LIVER AND GALLBLADDER MODEL
141 A51

TEACHER MANUAL & KEY

CORRELATED TEACHING AIDS

A93, 143 Digestive System Model
A56, 146 Internal Organs Model
1405 Digestive System Wall Chart (36"x44")

CARE OF DENOYER-GEPPERT MODELS

Your Denoyer-Geppert model was designed and manufactured to provide years of satisfactory service. Molded of durable vinyl plastic, the finest lacquers and inks were used in hand-painting and numbering the model.

In order to clean the model, you should wipe it with a damp cloth, or a cloth wet with a mild soap solution, and dry.

Avoid placing the model in direct sunlight for extended periods. A cloth cover or case will help keep the model clean. Plastic covers should not be used.

PRESENTATION OF THE MODEL

Some facts which may stimulate interest in the class if stated at the beginning of this study are as follows:

1. The liver is the largest gland of the body.
2. It has five separate vascular systems.
3. The liver weighs about one-fortieth (1/40) of the body weight in an adult.

Most teachers prefer to delay the study of the detailed gross anatomy of any specialized organ or gland until first making a study of its neighboring structures.

Let us follow the accepted procedure by beginning the study of the liver in its proper body location. First, we can study its relation to the outside surface of the body. In addition to the available Teaching Aids which are used, it is also helpful to draw an outline of the body on the blackboard with the Liver marked in by means of dotted lines. Or if you feel inclined the liver can be marked on the actual surface of the body by means of a heavy lead pencil. Some male student in class should be willing to strip to the waist to demonstrate this. If in doubt as to the liver area beneath the abdominal wall, it can be traced by tapping the area as a physician taps the chest in making a physical examination. The liver has a dull flat sound.

Lift the model from its pedestal and permit the students to observe it from different angles. Let them try to describe its actual shape and make a rough drawing of it. Be sure that each student is able to hold the liver model so that it is in the same relative position as his own.

The liver is shaped somewhat by its surroundings, in that the structures immediately adjacent to it press against the liver and form indentations or impressions. Consider the **colic impression** (27) mad by the colon, the **esophageal impression** (28), the **renal impression** (26), the **duodenal** (250 and **pyloric** (24) **impressions.** In addition the entire upper dome shaped surface is "molded" by the diaphragm.

The liver weighs about one-fortieth (1/40) of the total weight of the body in the adult. This averages from three and a half to four pounds. In fetal life and in childhood the proportion is greater. This heavy gland is supported or suspended in the upper part of the abdominal cavity. This fact is somewhat surprising because of the comparatively heavy weight, and none of the viscera beneath it seem able to give solid support. It would follow that the liver should rest on the floor of the abdominal cavity instead of being supported in the upper part.

However, several structures contribute to the engineering job of supporting the liver: by means of the **coronary ligament*** (20 and 21) and the **triangular ligament*** (not shown) the liver is attached to the diaphragm, a strong muscular organ just above it.

The **inferior vena cava** (7) and its network of veins within the liver help to support the posterior portion.

A good share of support is given by the abdominal viscera for they completely fill the cavity and are prevented from "sagging" by the proper muscle tone in the abdominal wall. In other words, posture has something to do with the support of the liver,- as well as the proper placement of all the viscera.

The liver fits so perfectly against the diaphragm that atmospheric pressure would tend to hold it in place. The diaphragm itself is supported in part by the negative pressure in the lungs.

The **falciform ligament*** (19) is slightly lax and could hardly carry much weight. Yet it no doubt prevents displacement of the liver sideways.

The **round ligament** (18) although it does not play a direct role in supporting, also prevents lateral displacement. This is an interesting ligament, as it is the remnant of what was formerly the umbilical vein, a very important part of the human circulatory system before birth.

Another ligament, closely akin to the round ligament in that it is a remnant of the fetal circulation, is the **ligament of ductus venosus** (22). It helps to maintain the liver in its proper position.

So far we have not considered the function of the liver. What it does ... and how ... is real reason for even having a liver. Let us first consider its duties: there are four. Some people argue about a fifth, but that can wait until it is settled.

1. PRODUCTION OF BILE: The working unit of the liver is the lobule which is about the size of a millet seed or, in other words, from one to two and a half millimeters in diameter (Gray's Anatomy). Within it are found small bile passages, or bile capillaries. These pick up the bile as it is produced by the cells. The capillaries open into interlobular bile ducts, which in turn join other ducts of similar size until by a constant uniting of tributary vessels, fairly large vessels are formed (15). These larger bile ducts continue to join until two large trunks unite to form the **hepatic duct** (14). Leading from the hepatic duct is the **cystic duct** (16), running to a bile reservoir or **gallbladder** (17). Here bile can be stored between meals and called for immediately when eating begins.

Where the cystic duct leaves the hepatic duct, or if you choose, where the cystic duct joins the hepatic duct, we have the common bile duct from there on to a point where a duct from the pancreas joins in to form a small tube or ampulla-shaped opening into the duodenum. The bile plays an important role in digestion.

We often hear of an ailment called gallstones. These are "stones" formed by the solidification of bile salts in the gallbladder (17). When these stones pass through the cystic and common bile ducts, they give considerable pain - if they are a little too large for the ducts. This is especially true in the cystic duct the lumen of which follows a slightly spiral course.

These ligaments are peritoneal folds, and only their areas of attachment are shown on the model.

If the stones get "stuck" in the common duct, the victim gets a yellow color, jaundice, because the bile must go somewhere, and since the duct is plugged, it spreads into the blood and tissue. If the cystic duct is plugged by a gallstone, another chain of symptoms are set up. It is better to leave this diagnosis to a physician.

Many times the stones get too large in the gallbladder to even start passing through the cystic duct. When this condition causes objectionable symptoms, a surgeon can cut out the gallbladder. People get along fairly well in this condition. Digestion is impaired a little, but with care the victim can enjoy food almost as well as before.

2. STORAGE OF GLYCOGEN: Notice that there is a set of vessels in the liver which are not found every place in the body. In the cut away section of the model, they are colored lavender. These are the **portal vein** (10), and its ramifications (11) within the liver. These veins branch many times until small capillaries reach the working unit of the liver, the lobule. The portal vein originates mostly in the small intestine where as capillaries, it picks up the products of digestion. (The portal system begins and ends in capillaries: a distinctive feature.) From there, the veins run through the mesentery, joining together to form the hepatic portal vein which in turn does not go far before it enters the liver and starts dividing as described earlier.

Digested carbohydrates in the form of a sugar called dextrose or levulose are picked up by the hepatic portal system, along with all other digested foods. In the liver, this dextrose or levulose is changed into glycogen and stored there for future use. When the stored sugar is needed by the body, the liver releases it by changing glycogen to dextrose and setting it free into the blood stream.

Sugar	-	Water	=	Glycogen
$C_6H_{12}O_6$	-	H_2O	=	$C_6H_{10}O_5$
Glycogen	-	Water	=	Sugar
$C_6H_{10}O5$	-	H_2O	=	$C_6H_{12}O_6$

It can be seen that the liver accomplishes this change over from dextrose to glycogen and back again by simply taking away or adding a molecule of water.

3. FORMATION OF UREA: In addition to the portal system of blood vessels, the liver has arteries (12) and veins (23) just as any other structure in the body. A large percentage of blood in the body is in the liver at all times. By means of the regular arteries, the waste products of muscle metabolism are brought into the liver, and there changed to urea, which is then returned to the blood stream by way of the veins. In the form of urea, the kidneys can separate these waste products from the blood and excrete them in urine.

4. ELIMINATION OF BROKEN DOWN RED BLOOD CELLS: When the red blood cells have outlived their usefulness, they disintegrate and become broken down. The liver picks the remnants out of the blood stream and eliminates them through the bile.

This is one of the reasons why the liver contains blood forming material. People who lack the required number of red blood cells, either because of disease or hemorrhage, have liver prescribed in their diet. When quick and positive action is needed, liver extract is sometimes injected intramuscularly. This red blood cell deficiency disease is called anemia.

While discussing the work of the liver, we have at the same time considered some of its gross structures. In the way of review then:

The working unit of the liver is the lobule which is supplied by capillaries of the arteries (12 and 13) and hepatic portal vein (10 and 11).

The end products, bile and metabolic wastes of the lobules, are carried away by the capillaries of the veins (23, 8 and 9), the bile ducts (14 and 15), and the lymph vessels (not shown).

So far nothing has been said about the lymph vessels, but they are found throughout the fibrous supporting tissue of the liver carrying on with their normal function, which is the carrying away of the serous portion of the blood that escapes from the capillaries into the intercellular spaces.

Other structures are labeled for more detailed study.

DEMONSTRATIONS

1. If facilities are available, allow the class to study the lobules of the liver through a microscope.
2. Have individual students explain one or more functions of the liver, using the model to point out the structures involved.

Use the model for spot tests and individual study.

KEY

No.	English	No.	Latin
1.	Right lobe	1.	Lobus hepaticus dexter
2.	Left lobe	2.	Lobus hepatis sinister
3.	Quadrate lobe	3.	Lobus quadratus
4.	Caudate or spigelian lobe	4.	Lobus caudatus (Spigeli)
5.	Papillary process	5.	Processus papillaris
6.	Caudate process	6.	Processus caudatus
7.	Inferior vena cava	7.	Vena cava inferior
8.	Hepatic veins	8.	Vv. Hepaticae
9.	Ramification of hepatic veins in liver	9.	Rami Vv. Hepaticae
10.	Portal vein	10.	V. portae
11.	Ramification of portal vein	11.	Rami v. portae
12.	Hepatic artery	12.	A. hepatica
13.	Ramification of hepatic artery	13.	Rami a. hepaticae
14.	Hepatic duct	14.	Ductus hepaticus
15.	Ramification of hepatic duct	15.	Rami ducti hepatici
16.	Cystic duct	16.	Ductus cysticus
17.	Gallbladder	17.	Vesica fellea
18.	Round ligament	18.	Lig. teres hepatis
19.	Falciform ligament	19.	Lig. falciforme
20.	Coronary ligament, superior leaf	20.	Lig. coronarium, lamina superior
21.	Coronary ligament, posterior leaf	21.	Lig. coronarium, lamina posterior
22.	Ligament of ductus venosus (Arantii)	22.	Lig. ducti venosi hepatis (Atantii)
23.	Hepatic veins, branching off from inferior vena cava	23.	Vv. Hepaticae
24.	Pyloric impression	24.	Impressio gastrica (pylori)
25.	Duodenal impression	25.	Impressio duodenalis
26.	Renal impression	26.	Impressio renalis
27.	Colic impression	27.	Impressio colica
28.	Esophageal impression	28.	Impressio oesophagea

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