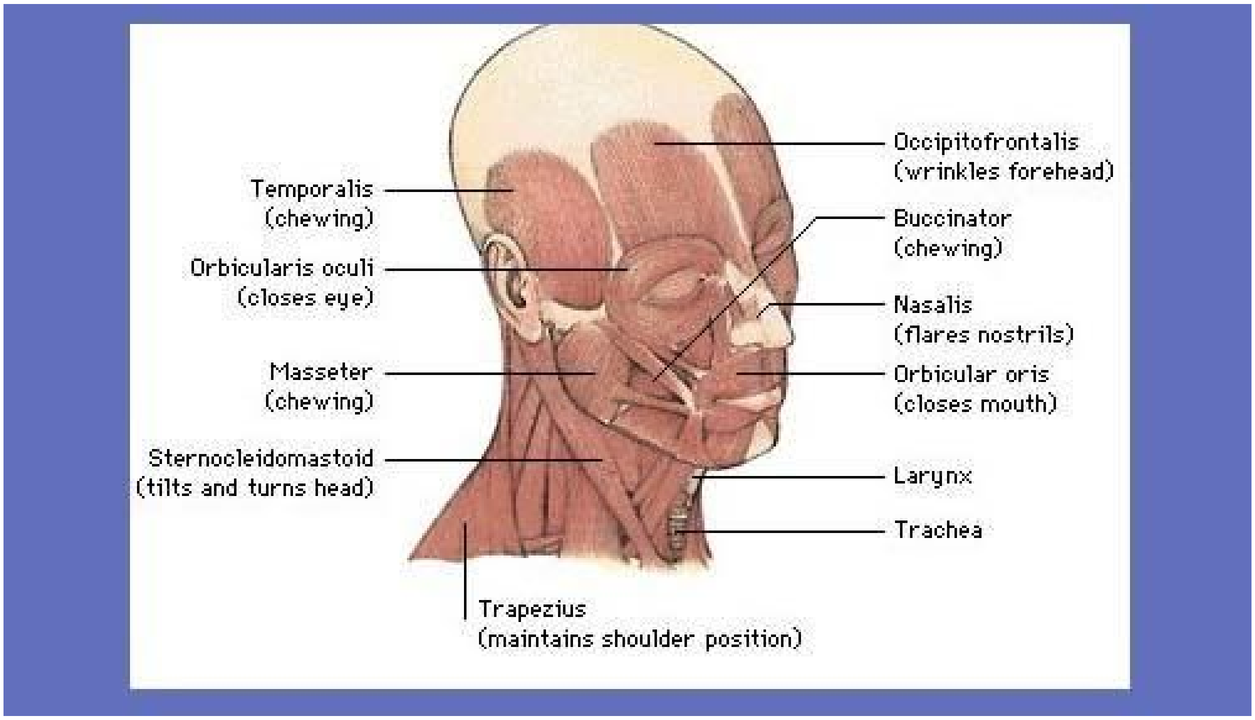
BioMight has knowledge of each muscle, muscle groups, their interactions, and their location in the human composition. Shown below is a representation of the muscle groups with BioMight's notion mode, toggled on.



3.5.1

Decomposition Tool- Head

BioMight can render each of the facial muscles…



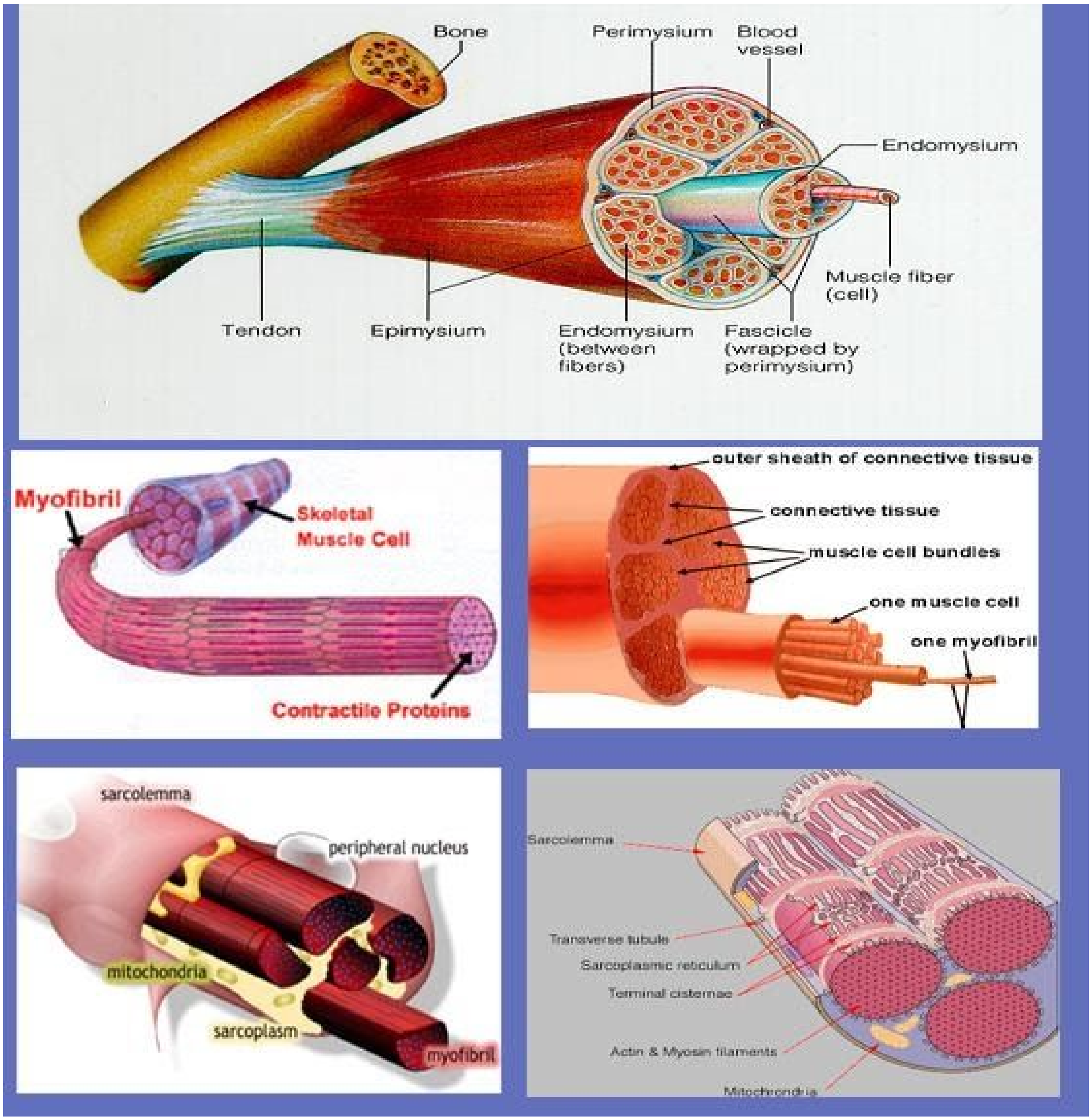
3.5.2 Decomposition Tool- The Arm

Activation the tool in this component of BioMight opens a window

3.5.3

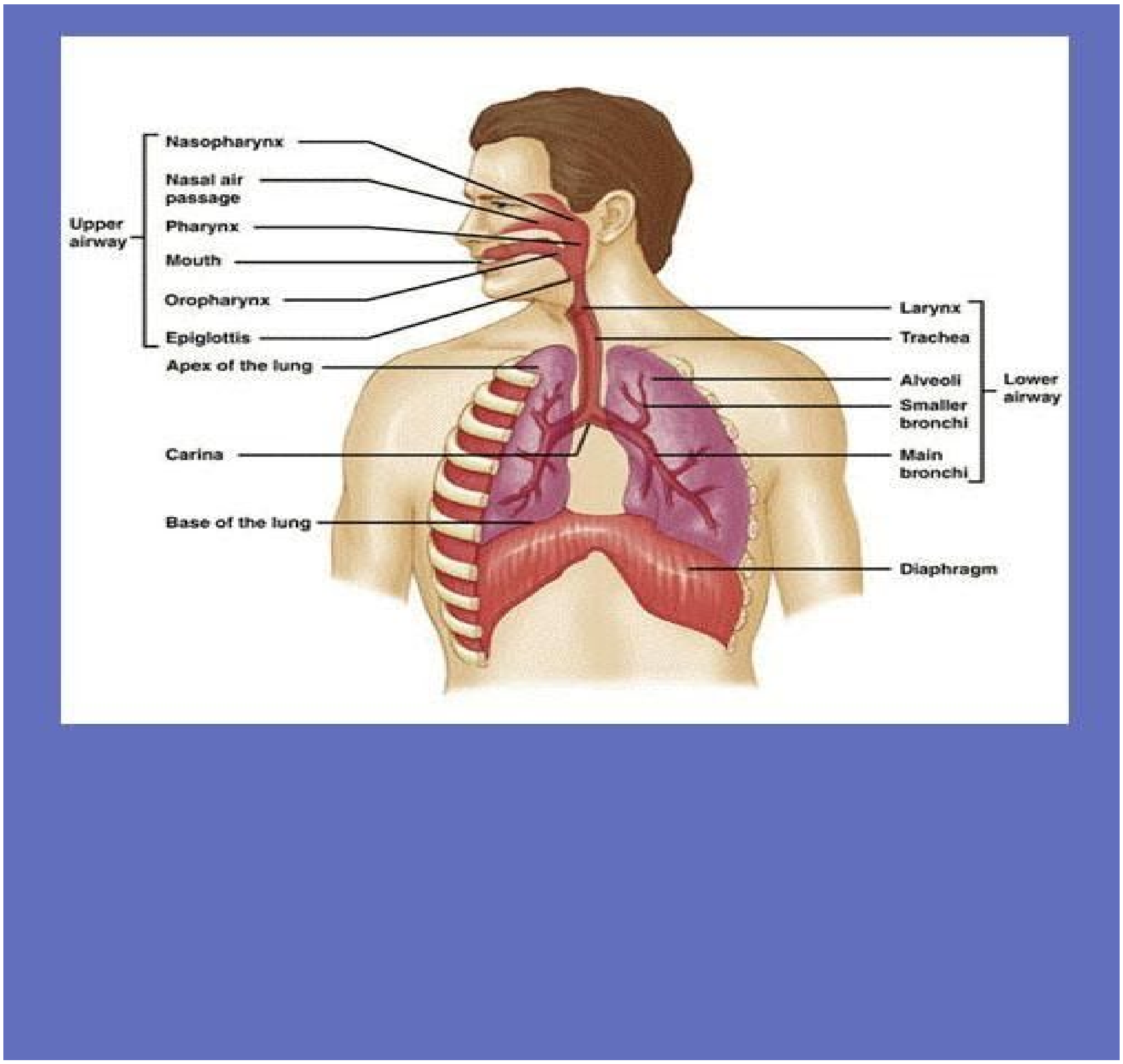
Decomposition Tool – Muscle Tissue

Using the Cross Section tool, one can drill down into the details of BioMight's Muscle System model. When activated, a library of views that allow one to choose the level of detail one wishes to use in their animation appears. Using the BioMight animate one can animate the models, and the configuration engine can be used allow the user to change the colors and perspectives.



3.6 Respiratory System

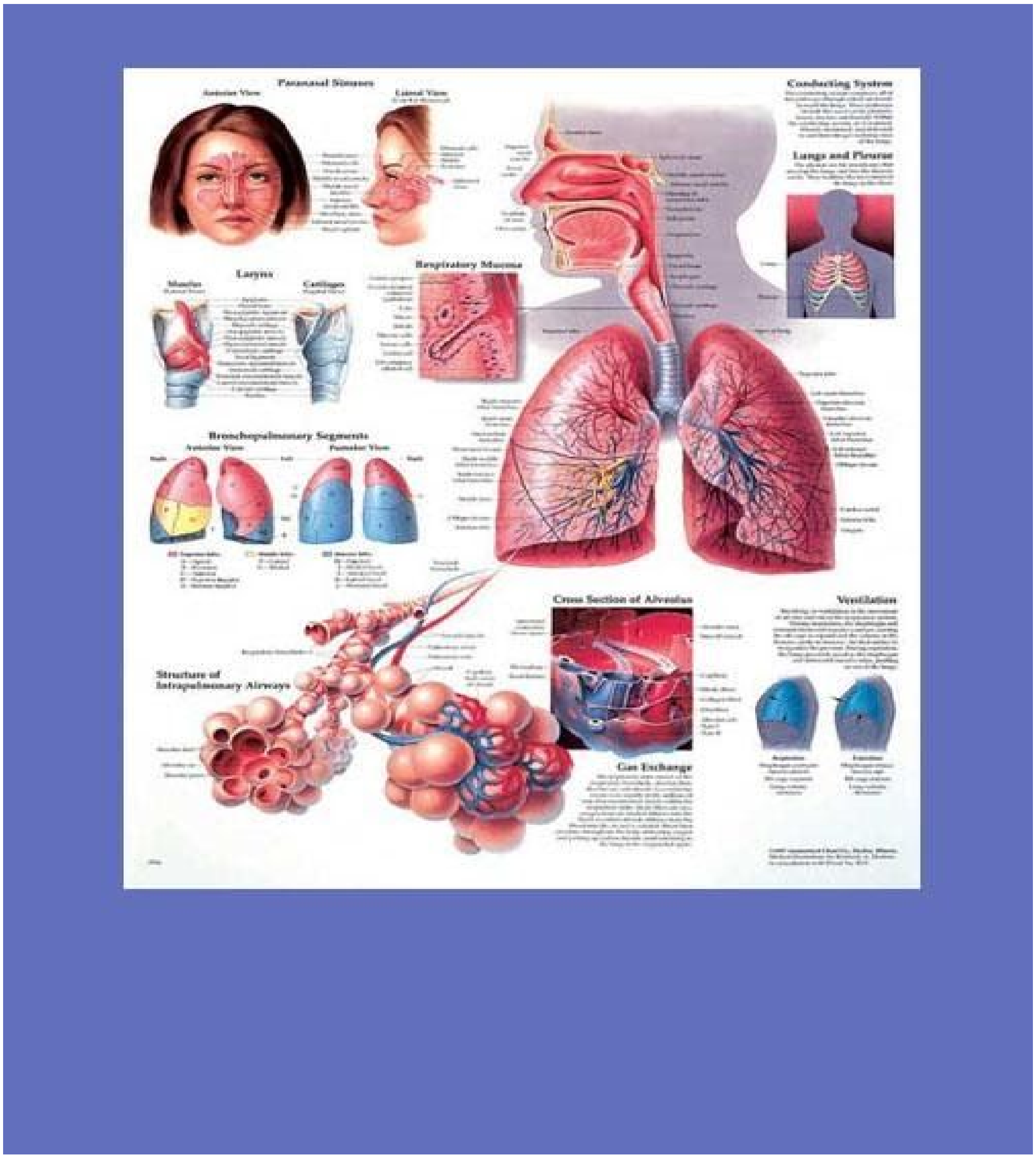
The BioMight Respiratory System will allow one to view and interact with details of the respiratory system. Shown below is a top-level view of the organs and structures that comprise the system.



3.6.1

Encyclopedia Tool

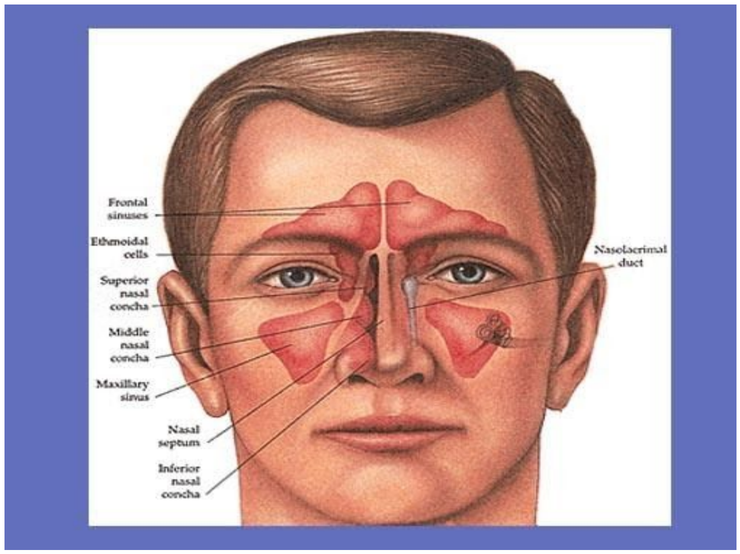
Using BioMight's Encyclopedia mode, one is delivered a plethora of information custom configured to the user's level of expertise defined their profile, and stored as configuration parameters.   For example, the information delivered to the



3.6.2

Decomposition Tool –Nose External

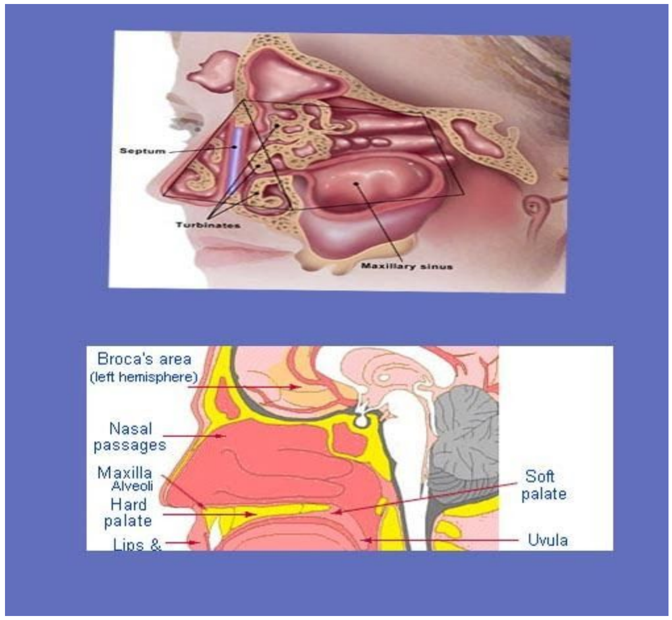
BioMight presents an external view of the nose as it does with



3.6.3

Decomposition Tool –Nose Internal

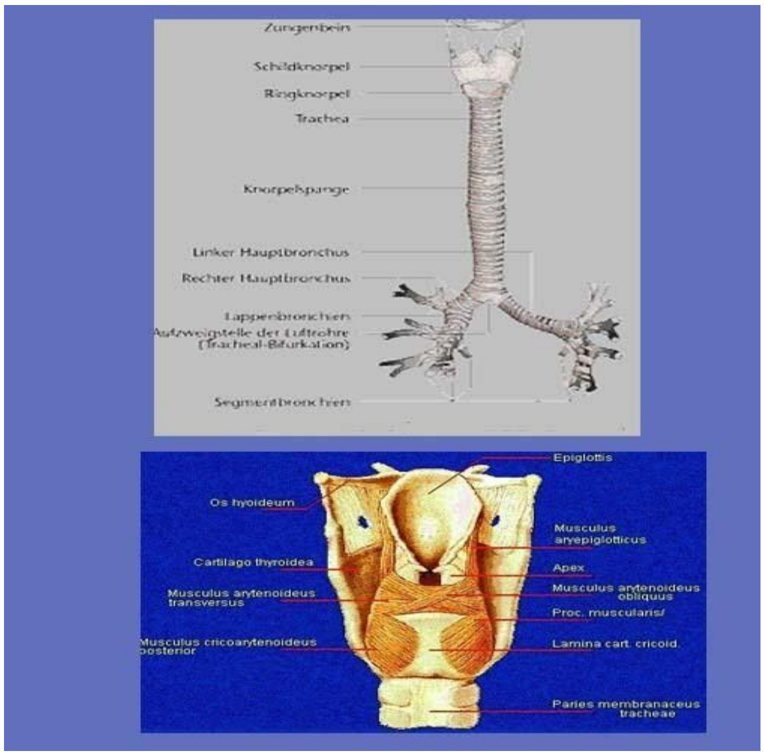
BioMight presents an internal



3.6.4

Decomposition Tool – The Trachea

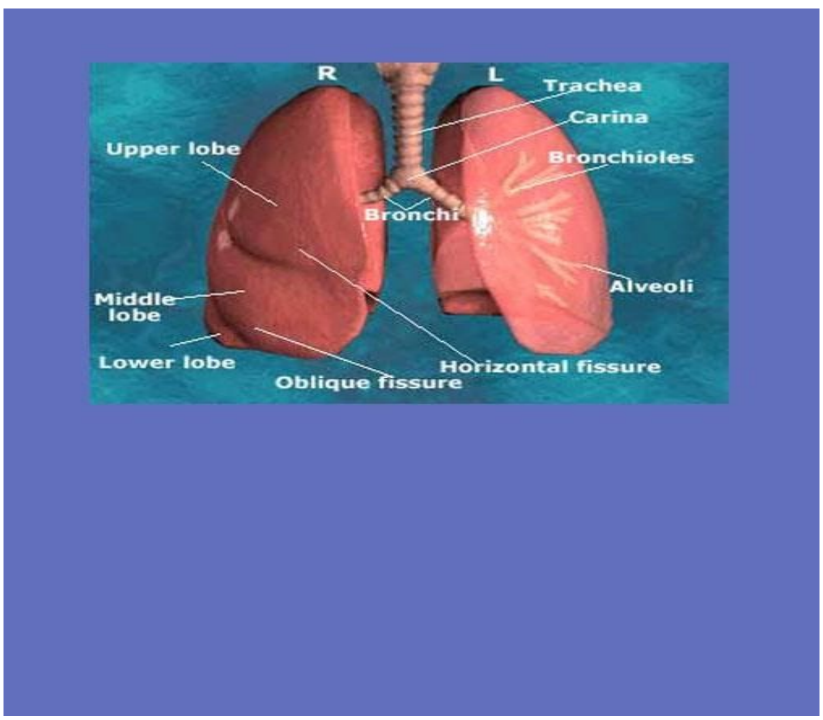
The trachea is a central conducting airway between the larynx and principal bronchi. It is 4.5 inches long and ¾ inches in diameter. Consists of a supporting layer of connective and muscular tissue in which are embedded from16 to 20 U-shaped rings of hard cartilage that encircle the front of the tube.



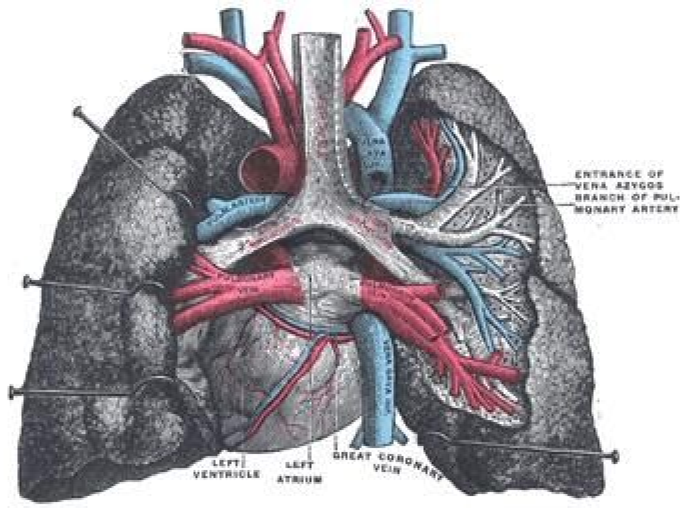
3.6.5 Decomposition Tool – Lungs

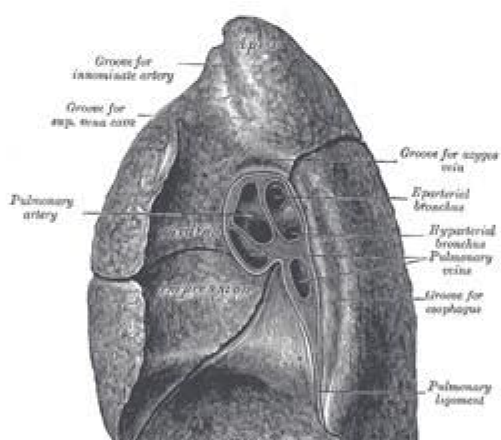
Using the Cross Section tool…. The lungs are a pair of cone shaped, highly elastic and spongy organs located in the chest. They are the main organs of the respiratory system. The lungs stretch from your collarbones down to the edge of your rib cage, and are composed of units called lobes. The right lung has three lobes, while the left lung has only two.

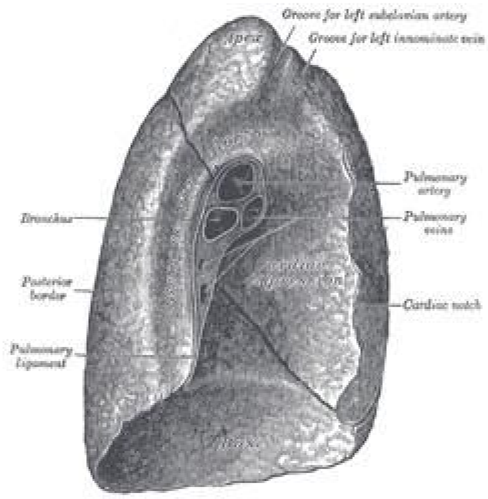
The lungs are the essential organs of respiration; they are two in number, placed one on either side within the thorax, and separated from each other by the heart and other contents of the mediastinum. The substance of the lung is of a light, porous, spongy texture; it floats in water, and crepitates when handled, owing to the presence of air in the alveoli; it is also highly elastic; hence the retracted state of these organs when they are removed from the closed cavity of the thorax. The surface is smooth, shining, and marked out into numerous polyhedral areas, indicating the lobules of the organ: each of these areas is crossed by numerous lighter lines.



Each lung is conical in shape, and presents for examination an **apex,** a **base,** three **borders,** and two **surfaces.** 4 The **apex** (*apex pulmonis*) is rounded, and extends into the root of the neck, reaching from 2.5 to 4 cm.. The **base** (*basis pulmonis*) is broad, concave, and rests upon the convex surface of the diaphragm, which separates the right lung from the right lobe of the liver, and the left lung from the left lobe of the liver, the stomach, and the spleen. Since the diaphragm extends higher on the right than on the left side, the concavity on the base of the right lung is deeper than that on the left. Laterally and behind, the base is bounded by a thin, sharp margin which projects for some distance into the phrenicocostal sinus of the pleura, between the lower ribs and the costal attachment of the diaphragm.







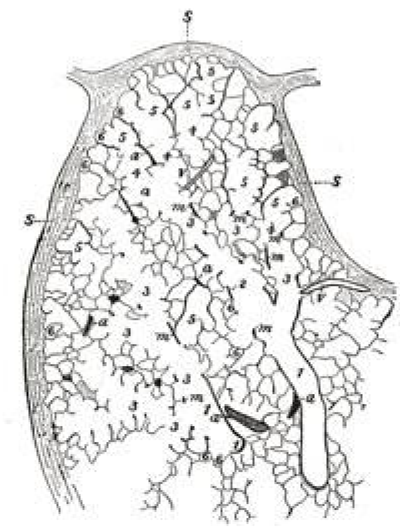


FIG. 974– Part of a secondary lobule from the depth of a human lung, showing parts of several primary lobules. 1, bronchiole; 2, respiratory bronchiole; 3, alveolar duct; 4, atria; 5, alveolar sac; 6, alveolus or air cell: *m,* smooth muscle; *a,* branch pulmonary artery; *v,* branch pulmonary vein; *s,* septum between secondary lobules. Camera drawing of one 50 µ section. X 20 diameters. (Miller.) (See enlarged image)

Each *bronchiole* divides into two or more **respiratory bronchioles,** with scattered alveoli, and each of these again divides into several **alveolar ducts,** with a greater number of alveoli connected with them. Each alveolar duct is connected with a variable number of irregularly spherical spaces, which also possess alveoli, the **atria.** With each atrium a variable number (2–5) of **alveolar sacs** are connected which bear on all parts of their circumference **alveoli** or air sacs. (Miller.) 26 The **alveoli** are lined by a delicate layer of simple squamous epithelium, the cells of which are united at their edges by cement substance. Between the squames are here and there smaller, polygonal, nucleated cells. Outside the epithelial lining is a little delicate connective tissue containing numerous elastic fibers and a close net-work of blood capillaries, and forming a common wall to adjacent alveoli (Fig. 975). 27

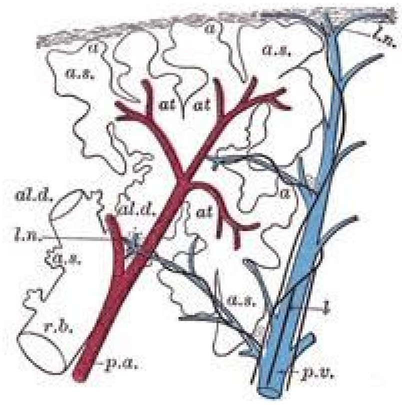


FIG. 975– Schematic longitudinal section of a primary lobule of the lung (anatomical unit); *r. b.,* respiratory bronchiole; *al. d.,* alveolar duct; *at.,* atria; *a. s.,* alveolar sac; *a,* alveolus or air cell; *p. a.:* pulmonary artery: *p. v.,* pulmonary vein; *l.,* lymphatic; *l. n.,* lymph node. (Miller.) (See enlarged image)

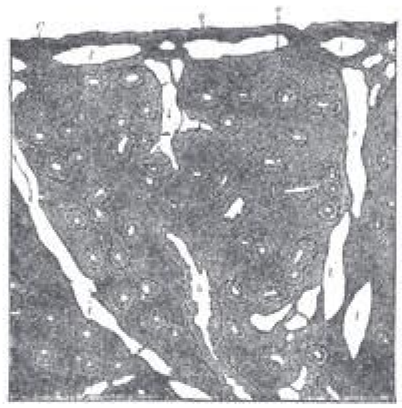


FIG. 976– Section of lung of pig embryo, 13 cm. long, showing the glandular character of the developing alveoli (J. M. Flint.) X 70. *a.* Interstitial connective tissue. *b.* A bronchial tube. *c.* An Alveolus. *l.* lymphatic clefts. *q.* Pleura. (See enlarged image)

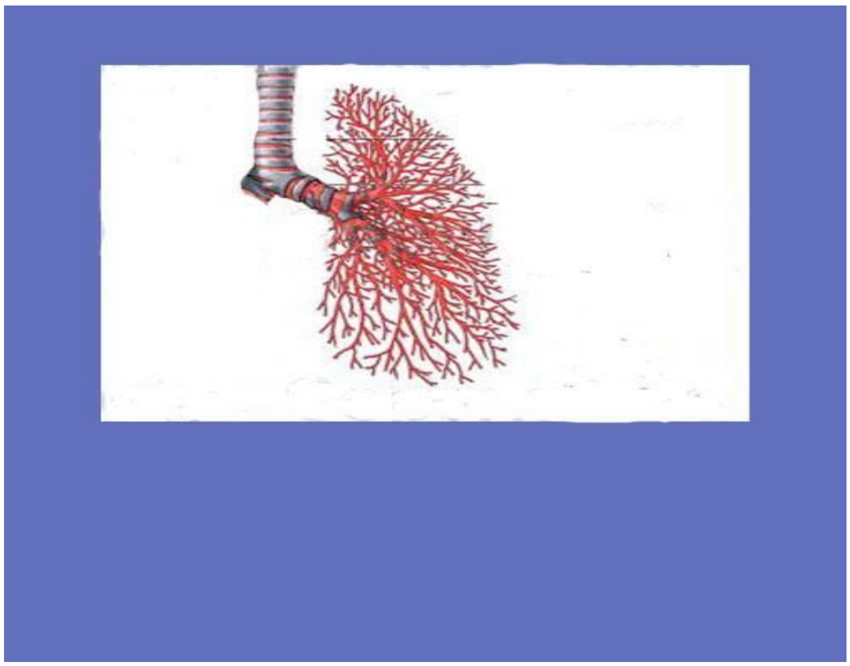
The fetal lung resembles a gland in that the alveoli have a small lumen and are lined by cubical epithelium (Fig. 976). After the first respiration the alveoli become distended, and the epithelium takes on the characters described above. *28* **Vessels and Nerves.**—The **pulmonary artery** conveys the venous blood to the lungs; it divides into branches which accompany the bronchial tubes and end in a dense capillary net-work in the walls of the alveoli. In the lung the branches of the pulmonary artery are usually above and in front of a bronchial tube, the vein below. *29* The **pulmonary capillaries** form plexuses which lie immediately beneath the lining epithelium, in the walls and septa of the alveoli and of the infundibula. In the septa between the alveoli the capillary net-work forms a single layer. The capillaries form a very minute net-work, the meshes of which are smaller than the vessels themselves; their walls are also exceedingly thin. The arteries of neighboring lobules are independent of each other, but the veins freely anastomose. *30*

The **pulmonary veins** commence in the pulmonary capillaries, the radicles coalescing into larger branches which run through the substance of the lung, independently of the pulmonary arteries and bronchi. After freely communicating with other branches they form large vessels, which ultimately come into relation with the arteries and bronchial tubes, and accompany them to the hilus of the organ. Finally they open into the left atrium of the heart, conveying oxygenated blood to be distributed to all parts of the body by the aorta. *31* The **bronchial arteries** supply blood for the nutrition of the lung; they are derived from the thoracic aorta or from the upper aortic intercostal arteries, and, accompanying the bronchial tubes, are distributed to the bronchial glands and upon the walls of the larger bronchial tubes and pulmonary vessels. Those supplying the bronchial tubes form a capillary plexus in the muscular coat, from which branches are given off to form a second plexus in the mucous coat; this plexus communicates with small venous trunks that empty into the pulmonary veins. Others are distributed in the interlobular areolar tissue, and end partly in the deep, partly in the superficial, bronchial veins.

Lastly, some ramify upon the surface of the lung, beneath the pleura, where they form a capillary network. *32* The **bronchial vein** is formed at the root of the lung, receiving superficial and deep veins corresponding to branches of the bronchial artery. It does not, however, receive all the blood supplied by the artery, as some of it passes into the pulmonary veins. It ends on the right side in the azygos vein, and on the left side in the highest intercostal or in the accessory hemiazygos vein. *33* The **lymphatics** are described on page 718. *34* **Nerves.**—The lungs are supplied from the anterior and posterior pulmonary plexuses, formed chiefly by branches from the sympathetic and vagus. The filaments from these plexuses accompany the bronchial tubes, supplying efferent fibers to the bronchial muscle and afferent fibers to the bronchial mucous membrane and probably to the alveoli of the lung. Small ganglia are found upon these nerves.

Decomposition Tool – Lung Bronchi & Brochioles

BioMight presents an internal



3.6.6

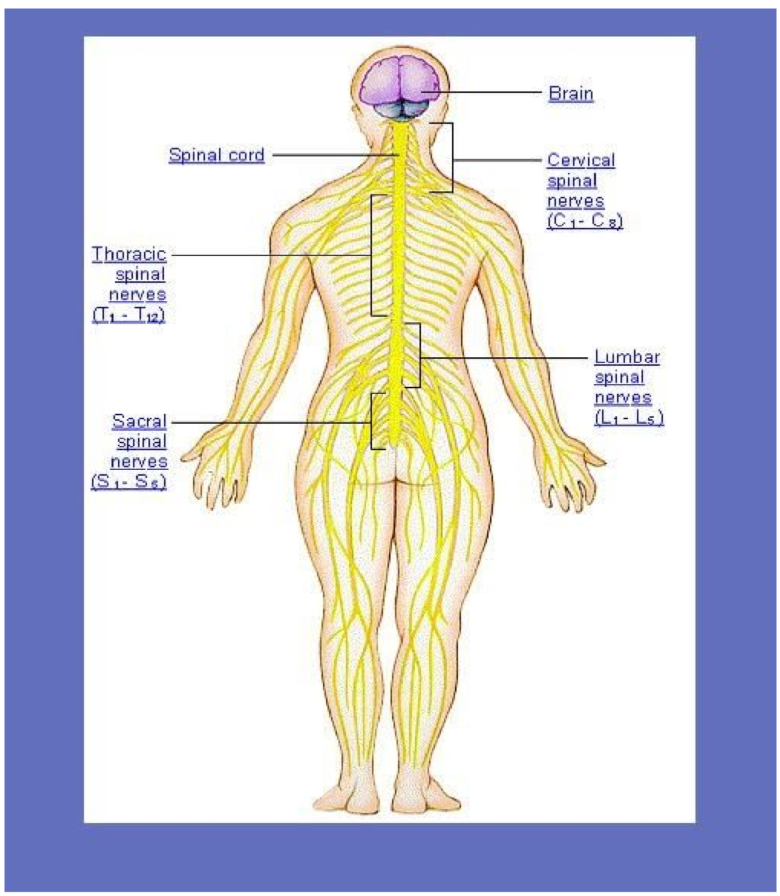
Decomposition Tool – Alveoli

BioMight presents an internal

3.7 Nervous System

The Nervous System may be view as two parts, central and peripheral, with the central nervous system containing the brain, and spinal cord and the peripheral connecting with the rest of the body.

The nerves may be arranged in two groups, cerebrospinal and sympathetic. The cerebrospinal nerves are forty-three in number on either side—twelve cranial, attached to the brain, and thirty-one spinal, to the medulla spinalis. They are associated with the functions of the special and general senses and with the voluntary movements of the body. The sympathetic nerves transmit the impulses which regulate the movements of the viscera, determine the caliber of the blood vessels, and control the phenomena of secretion.. Appearing below is a representation of the human's nervous system.



3.7.1

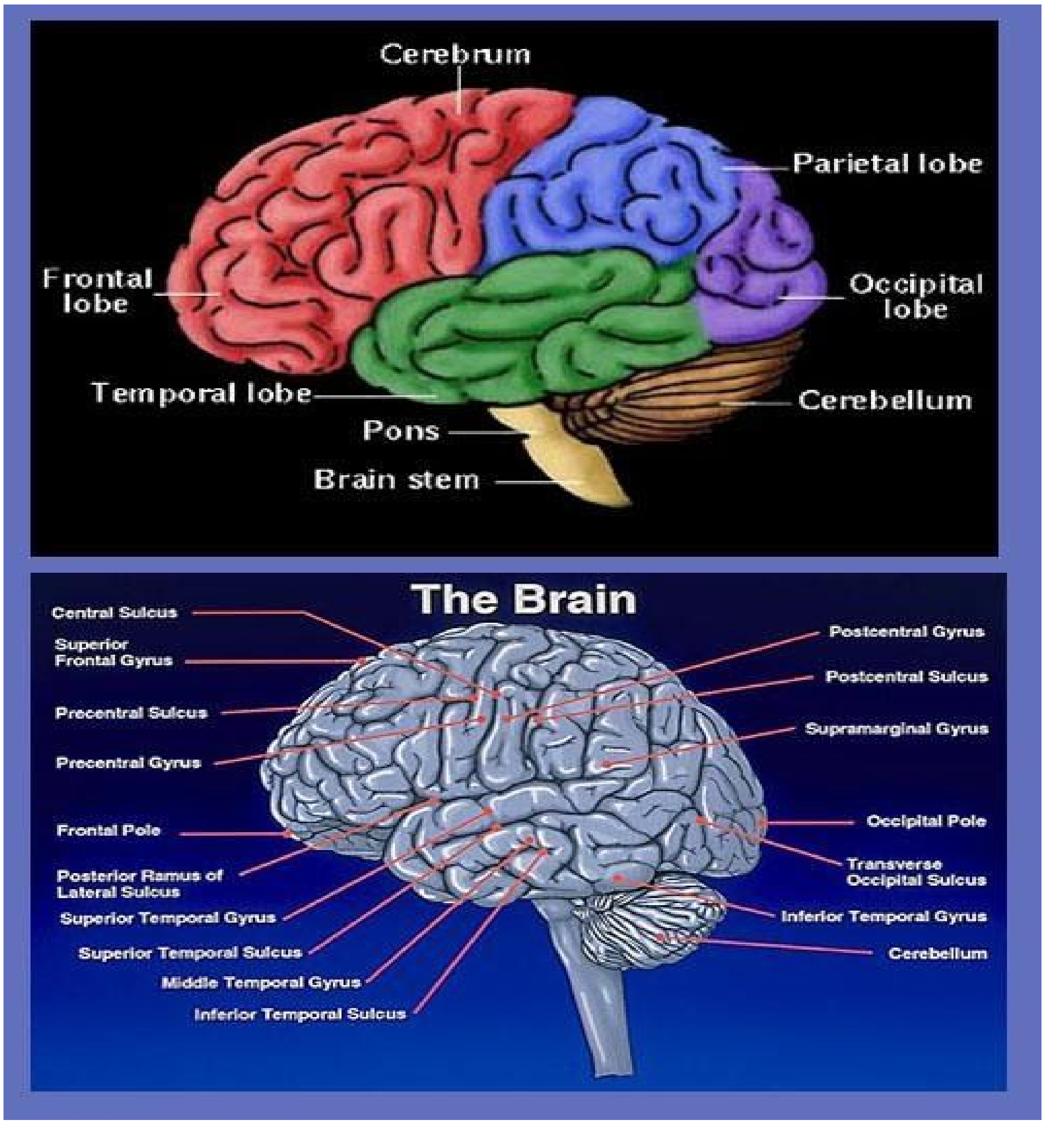
Encyclopedia Tool

Activation the tool in this component of BioMight opens a window

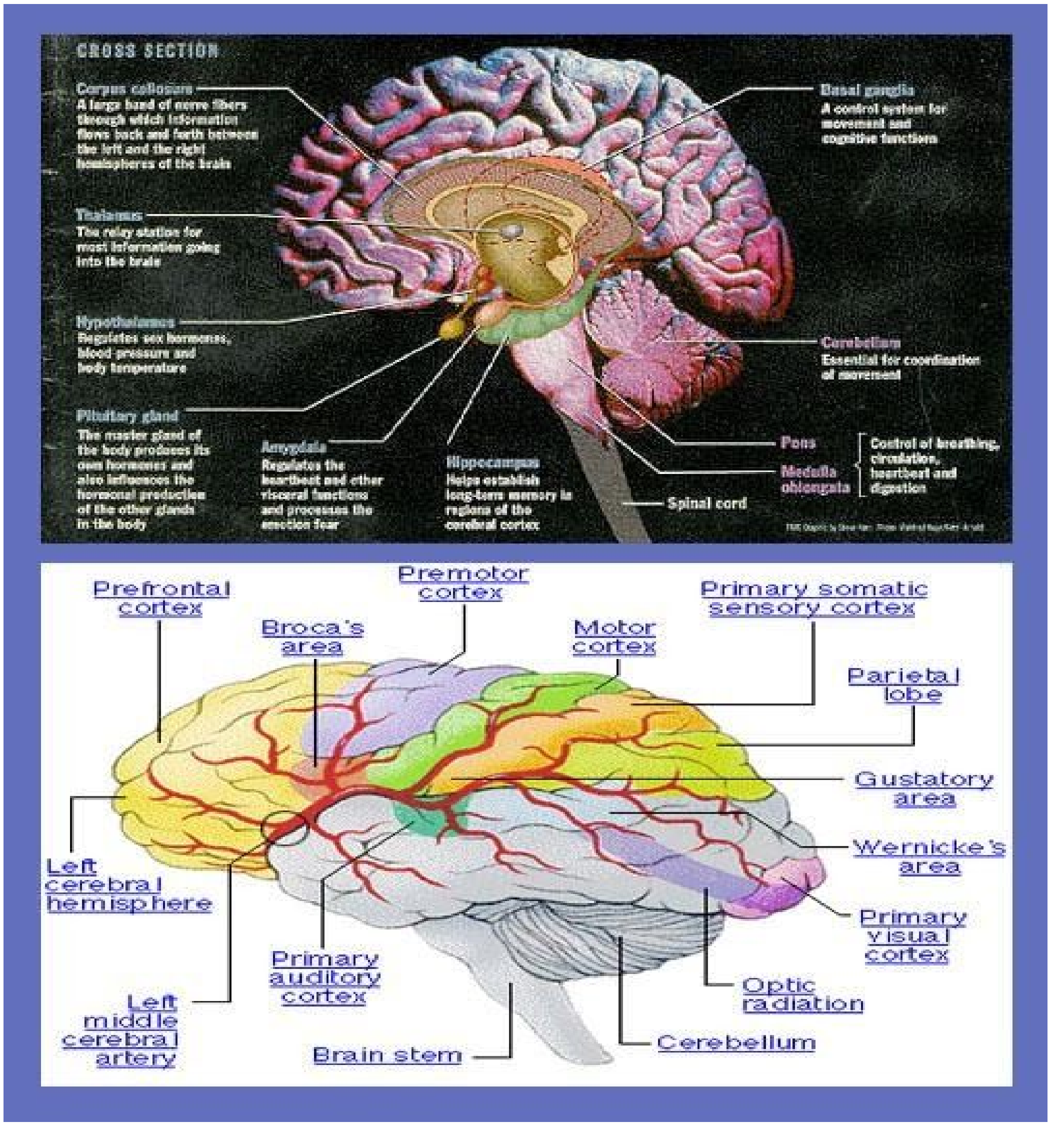
3.7.2

The Brain – Decomposition Tool

Clicking on the brain from the top-level Nervous System view activates the brain detail view. Here one can view different representations of BioMight's model. The illustration in the upper portion show the brain colored coded by major brain structures. In the illustration appearing below, the user has selected a monochrome color scheme and has added enabled the detailed notation option.



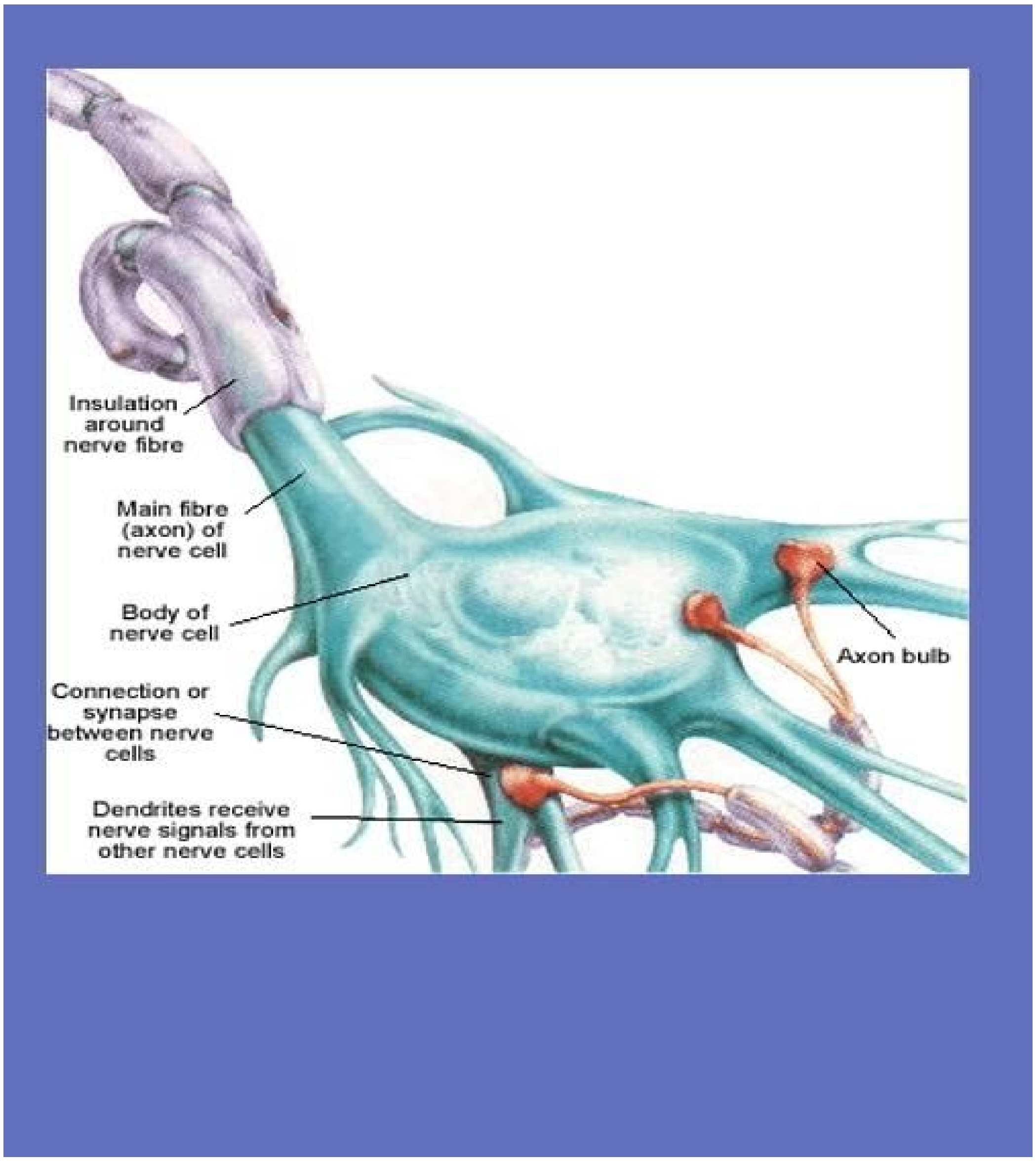
Appearing below are two other representations of BioMight's Brain model. In the top view, one has used the "realism" theme and applied the cross section tool elucidate the inner structures, while in the lower model, the usr



3.7.3

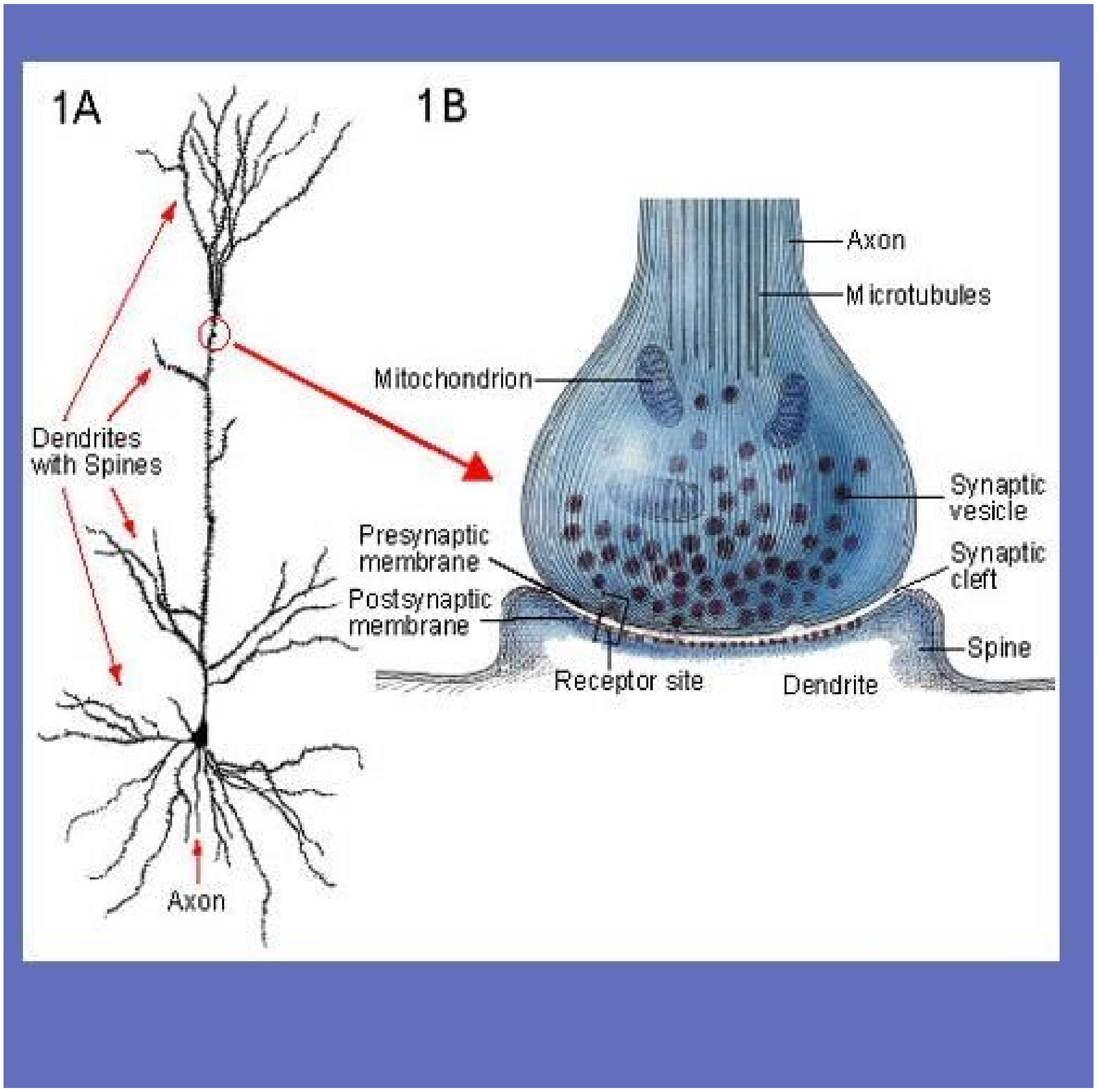
Nerves – Decomposition Tool

Selecting a nerve in the top-level model with the Decomposition tool allows one to see a detailed composition of a nerve. Please note below that the annotation option has been enabled, which points out the various components. The theme selected for the view is “fantasy”.



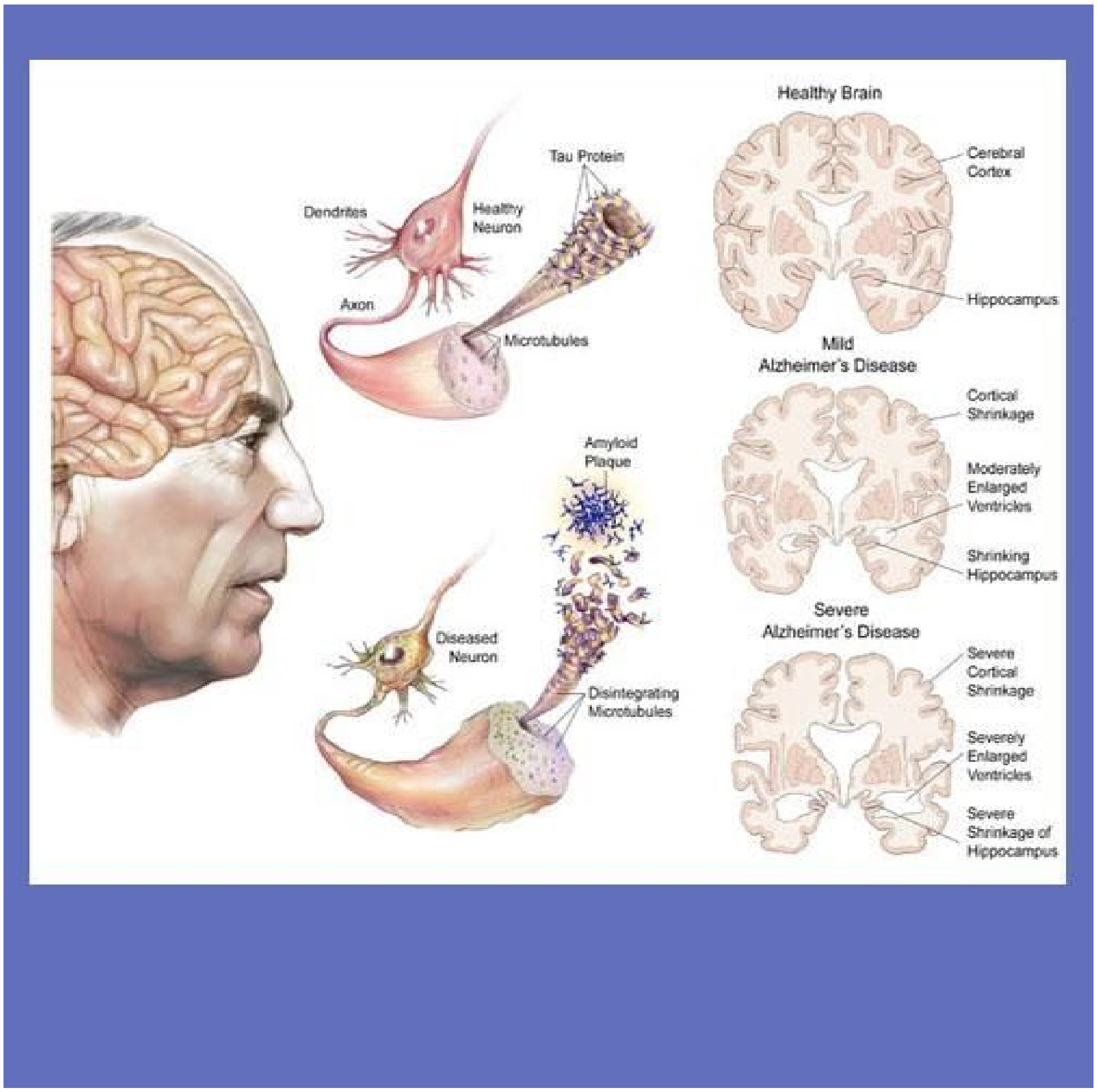
3.7.4 Nerves – Decomposition Tool

Use the Decomposition Tool, one can further drill down into the model, observing how information exchange occurs in the synapse.



3.7.5 Disease Tool

Utilizing BioMight's Disease Tool one can affect the Nervous System with physical aliments and view representations of BioMight's models under diseased state.



3.8

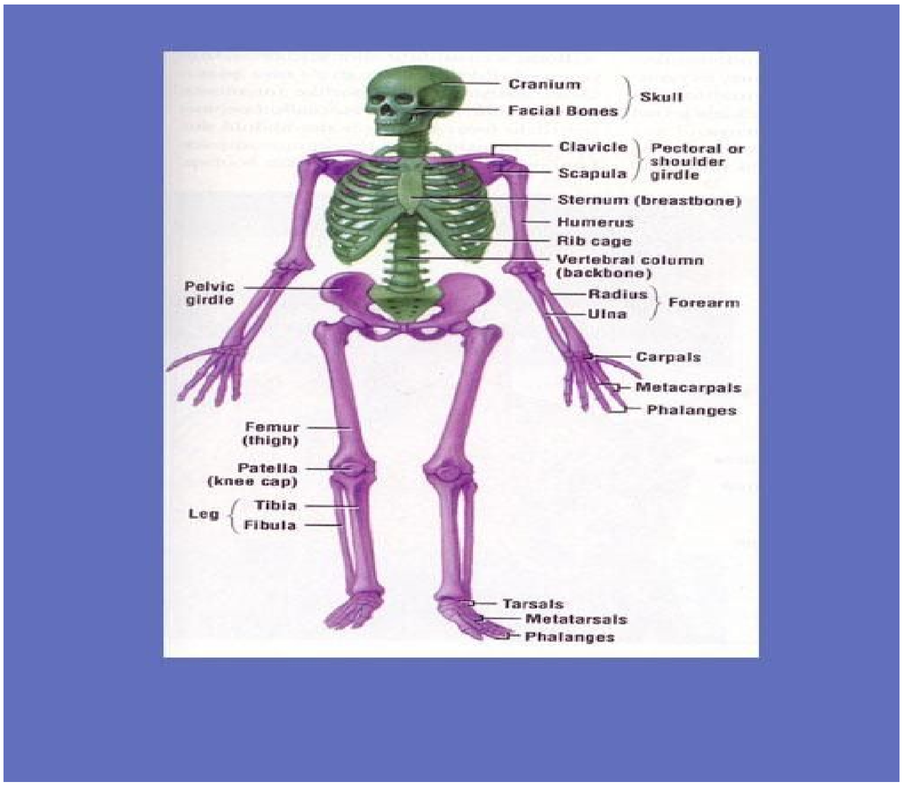
Reproductive System

BioMight's Lymphatic system top-level

3.9

Skeletal System

The general framework of the body is built up mainly of a series of bones, supplemented, however, in certain regions by pieces of cartilage; the bony part of the framework constitutes the **skeleton.** In the skeleton of the adult there are 206 distinct bones.



Axial Skeleton	Vertebral column	26	
	Skull	22	
	Hyoid bone	1	
	Ribs and sternum	25	
		—	74
Appendicular Skeleton	Upper extremities	64	
	Lower extremities	62	
		—	126
Auditory ossicles			6
			—
	Total		206

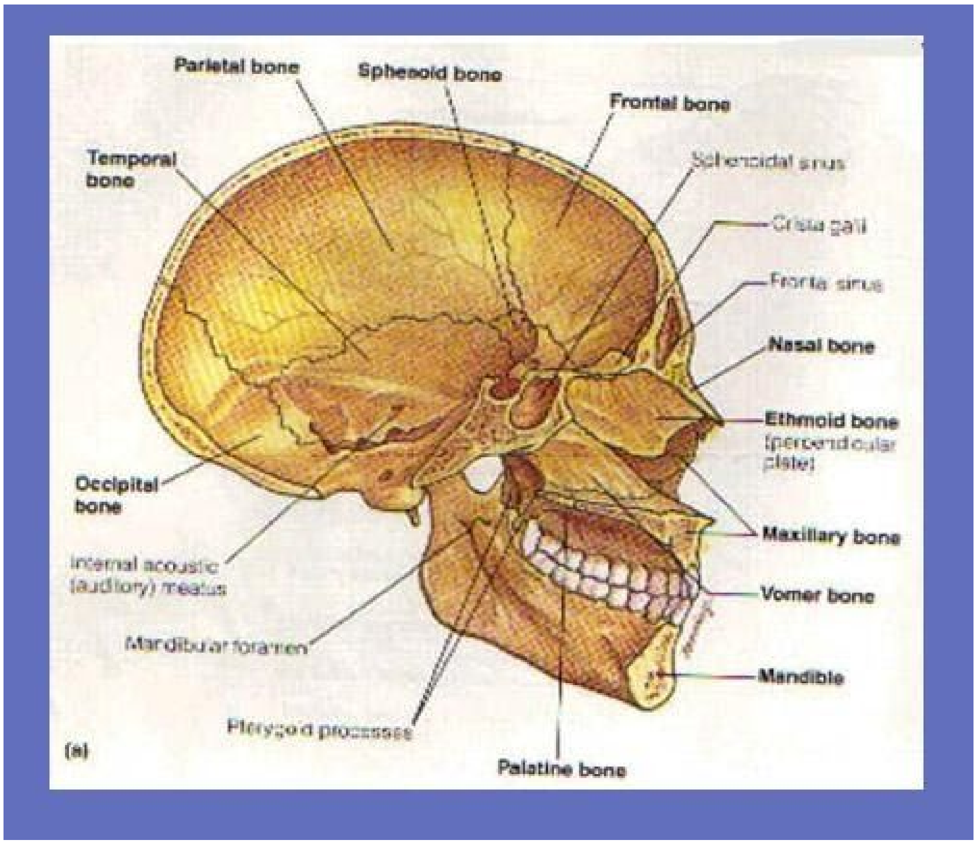
3.9.1

Encyclopedia Tool

Activation the tool in this component of BioMight opens a window

3.9.2 Decomposition Tool - Cranium

Using the Decomposition the tool, one can view the details of the skull. One can further drill down into the mode by selecting the segments that are currently annotated.



The **occipital bone** (Figs. 129, 130), situated at the back and lower part of the cranium, is trapezoid in shape and curved on itself. It is pierced by a large oval aperture, the **foramen magnum,** through which the cranial cavity communicates with the vertebral canal.

3.9.3 The Vertebral Column

3.9.3.1 The Cervical Vertebrae

3.9.3.2 The Thoracic Vertebrae

3.9.3.3 The Lumbar Vertebrae

3.9.3.4 The Sacral and Coccygeal Vertebrae

3.9.4 The Thorax

The Sternum
The Ribs
The Costal Cartilages

The Skull

The Extremeties

The Lower Extremity

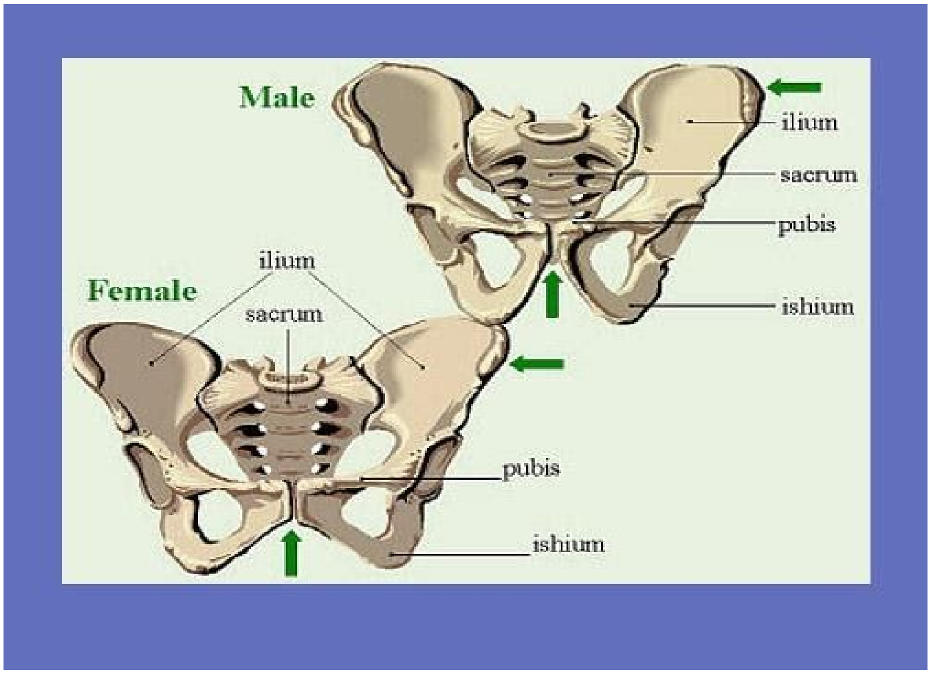
The Foot
The Tarsus
The Metatarsus
The Phalanges

Decomposition Tool – Vertebral Column

The **vertebral column** is a flexuous and flexible column, formed of a series of bones called **vertebræ.** The vertebræ are thirty-three in number, and are grouped under the names **cervical, thoracic, lumbar, sacral,** and **coccygeal,** according to the regions they occupy; there are seven in the cervical region, twelve in the thoracic, five in the lumbar, five in the sacral, and four in the coccygeal.

Decomposition Tool

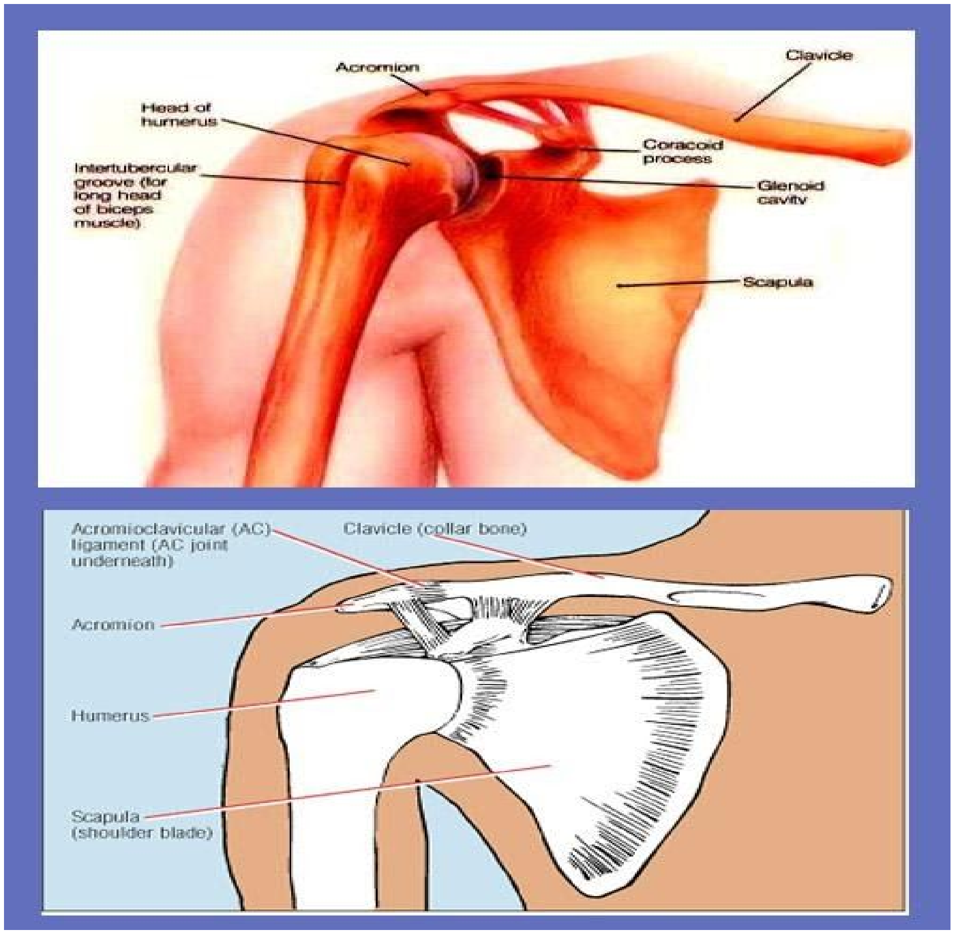
Using the decomposition tool, one can view the detail of all --- bones in the human body.



3.9.5

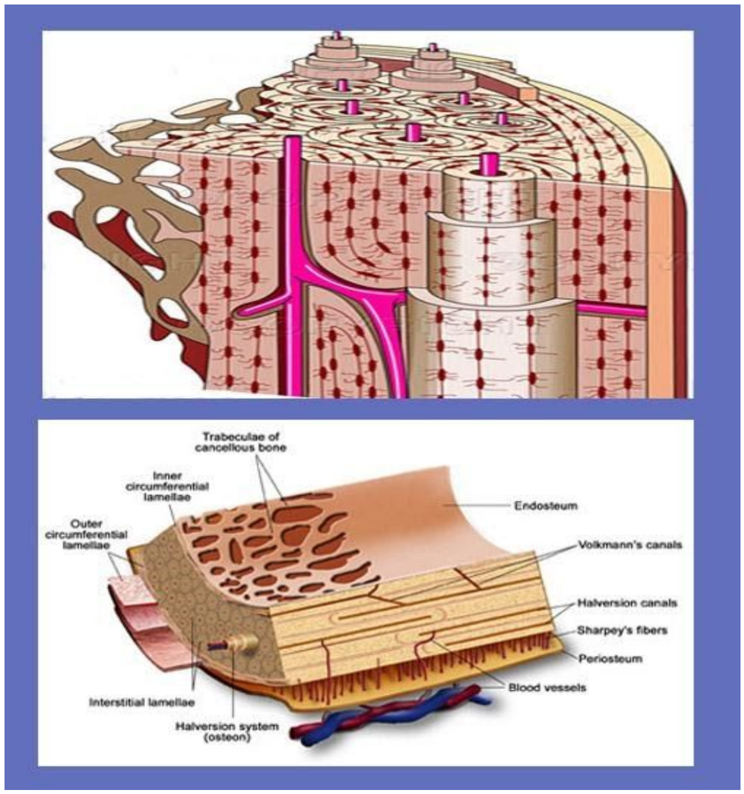
Decomposition Tool

Below is another example of the Decomposition tool and the theme selections available in BioMight.



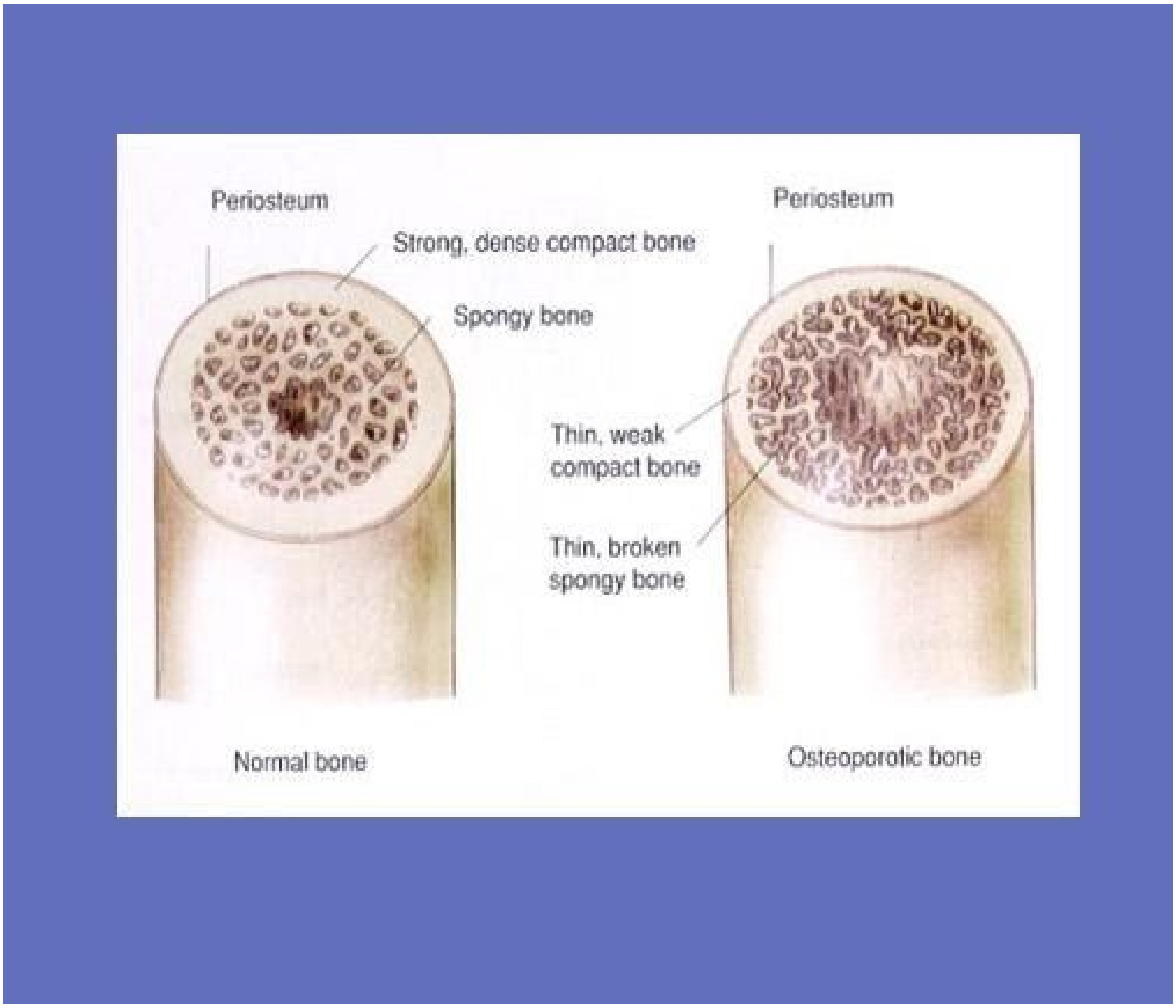
3.9.6 Cross Section Tool (Bone)

BioMight will allow the user to dive into the details of Bone structure.



3.9.7 Cross Section Tool (Bone)

Using the Disease Tool in a Bone Cross section view, one can introduce Osteoporosis as shown below. The tool allows one to view the results of the disease at the onset as well as when progressed.



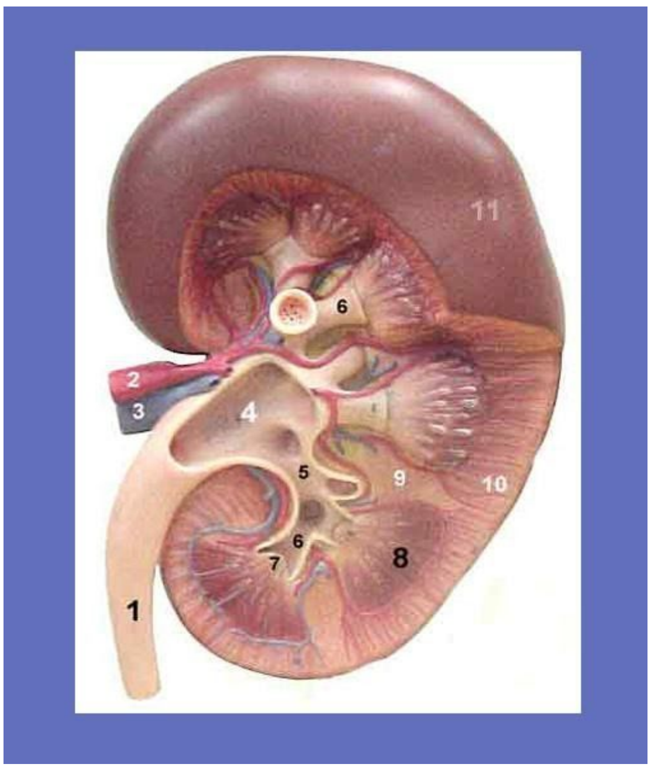
3.10

Urinary System

3.10.1 Decomposition Tool – Kidney

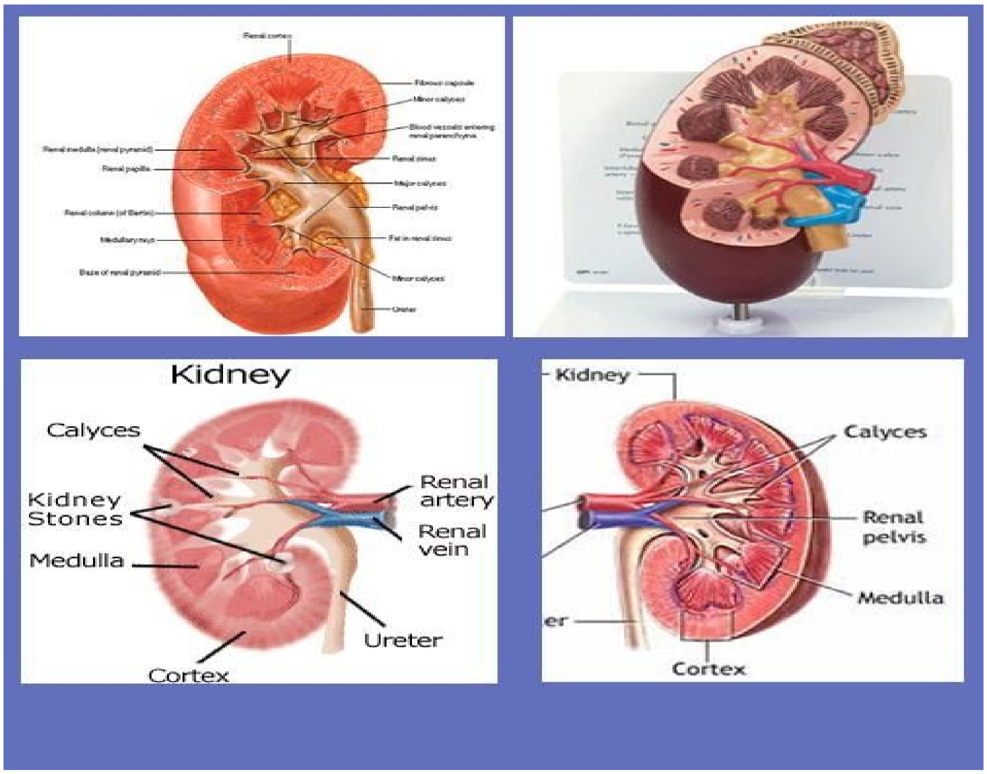
BioMight’s kidney model. Consists of two million nephrons. The kidneys are located on the dorsal body wall in the superior lumbar region (near the lower vertebral costa). The right kidney is slightly lower than the left kidney because of the liver's size and position. Usually, adipose capsules attach the kidneys to the retroperitoneam (the space behind the peritoneum).

The kidneys are located on the posterior wall of the abdomen at waist level. Each kidney is roughly 10 cm long and 5 cm wide, and is encased in a fibrous outer capsule called the renal capsule.



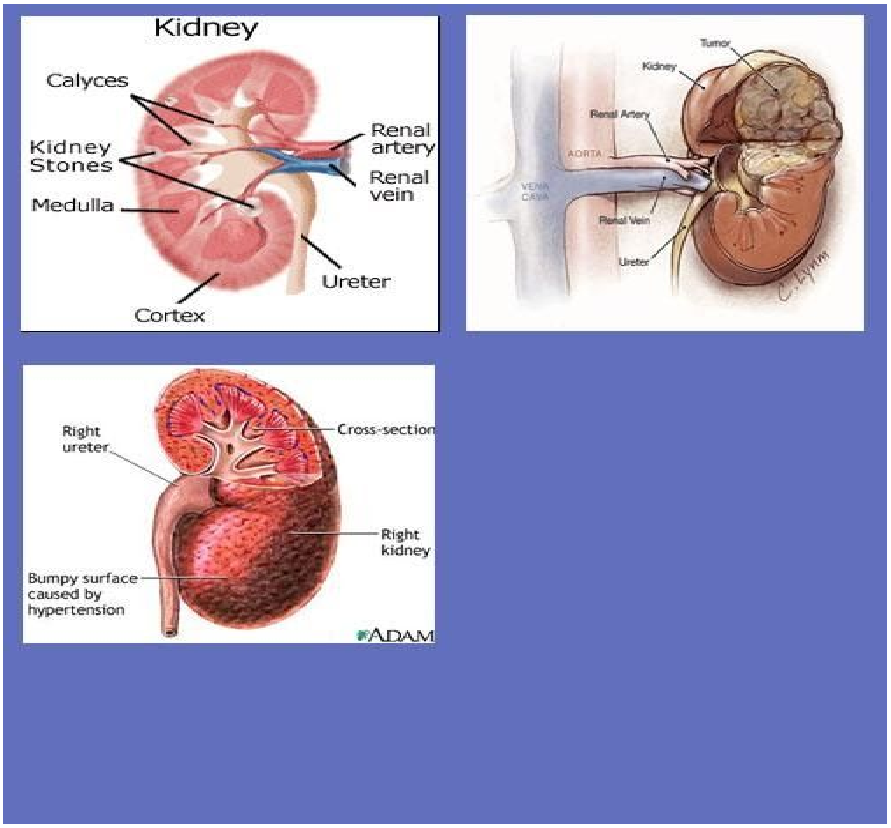
3.10.2 Decomposition Tool – Kidney Substructures

BioMight's Kidney model



3.10.3 Disease Tool – Kidney

BioMight's kidney model

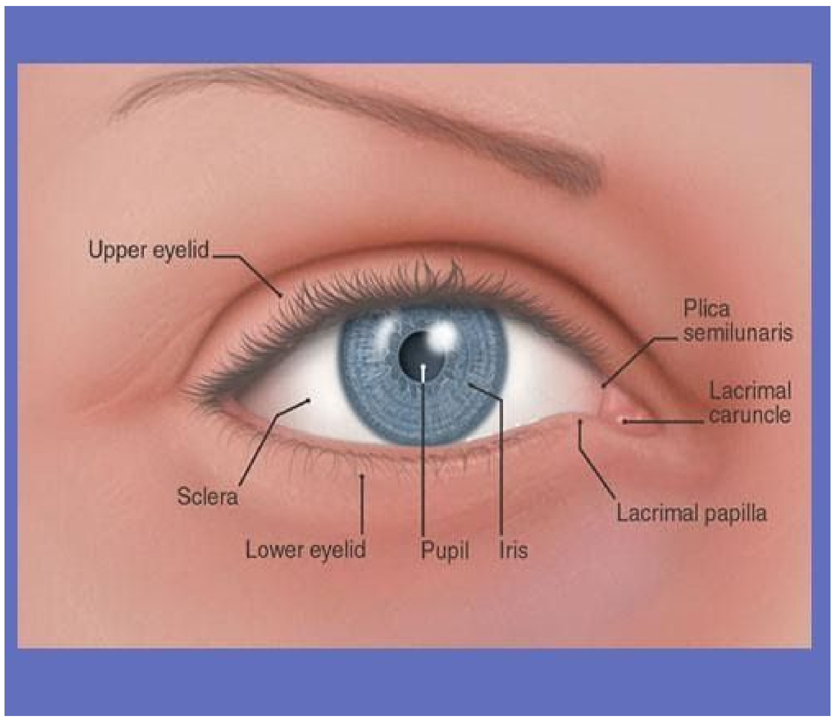


4.

Sense Organs

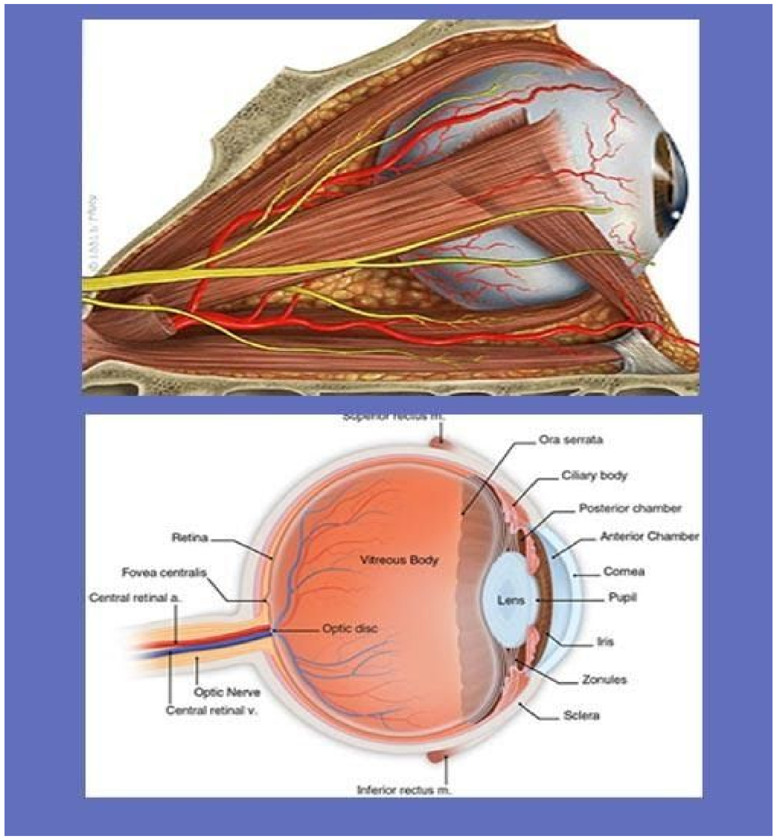
4.1 The Eye

BioMight's eye model can be rendered in a variety of ways based on the configuration and phenotypes being expressed. In this model, the shade of the eyes is set to blue and the rendering is using a female form. BioMight eye model can also be displayed in a animation that shows the administration of medicine.



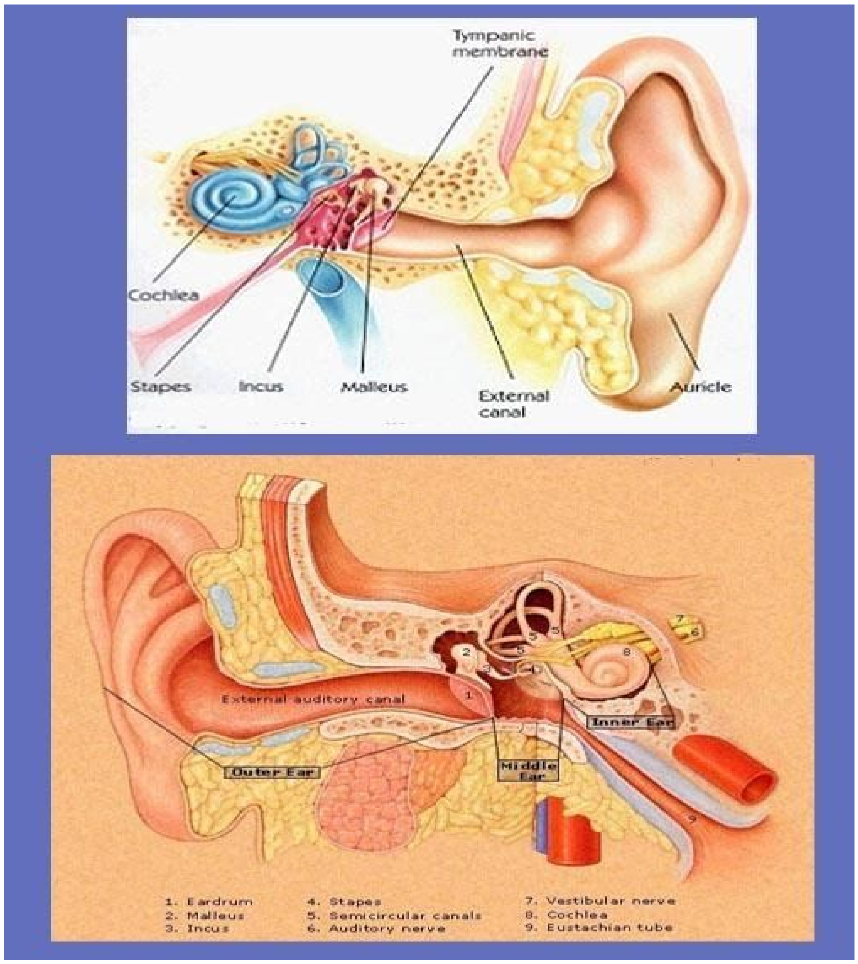
4.1.1 Decomposition Tool – The Eye Tissue

Moving behind the external view, BioMight models can reveal the eye's underlying details.



4.2 The Ear

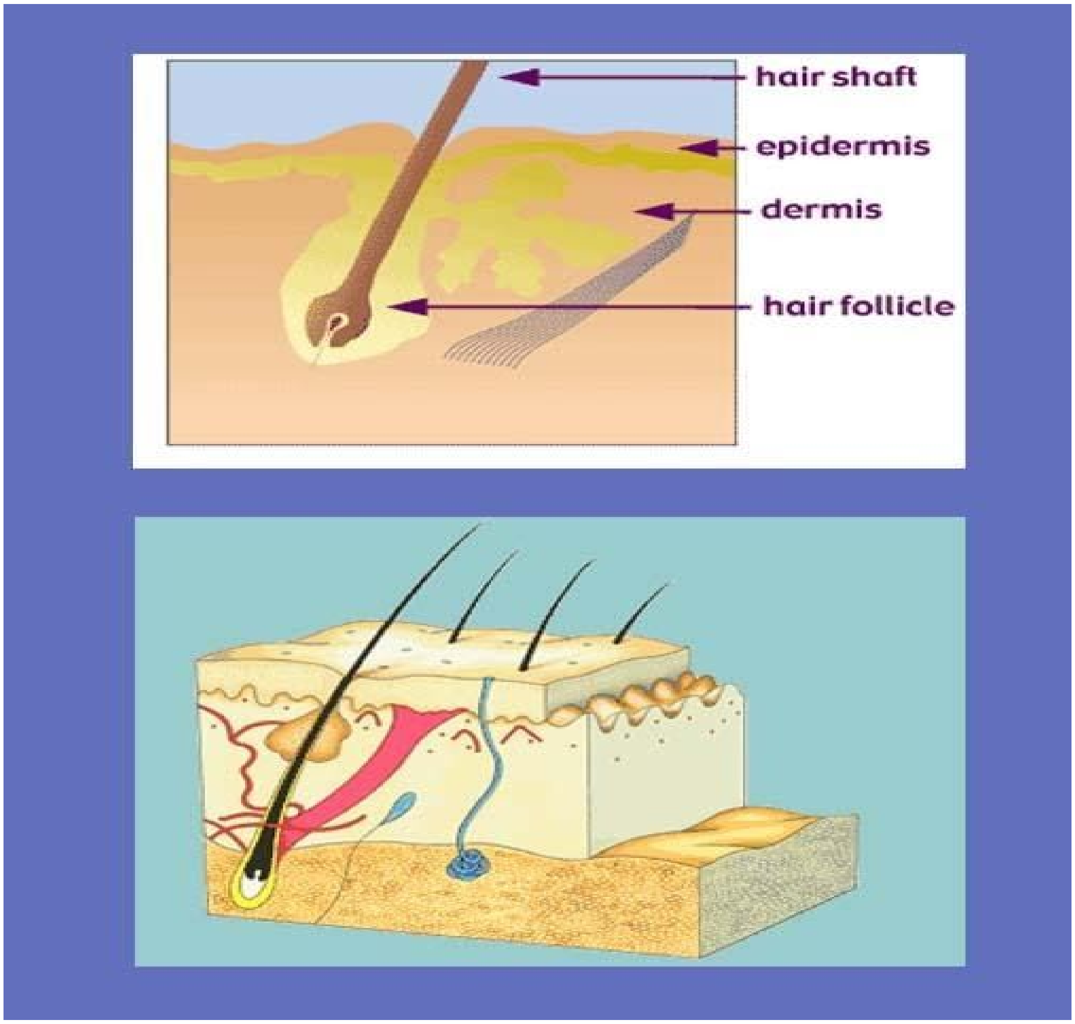
BioMight's Ear model..



5.

Skin, Hair & Nails

Next, one c



6. BioMight Composite View

BioMight's composite view allows one to view the body by component, rather than by system. Whereas you have the ability to view each of BioMight's individual systems, one can also view the collection of systems and how the relate symbiotically to each other.

Using a configuration menu, one can interactively choose the components one wishes to see. For instance, if one is viewing the head, one can enable the skull, the muscle, the arteries, and veins, to get a view of how they weave together to make a functioning unit. Based on the level of abstraction one is currently viewing the option menu choices will adapt accordingly.

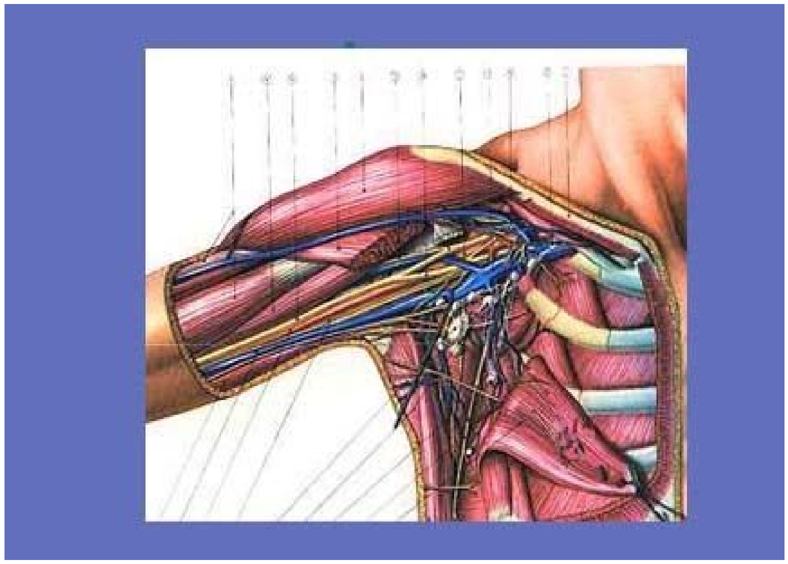
6.1 The Upper Body

BioMight's eye model

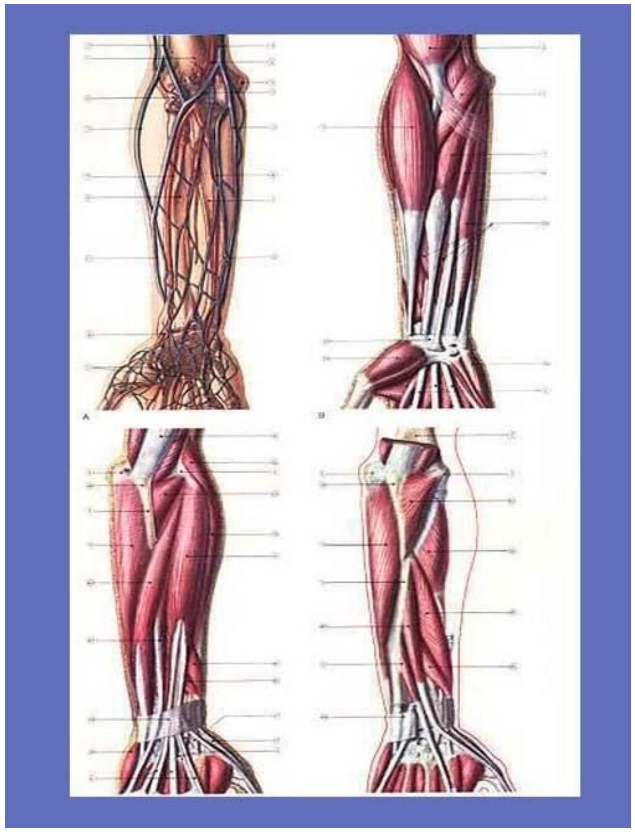
6.1.1 Composite Tool – The Head

Moving behind the external

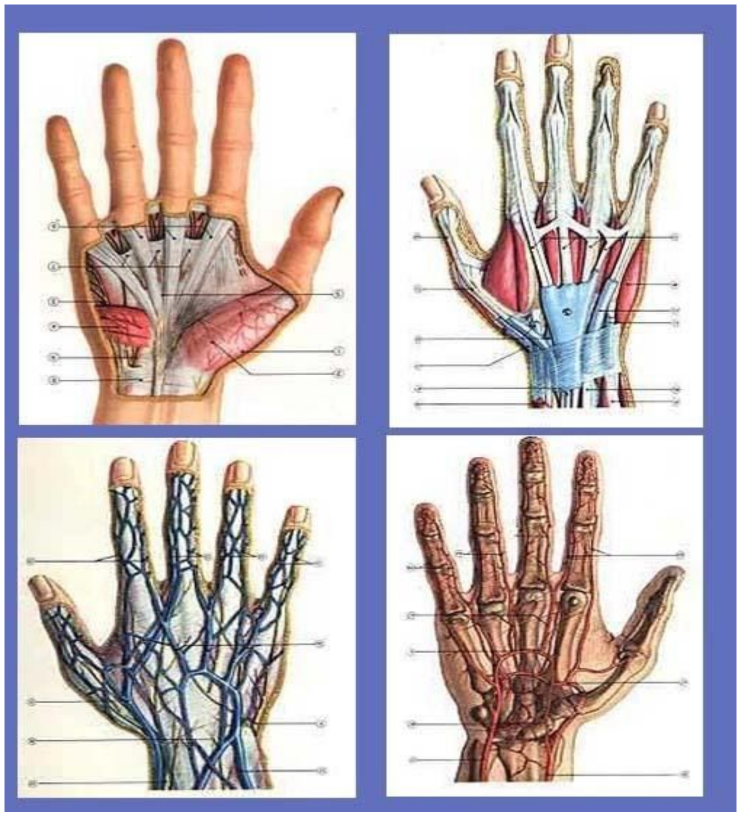
6.1.2 Composite Tool – The Shoulder



6.1.3 Composite Tool – The Forearm

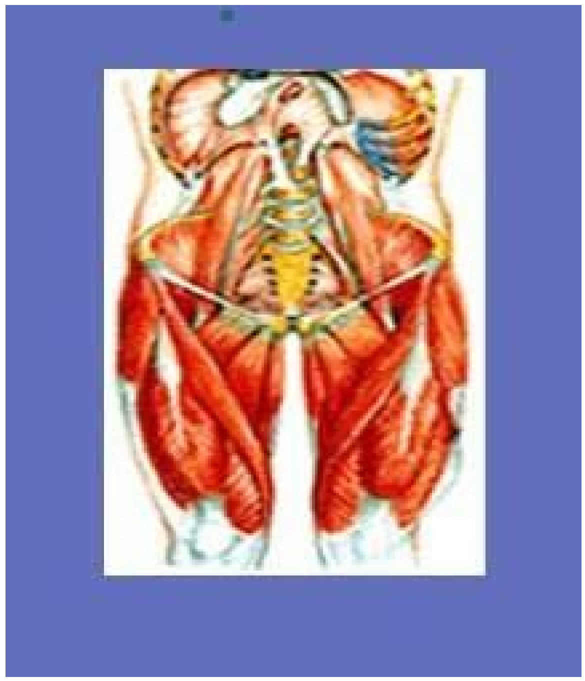


6.1.4 Composite Tool – The Hand



6.2 The Lower Body

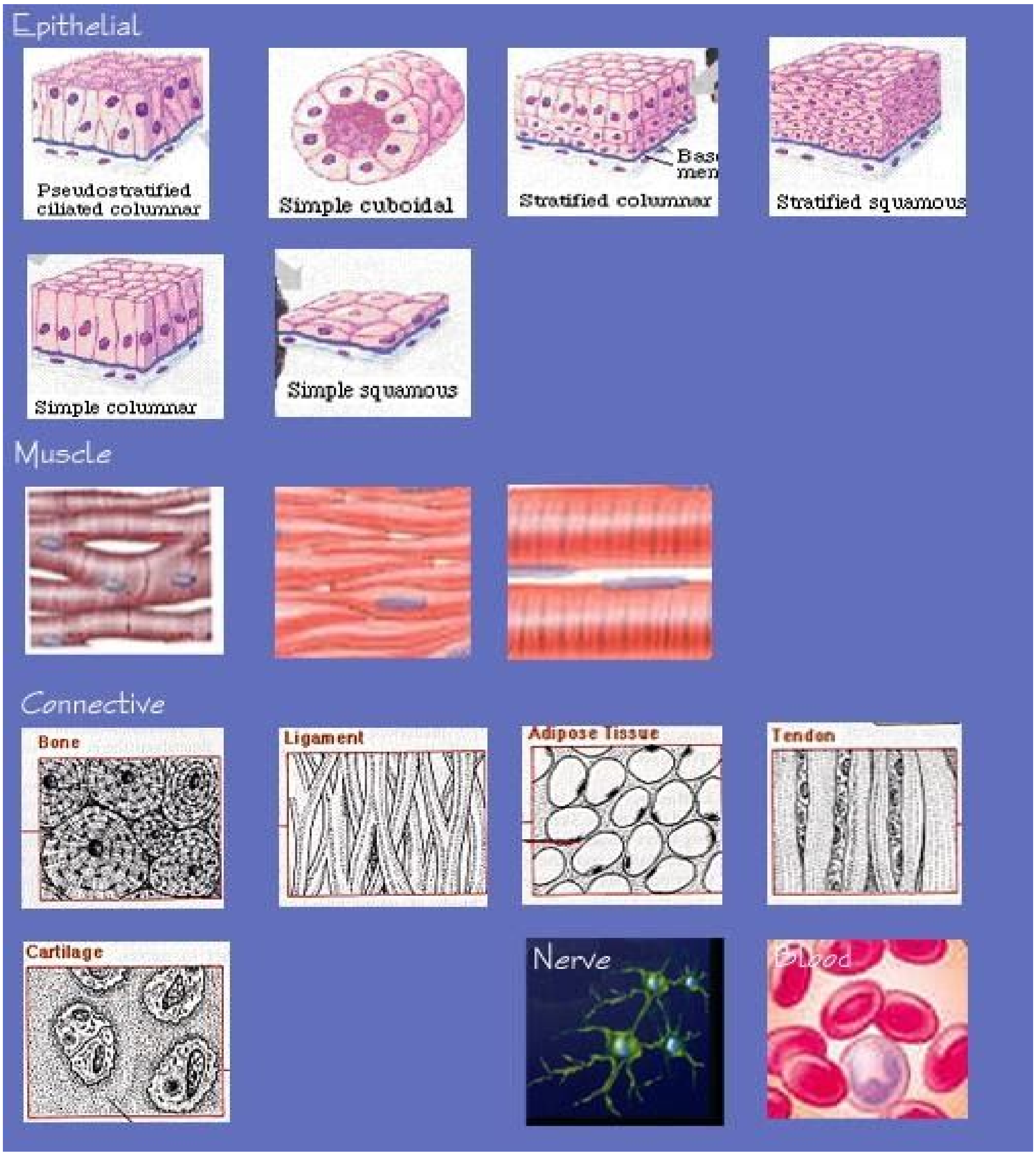
6.2.1 Composite Tool – The Torso



7.

Tissues

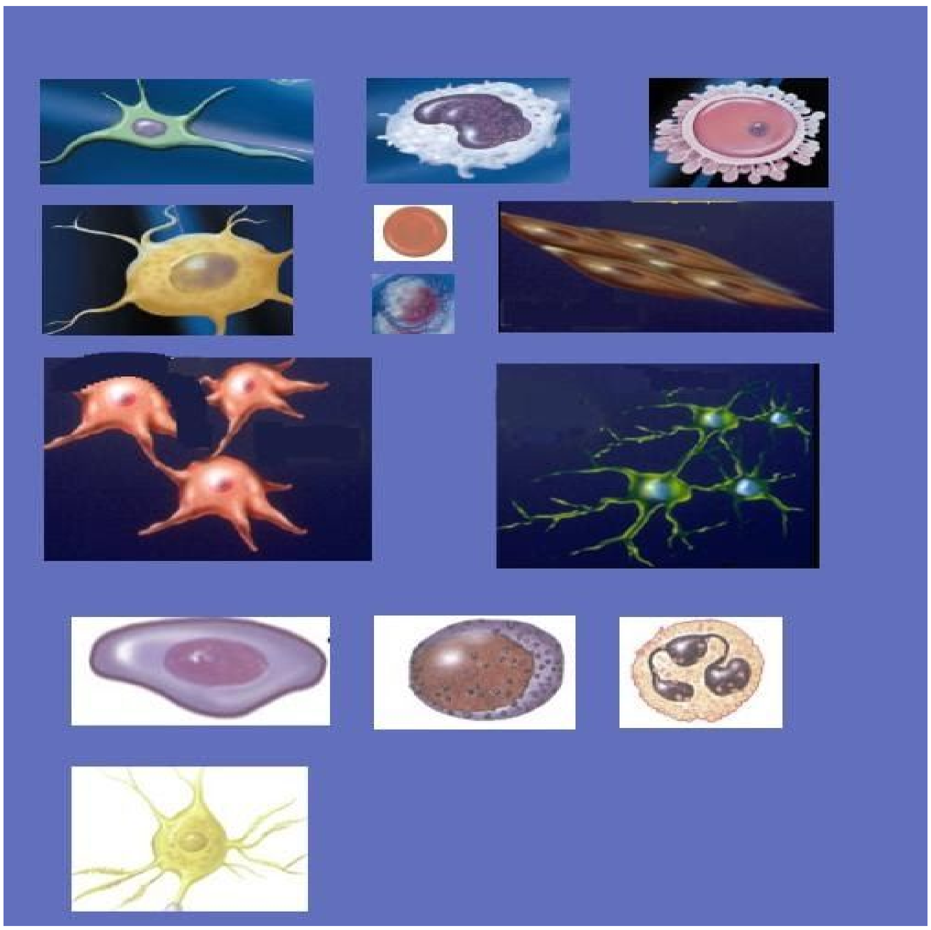
Next, one could venture to the Tissue Knowledge Library to specify the type of tissues they wish their selected hormones to interact with. In our BioMight animation, one would have selected smooth muscle tissue.



8.

Cellular System

BioMight's Cellular System allows one to select from BioMight's library of cell representations. From here, user's will be able to add individual cells to their animations/illustrations or a bind them into a collective that represents a portion of cells bound in the body. BioMight offers numerous cell types and color schemes, containing varying levels of detail, such that one can create professional quality work that best fits the presentation or animation being developed.



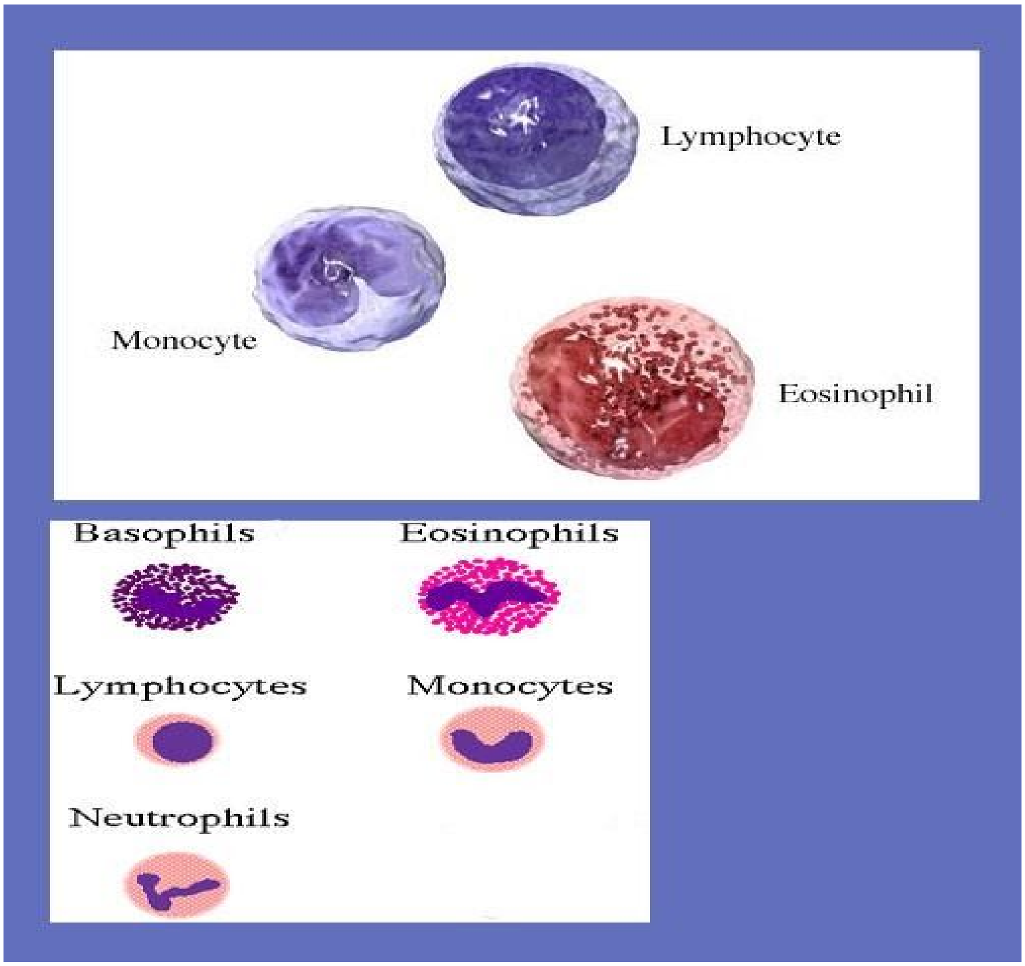
BioMight will be able to render all cell types found in the human body. If one wishes to zoom in

Encyclopedia Tool

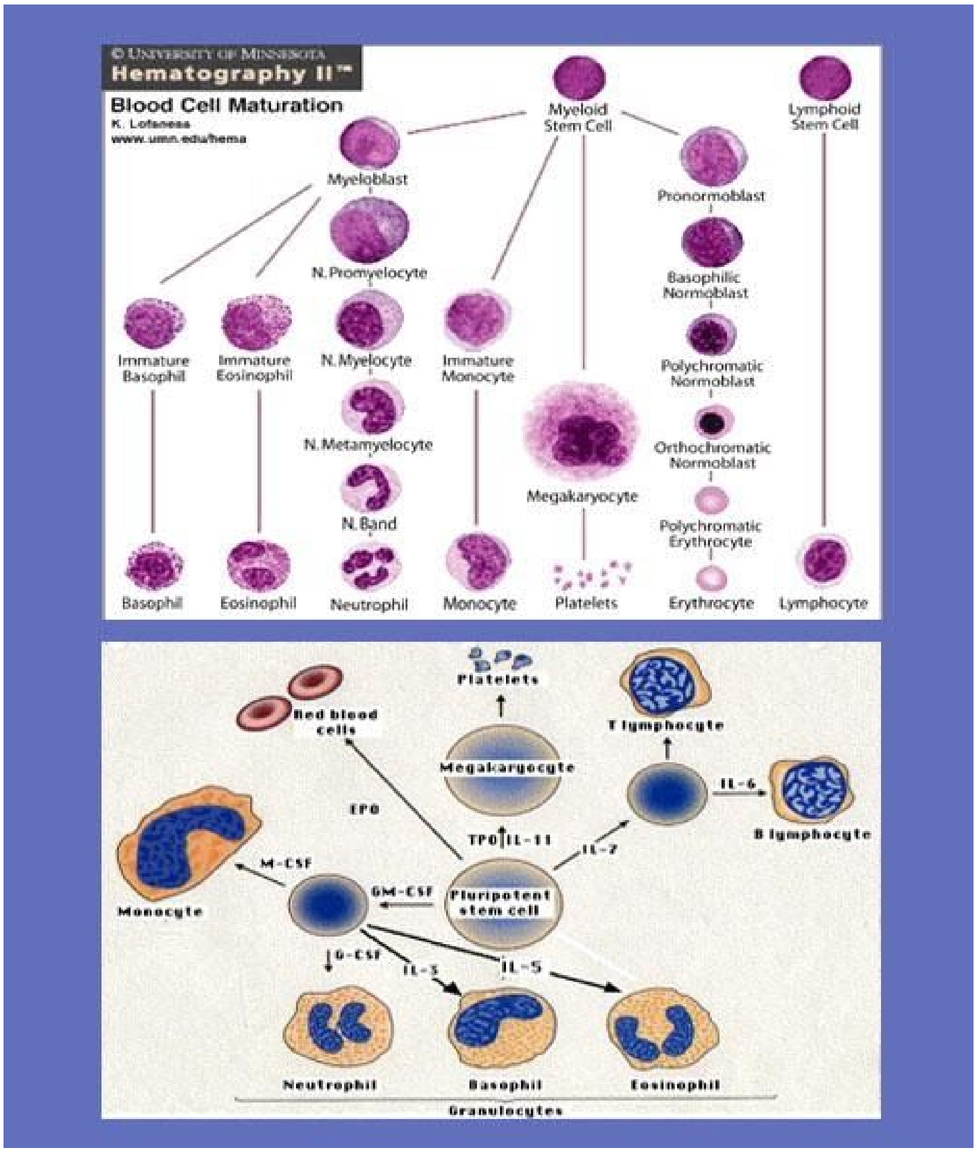
Activation the tool in this component of BioMight opens a window

8.1.1 Decomposition Tool

Drilling down into the White Blood Cell collection, one can select from a variety of themes applied to BioMight's representative cellular models. Shown in the top frame, is a science theme, while below illustrative cartoon is presented.



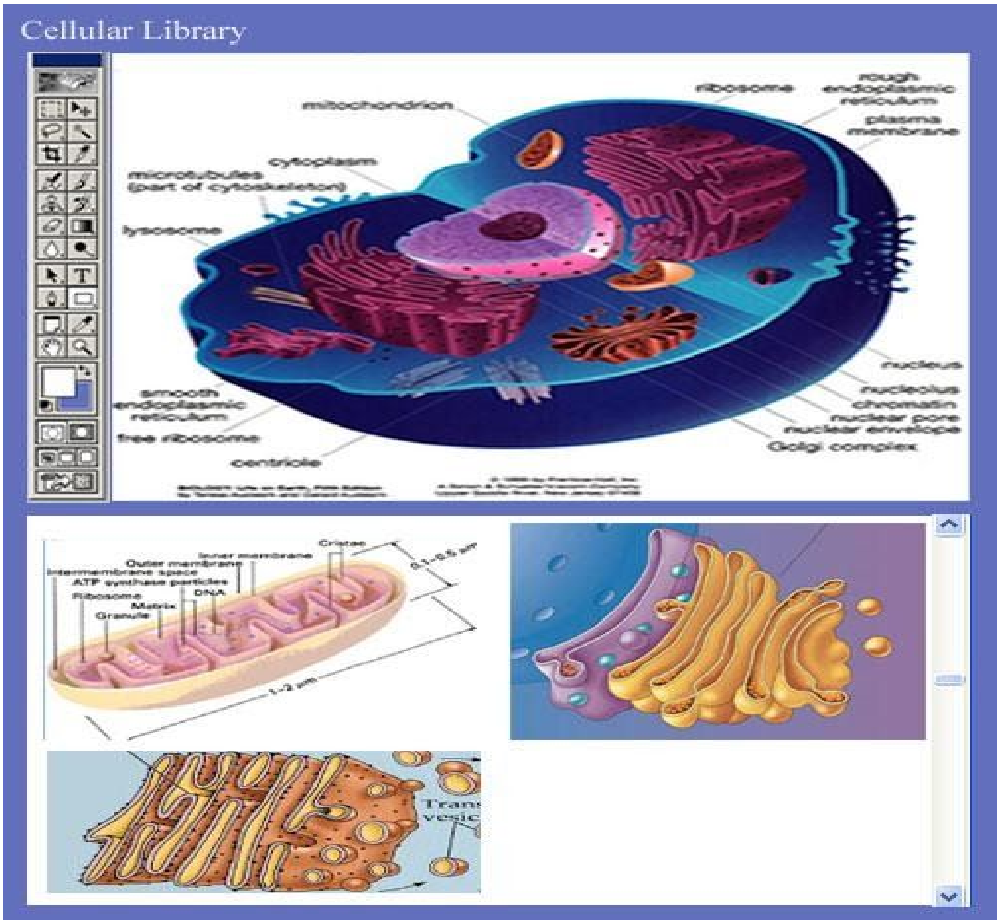
BioMight also understands the hierarchy



8.2

The Cell

In addition to selecting, constructing, and adapting from the cell collection, BioMight also allows one to drill down into the Cellular model. Shown below, BioMight's cross section tool has been used to open up the model.

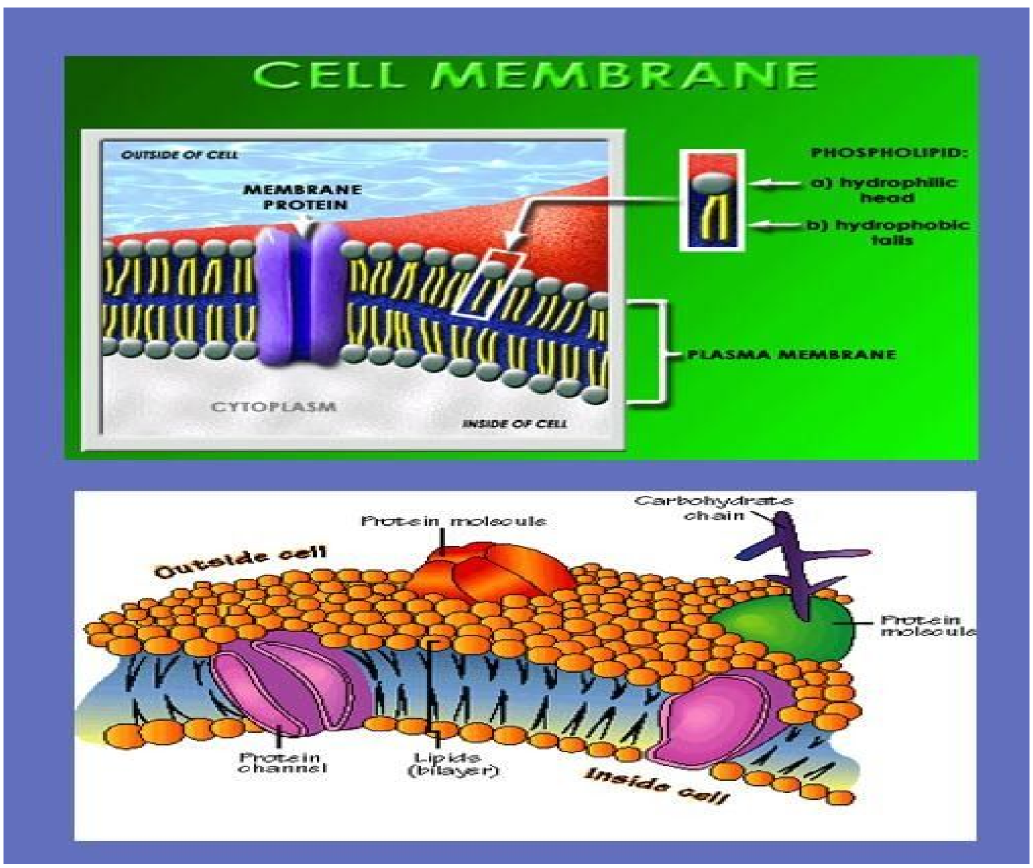


8.3 The Cellular Membrane

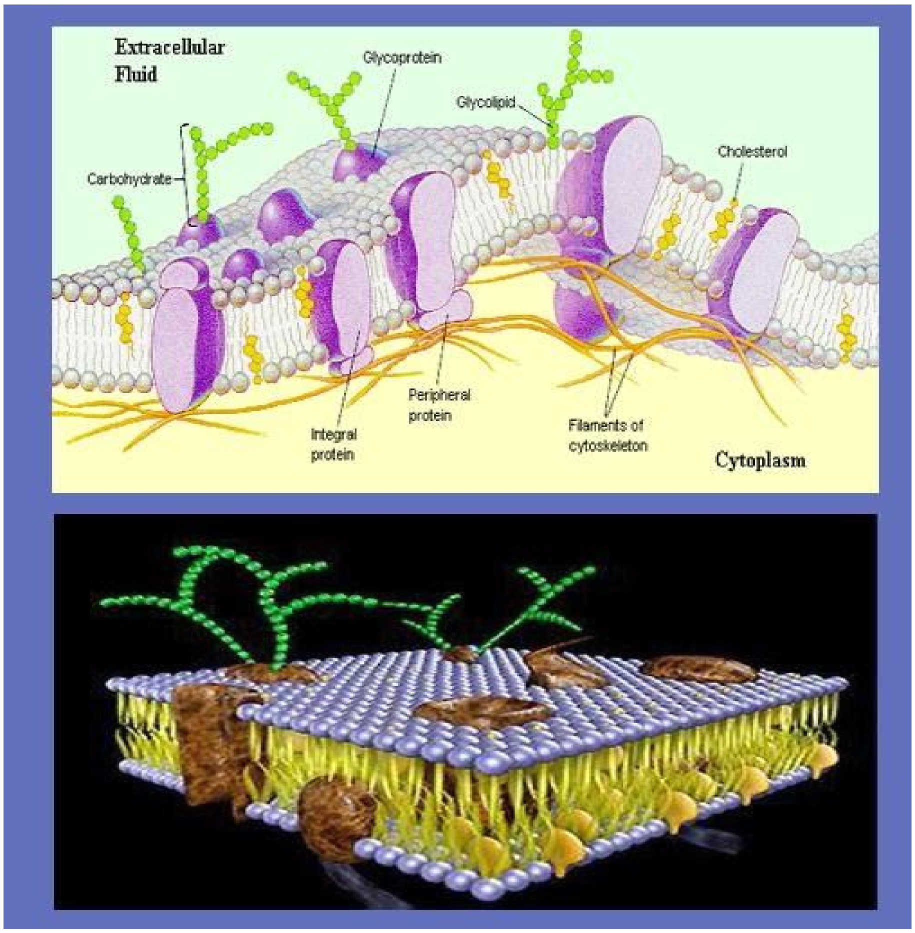
The Cellular membrane is a selectively permeable layer that surrounds cells. BioMight's Cellular membrane model is comprised of a number of components, just as in vivio.

BioMight's cellular membrane model can assume different appearances through the application of themes. Themes are pre-built color schemes as well as look and feel elements that change the appearance of the model, but not the underlying data model.

Shown below, one sees several representations of the cellular membrane model. Using BioMight's transformation tool, one can also adapt the structure to take on a variety of orientations the structure could assume under normal conditions.



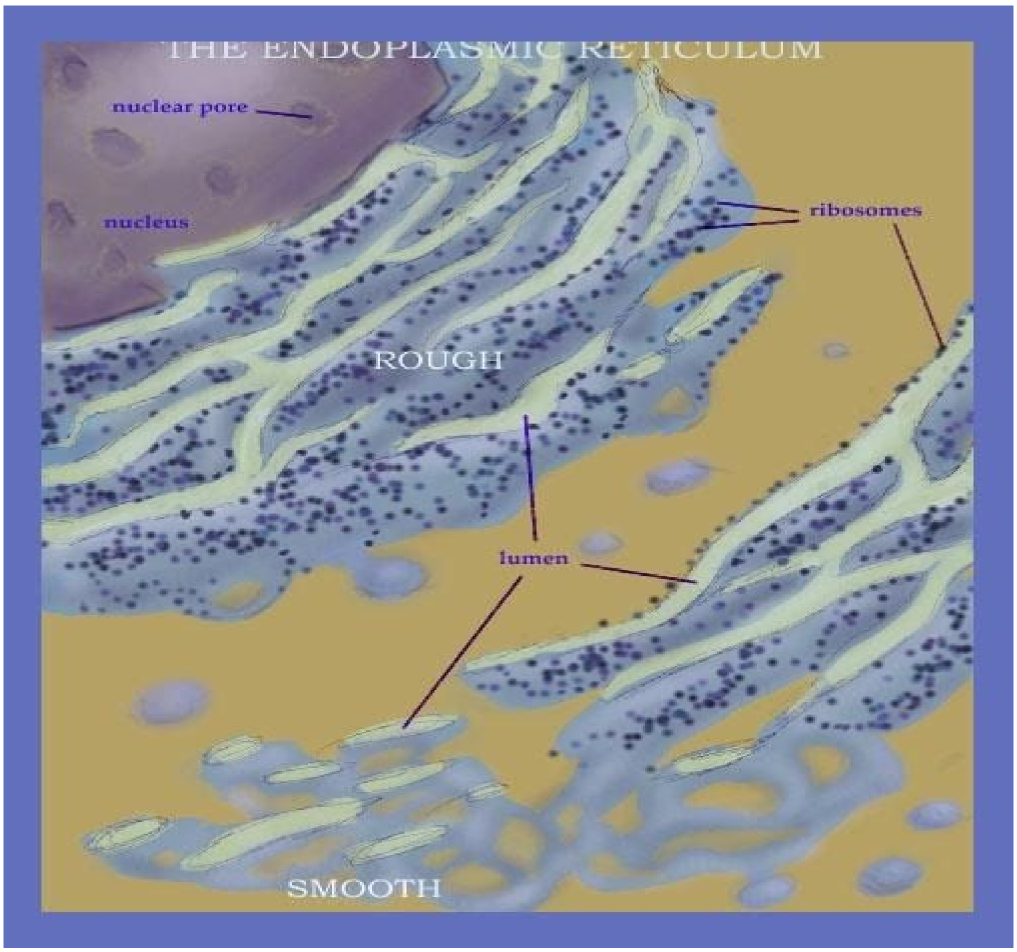
To display a model that takes on a more detailed animation, one can



8.4

The Endoplasmic Reticulum

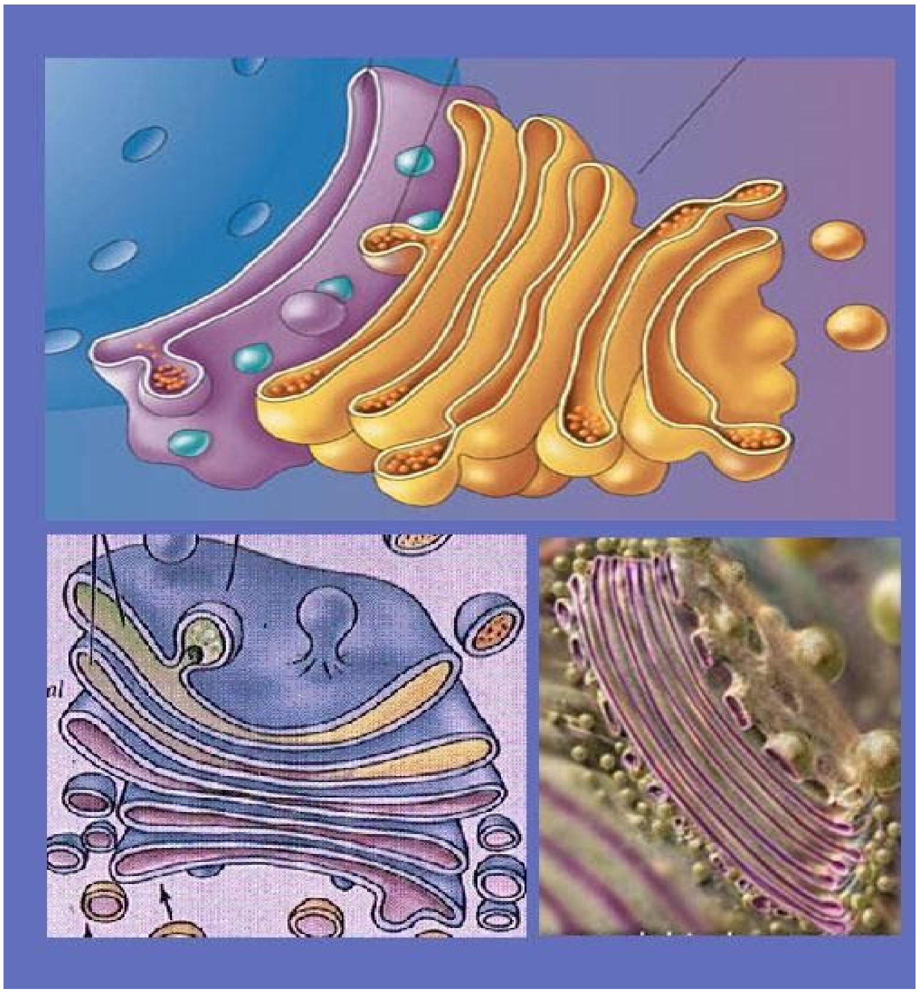
BioMight's Endoplasmic Reticulum model can be used to show processes such as assembly of proteins and their movement through the ER's assembly line. Utilizing the Configuration tool, one can set parameters, such as the number of ribosome's that appear, the size and depth of the channels, and the number of grooved chambers. Using the palette tool, one can also adjust the colors and hues presented in the model.



8.5

The Golgi

Shown below are a few representations of the Golgi themes that may be selected.



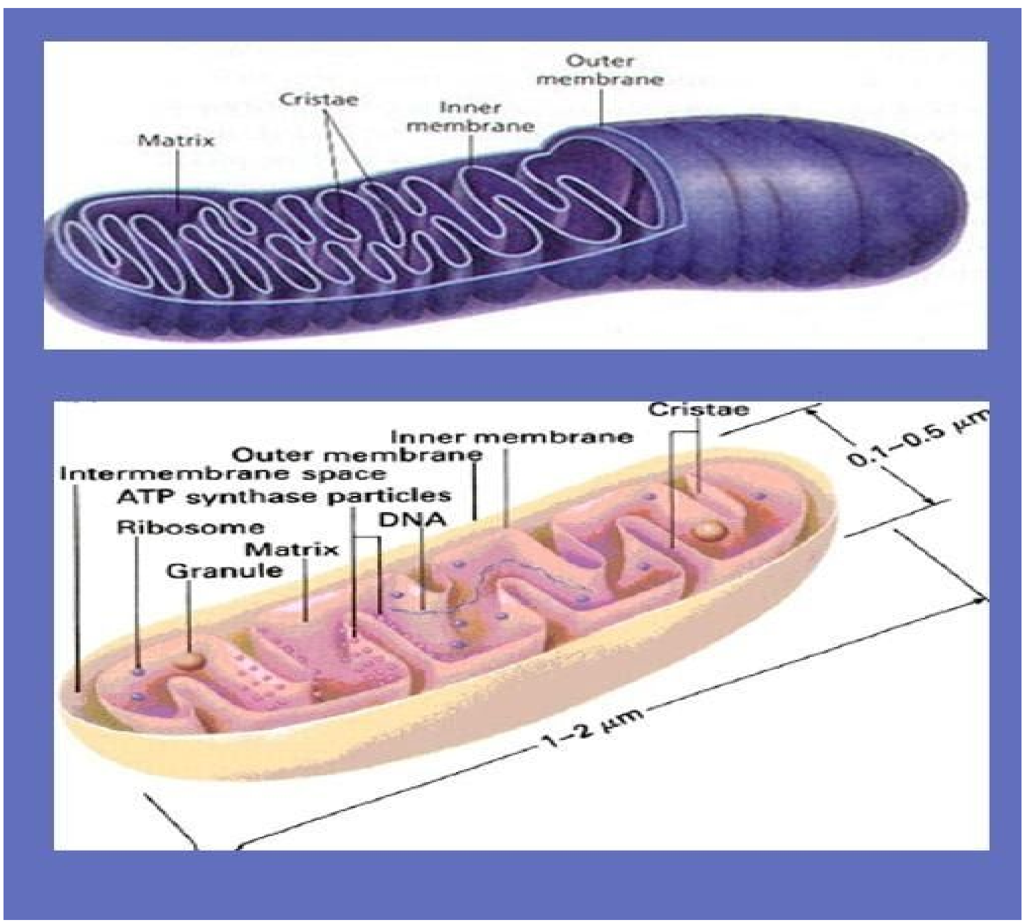
8.6

The Mitochondrion

BioMight offers several pre-built templates of mitochondria that allow the user to get up and running quickly. Each of these can further adapted by the user by utilizing BioMight tools and configurability options.

Show below, are two representations. In the top illustration, the user has chosen to color the "powerhouse of the cell", a transparent purple. Also, the user has only applied the cross section tool to a section of the model, versus the bottom depiction where it was applied symmetrically across the horizontal plane.

In the lower illustration, the user has enabled BioMight's scale tool, which adds dimensional detail labeling to the model. Also note that the Cristae configurations in each of the representations differ. In this instance, the user has 'upped' the number of Cristae in the model, and BioMight has applied the transformation.



8.7 The Nuclear Envelope

BioMight offers

8.8

Calcium-Ion Channel

BioMight offers

8.9 The Cellular Assembler

The Cellular Assembler allows one to construct and group cells using a variety of cell types. One will be able to create a single cell, or group of independent cells, or even assemble them into tissues.

For instance, if one creates a few hundred thousand muscle cells, one can utilize BioMight tools to assemble them into a collective such as they resemble a particular muscle structure in the body.

As with other areas of BioMight, filtering may be applied such that the data sets only need represent that which the animator is truly interested in. For example, if one is interested in how the mitochondrion in a muscle cell works, then BioMight can apply filtering to screen out the golgi, peroxisomes, etc.

8.10 Cell Types

Muscle Cells
Epithelial Cell
White Blood Cells
- B Cells
- Helper T Cells (subsets)
- Cytotoxic T Cells

Red Blood Cells
- Granulacytes
- Nuetrophils
- Esinophils

Pituitary Cells
Lactrotrophs
Somatotrophs
Gonadotrops
Adipose

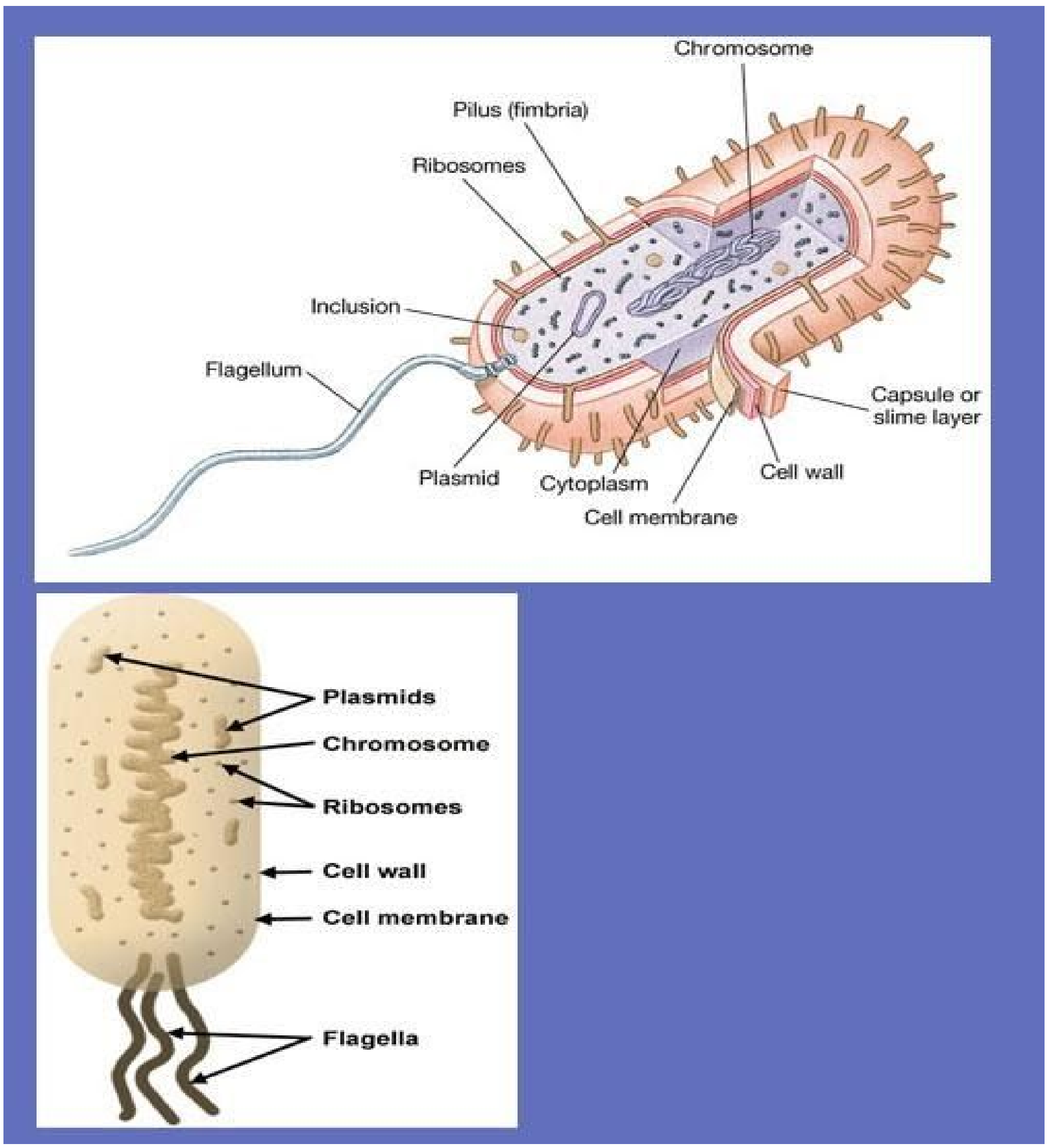
8.11 Cell Components

9.

Pathogens

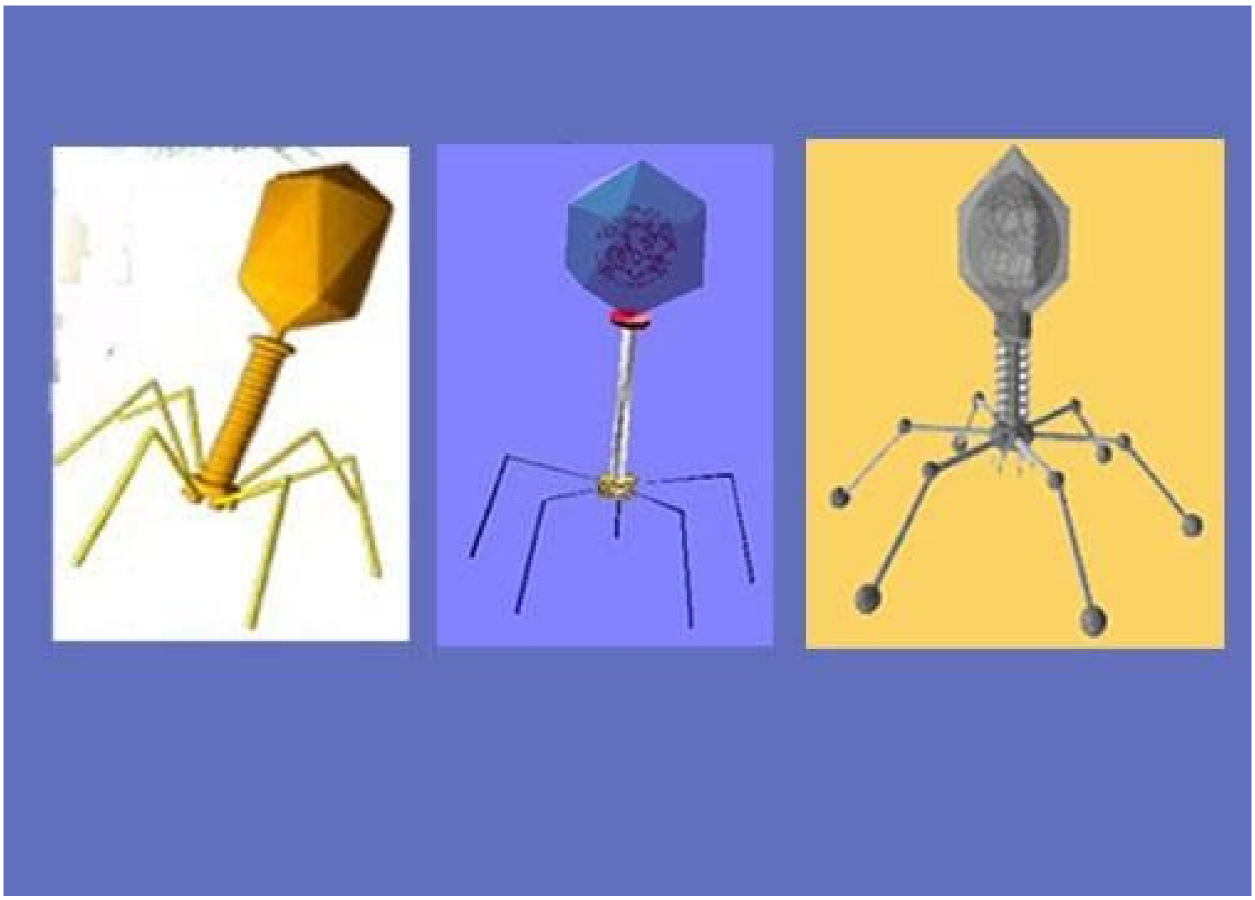
Next, one could venture to

9.1 Bacteria

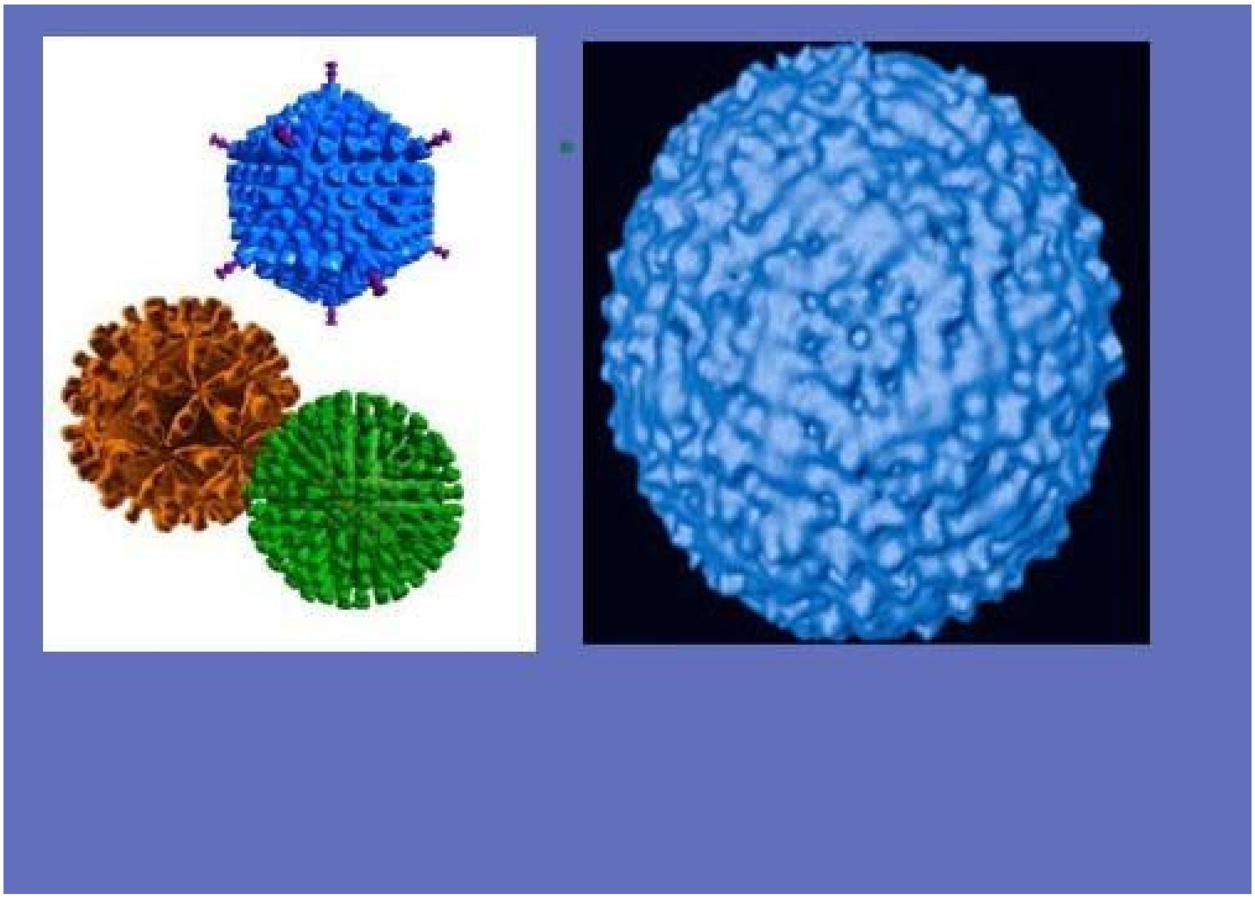


9.2 Viruses

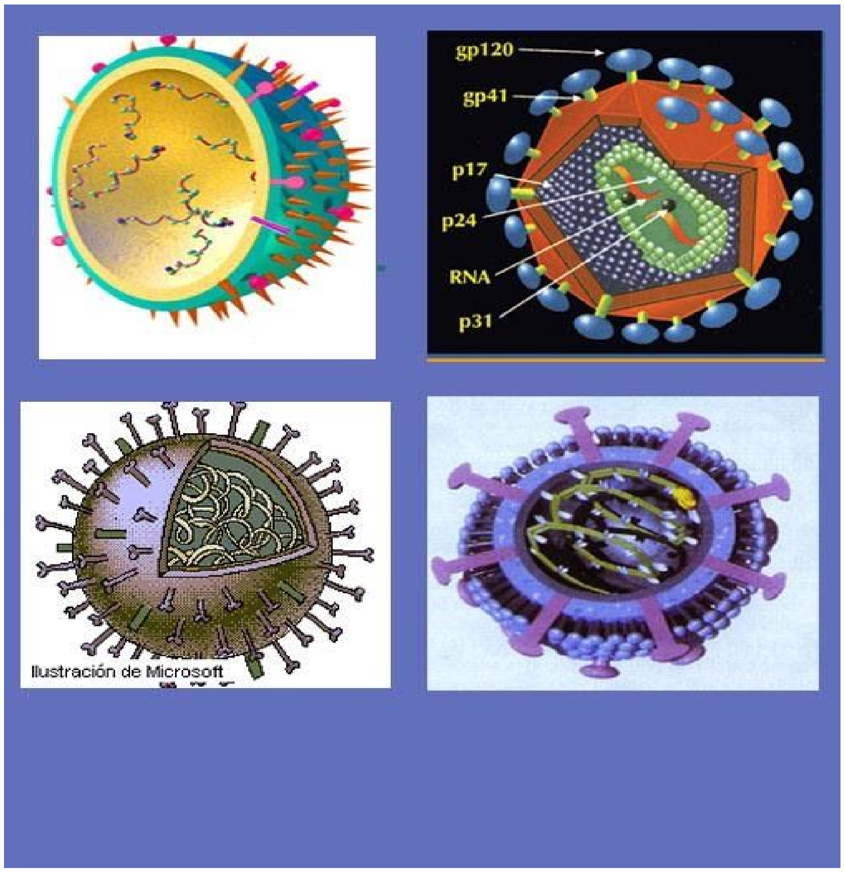
The virus tool…



The library offers a variety of themes applied to several viral models allowing one to customize their offering.



Using the cross section tool, one can open up the inside of the various viral models to reveal the details within.



9.3 Fungi

BioMight also offers a number of…

9.4 Helminthes

10. Molecular Assemblies

BioMight

Core Compounds

Nucleases	Thoilates	Amides	Amides	Aldehydes
Alkenes	Alkanes			

10.1 Proteins

BioMight's protein database is derived from information in the Protein Data Bank (PDB), whose coordinates are the standard for representing molecular protein models. BioMight will be able to read and render PDB defined images.

3D structures of proteins and other macromolecules are described with the PDB coordinate system. PDB stands for the Protein Data Bank. The standard way of accessing the data bank is through: PDB Server (RCSB) PDB is a huge collection of 3D structures produced by protein crystallographers, NMR spectroscopists or electron microscopists. The basic format of the pdb file is; For every atom

- there is a line in the PDB file beginning with the word "ATOM"
- the number of the atom in the file is indicated, e.g. 1
- the atom type is indicated, e.g. "N"
- the residues type is indicated, e.g. "ILE" for isoleucine
- there are atomic coordinates in the format x,y,z.

A very small pdb file describing a single atom would look like this:

```
ATOM 1 N ILE A 1 -2.507 87.140 25.856 1.00 17.81 SEGA N
```

Before the actual coordinates in the PDB file, there is a header with different sections containing information about the source of the protein, the methods used for obtaining the structure, the quality of the structure, secondary structure elements, active site and the sequence of the protein.

The application must be able to take PDB and create a representation in Flash, with the same features as Protein Explorer.

Amino Acids

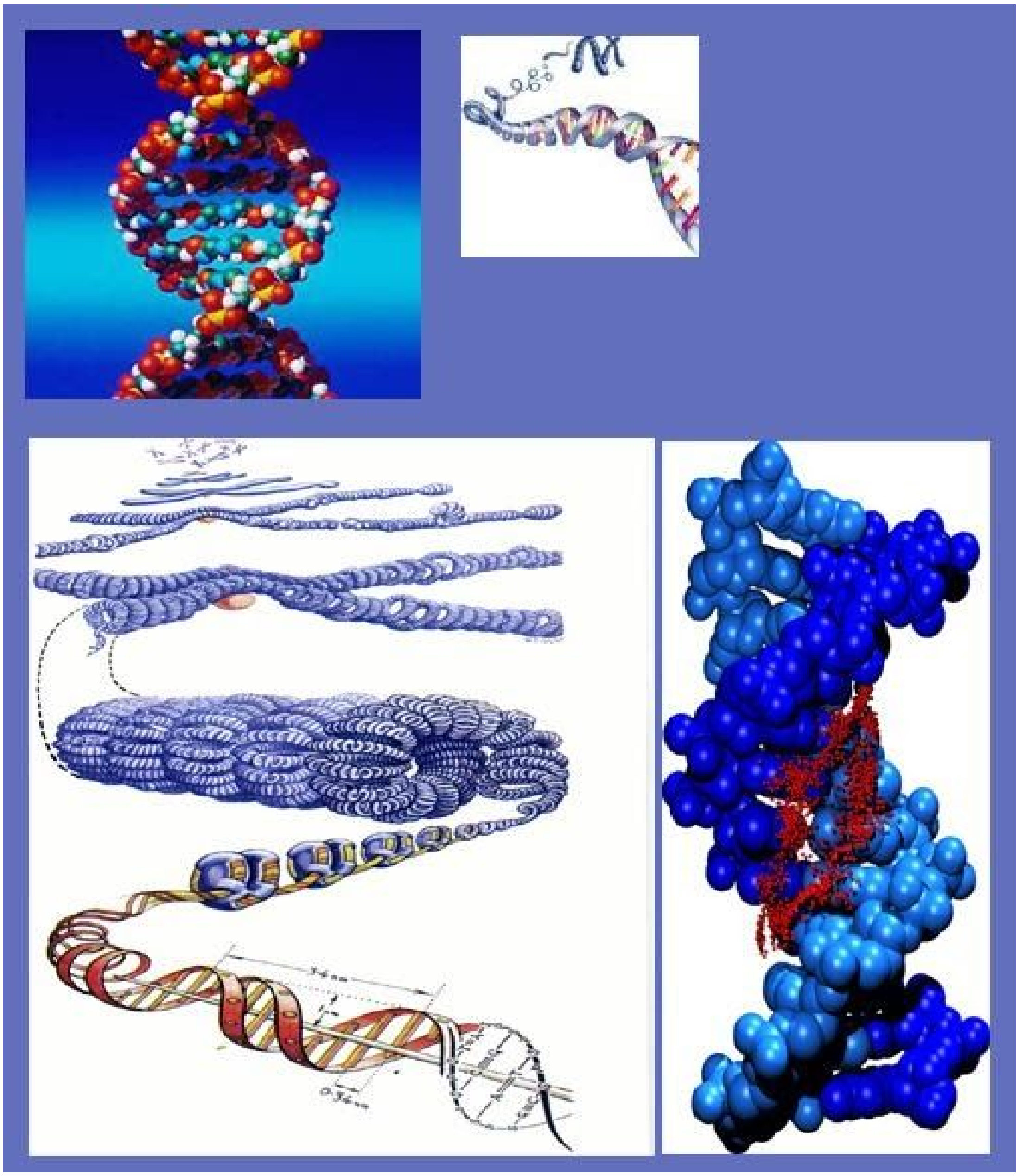
Alanine		Histodine		

10.2 Carbohydrates

10.3 Lipids

11. DNA & RNA

The DNA and RNA subsystem allows one to work with base pairs within a nucleotide chain, as well as apply affects utilizing the BioMight Toolset. BioMight offers the traditional ball and stick representation, as well as a number of others.



11.1.1

The Decomposition Tool

Using BioMight's Decomposition Tool, one can construct..

11.1.2 The DNA & RNA Assemblers

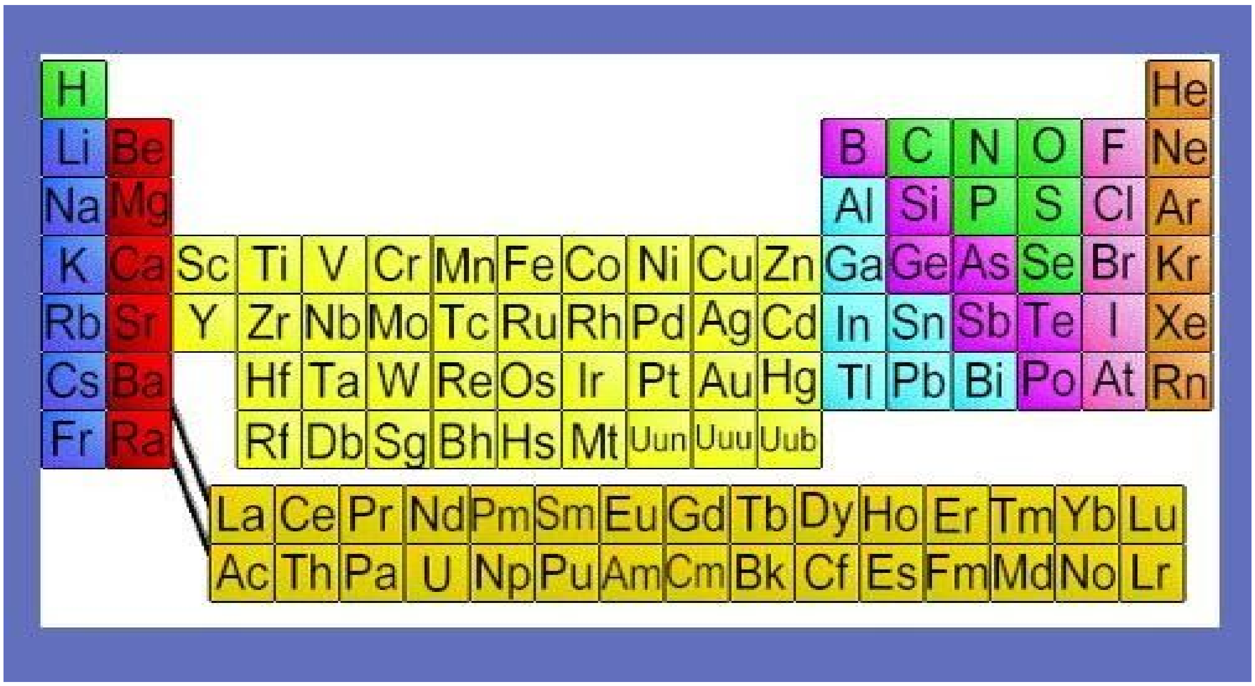
Using BioMight's assembler, one can construct,

DNA Components

Guanine	Cysteine	Thymine	Uracel	Adenine

12. The Elements

At a basic level, humans are comprised of a handful of elements found in the periodic table {H, C, N, O, Na, Mg, P, S, Ca, Fe, Zn}. BioMight provides models for each of the elements. These are selectable from the library and can be readily added into one's illustrations/animations.



At this level, the application will offer a palate of different atoms in which one can use to construct various molecules, ions, etc. When the atom is selected, a representation will be displayed on the screen in the proper scale with constituent elements being joined at the proper torsion angles. These basic elements string together in molecules, which in shape into amino acids, carbohydrates, Nitrogen rings, and so on.

13. Applying Disease

There are several modes for applying disease in BioMight.

Play Scenarios
One could bring up the Virus or Bacteria catalogues and select from the menu, set the desired parameters. These libraries will allow you to determine how many cells or capsids to introduce into the model.

Say for instance, the user wishes to introduce helicobacter bacteria through the model by having the subject eat contagion laden food. Medical science tells us that this bacteria will move through the stomach with degradation as it contains a coated membrane of hydrolyses that are impermeable to the gastric and bile that is secreted upon it in the stomach and small intestine.

The user could also select a particular area of the body and directly introduce the toxin or virus. This is done through the disease tool.

14. BioMight Tools

14.1 Animate Tool

The Animate Tool brings BioMight's static images to life. When clicked, the BioMight servers are called upon the retrieve a 3D flash animation of the model they are currently interested in viewing.

14.2 Blood Composition Tool

Blood is comprised of a number of different components, all being part of the BioMight repertoire. This tool allows one to modify, through configuration parameters, the makeup of the model's serum. (disease tool?)

14.3 Color Palette Tool

The Color Palette Tool will allow one to customize the colors that are used in the presentations of the BioMight models.

14.4 Decomposition Tool

This tool draws upon BioMight's knowledge of the component one has highlighted and presents a compositional view of the component at one layer lower of abstraction. For instance, if one clicks on a vein using this tool, a cross sectional view will be displayed that highlighting the tissues that make up the structures.

14.5 Disease Tool

In addition to introducing drugs, BioMight models have the ability to mimic disease and the responses to that disease. While constructing a project in BioMight, one can use the disease tool. Based on where one resides in the model, and the configuration parameters, a list of appropriate diseases appear.

14.6 Pathogen Tool

Using the pathogen tool one can introduce bacteria, virus, and fungi into BioMight's models.

14.7 Fly-Through Tool

The Fly-through tool allows the user to enter the system from a 3D first person "gaming perspective".

14.8 Gradient & Texture Tool

The Texture tool offers a variety of different textures. Depending upon the component of the model in which the user is currently working, the Textures displayed will vary. For instance, instance the textures that one is offered while working with epithelial tissue will be different than those offered when working with the components of DNA.

14.9 Pharmaceutical Tool

The Pharma System allows on

14.10 Sizing Tool

The Sizing tool allows one to enlarge or shrink the model so that it accommodates the users needs in building their presentations.

14.11 Text Tool

This tool allows one to annotate the models and animations.

14.12 Theme Tool

BioMight's theme tool…

14.13 Transformation Tool

The Transformation tool can be used to modify BioMight's 3D rendering of its model. The transformation model actually makes a copy of the existing BioMight that one is working with and allows manipulation of the points in 3D space.

14.14 Phenotype Type Tool

Using the Phenotype tool, one can also change the characteristics of the model. Phenotype is the expression of a gene. One can change the physical characters of a person such as height, weight, body shape, etc. Using the tool, one can select either female or male. They can then use the tool to specify whether the shape is to be endomorph, ectomorph, or mesomorph. One can further go one to select face shapes of Caucasian, Indian, Asian, European, etc. The flexibility in the tool and the various options allow one to create over a million variants.

14.15 Snapshot Builder Tool

This tool contains a wizard that walks one through creating a snapshot of a BioMight 3D rendering. The wizard first helps the user extract the image, and then provides a variety of background stock images on which to place the chosen image, if desired.

15. Tutoring BioMight

Suppose a researcher has generated new data on a particular protein that is currently housed in BioMight's knowledgebase. To construct a model that extends beyond the current capabilities of the system, the user can enable BioMight's tutor mode.

While operating in tutelage mode, the BioMight expert system is invoked. The expert system drills down and collects the details of the new data and allows the user to configure BioMight to use it. Their personal web session will allow use of the new information, while the rest of BioMight will work as usual not affecting the core knowledge base.

Before the data is truly incorporated into BioMight's core the new data will be verified, as is done with (PDB) Protein Data Bank submissions. The PDB is an industry standard knowledge base of proteins along with their structure described in coordinate space. PDB accepts data from labs, institutions, etc, and after verification, incorporates it into its "world renown" repository.

For those that participate in adapting BioMight's knowledge base and model construction capability, will receive reduced subscription rates or obtain vouchers that may be applied to their account. BioMight will uniquely allow one to select elements and process to create a highly effective animation.

Tissue Assembler

The Cellular Assembler allows one to construct cells

Targeting

Picture a white blood cell floating in the serum albumin of a human body. From BioMight, I can first zoom down and target my white blood cell. Then choose the injury site. When I click "Animate", the white blood cell will travel the lengths of the cardiovascular system until it reaches the target.

Configuration

15.1 Core Objects

Objects will exist for each of the elements defined in the various paradigm levels. In reality, they all exist at once, but as a human's perception is quite limited when in focus, we will only observe what we expressly look at, thereby limiting that what needs to be modeled and presented at any given moment.

Using on screen navigation, the user will be able to move through paradigms, from the Atomic and Molecular Level up to the Species Level. In theory, each foundation is constructed from the prior using the details of the first to build the encompassing view of the next.. In theory, one should be able to model a stomach by assembling the various cells that comprise it. The Base Object will model the lowest observable particulate and be assigned properties which appropriately describe it.

Base Object - Perception
Physical Characteristics/Properties
SVG Coordinates to render in 3D
Location in respect to currently constructed model
Molecular Weight
Molecular Charge

Base Object - Realization

Base Object Conceptualization

****
Assumptions: We have a preset, confined area in which the model is based. When you blow up the minute details of the full scale model, it is as enormous and wondrous as the galaxy the stretches out and dwarfs our being. We only need to present at a level of detail that provides value and get the initial dollars flowing into the organization.

There are well over a million synthetic organic compounds. Spatial Orientation needs to be considered. We know the shape and sizes of a million biological elements. Using the base templates within BioMight, one creates a custom animation.
****

15.2 User Adaptation

BioMight will also provide configuration options for the user, much like an internet portal. For instance, when a scientific researcher enters the site, they will most likely be offered a different set of services than that of an educator who uses BioMight to instruct a high school biology class. Based on the user defined parameters, BioMight will offer information in a customizable, intelligent manner.

15.3 Industry Standards Conformity & Future

SVG

RDF

15.4 Performance

We should investigate the Fire Fox model of distributed processing, where each user is connected to each other and they share computing power.

16.

Operations

Web Servers

Application Servers

Databases

Application Monitoring

Application Support

Pay Pal

We must create representations of each type of structure in the body.

Arteries

Veins

Cell

Proteins

White Blood Cells

Bacteria

Staph

Strep

Viruses

AIDS

Rubella

Measles

Mumps

Adenovirus

Poximilia

Small Pox

We must also be able to vary their size and morph their shape, respective to the whole entity. We must also allow the user to change the colors and transparency of the colors much like the 3D package.