

INTRODUCTION

When patients present with fulminant hepatic failure and subsequent multiple organ failure, the full ICU support may be required. Invasive monitoring of hemodynamics, vasopressor and inotropic support, mechanical ventilation and continuous renal replacement therapy are often necessary. The cooperation of many different specialties is required and the modern intensivist has the expertise to support the patient and coordinate care (**Jalan *et al.*, 2004**).

Patients with End Stage Liver Disease (ESLD) may present with progressive deterioration in hemodynamic, metabolic, endocrine, pulmonary, and nutritional status. Post transplant many of these complex derangements may initially continue, and certainly this is an additional challenging task for the critical care team (**Zoran and Paul, 2007**).

Nutrition is an integral part of health maintenance. The liver is the largest and most important metabolic organ, playing a pivotal role in integrating several biochemical pathways of carbohydrate, fat, protein, and vitamin metabolism. Malnutrition is a common complication of end-stage liver disease (ESLD). Progressive deterioration of nutritional status has been associated with poor outcome in cirrhotic patients. Liver transplantation (LT) revolutionized the management of liver disease (**Tran *et al.*, 2004**).

This work focuses on nutritional problems seen in patients with ESLD, with particular emphasis on nutritional assessment and support of patients before and after liver transplantation. Protein-energy malnutrition (PEM) is common in patients with ESLD and is highly prevalent in all forms of liver disease, regardless of etiology (**McCullough and Bugianesi, 2007**).

Nutritional therapy is essential in patients with ESLD and during all phases of LT. Adequate nutritional assessment before a transplant helps identify individual problems and may prevent complications. A multidisciplinary team involving the patient's primary care physician, hepatologist, registered dietitian, and nursepractitioner should be involved in management and education of patients under LT evaluation. In the acute posttransplant phase, early nutritional support can reduce complications. Long-term management should be aimed at preventive measures for the metabolic complications of LT. Provision of adequate nutritional support before and after LT will lead to improved outcomes (**Lochs and Plauth, 2006**).

AIM OF THE WORK

The aim of this work is to discuss the nutritional problems in patients with ESLD, nutritional assessment and support in liver transplanted patients and its impact on success rate and outcome in adult patients in the postoperative period.

ANATOMICAL CONSIDERATIONS OF THE LIVER

The liver is a reddish brown organ with four lobes of unequal size and shape. A human liver normally weighs 1.44–1.66 kg, and is a soft, pinkish-brown, triangular organ. It is both the largest internal organ (the skin being the largest organ overall) and the largest gland in the human body. It is located in the right upper quadrant of the abdominal cavity, resting just below the diaphragm. The liver lies to the right of the stomach and overlies the gallbladder. It is connected to two large blood vessels; hepatic artery and portal vein. The hepatic artery carries blood from the aorta, whereas the portal vein carries blood containing digested nutrients from the entire gastrointestinal tract and also from the spleen and pancreas. These blood vessels subdivide into capillaries, and then lead to the liver sinusoids which empty into the central vein of each lobule. Each lobule is made up of millions of hepatic cells which are the basic metabolic cells. Lobules are the functional units of the liver (**Cotran *et al.*, 2005**).

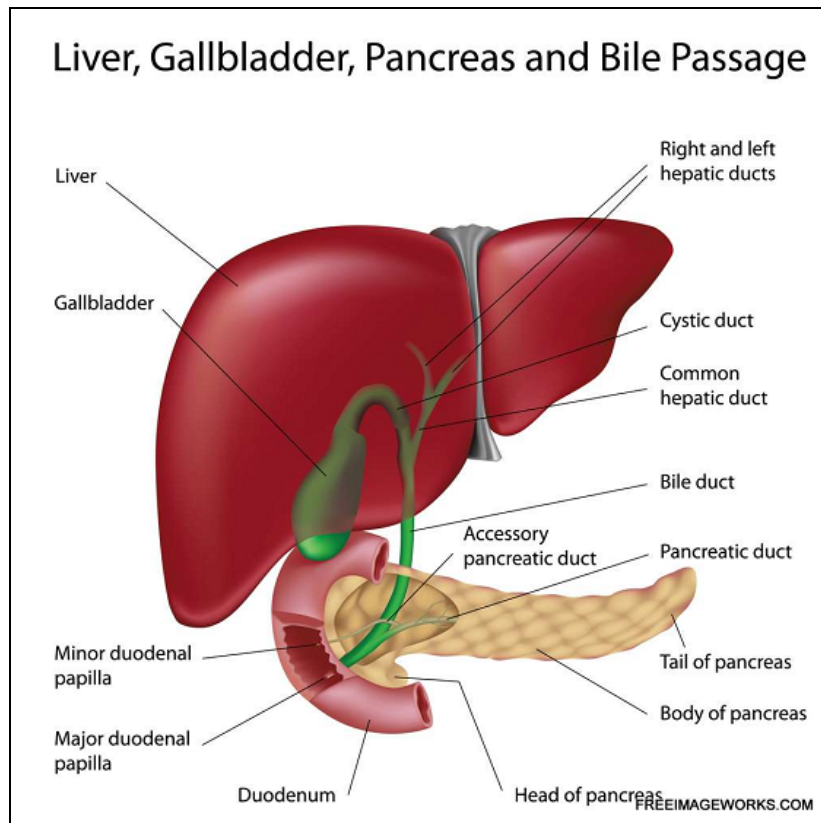


Fig. (1): Liver, Gallbladder, Pancreas and Bile Passage
(Cotran *et al.*, 2005).

Cell types

Two major types of cells populate the liver lobes: parenchymal and non-parenchymal cells (Figure 2). 80% of the liver volume is occupied by parenchymal cells commonly referred to as hepatocytes. Non-parenchymal cells constitute 40% of the total number of liver cells but only 6.5% of its volume. Sinusoidal endothelial cells, kupffer cells and hepatic stellate cells are some of the non-parenchymal cells that line the hepatic sinusoid (Kmieć, 2011).

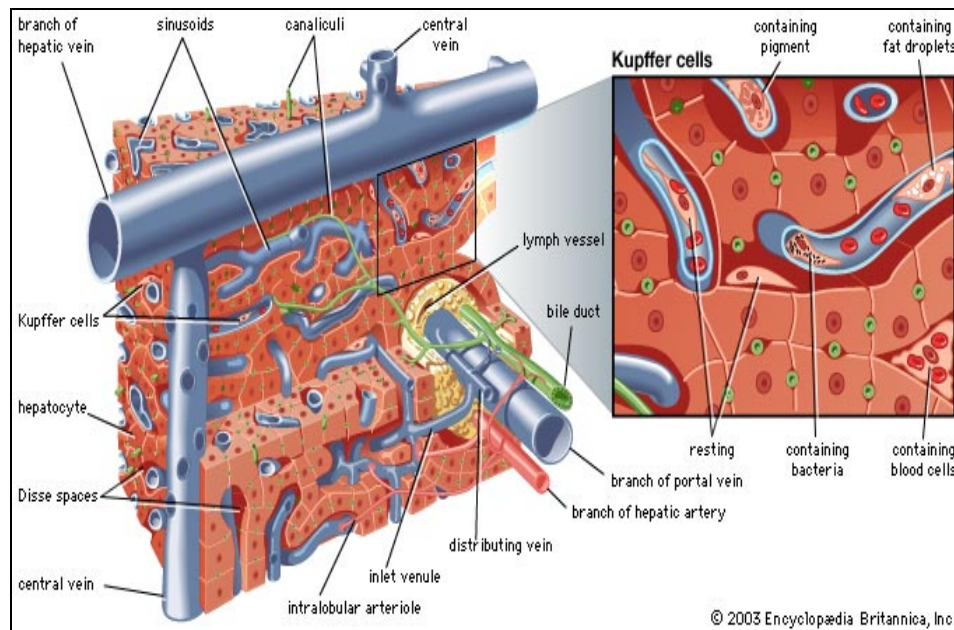


Fig. (2): Cell Types of the Liver (Kmieć, 2011).

Blood flow

The liver gets a dual blood supply from the portal vein and hepatic arteries (Figure 3). Supplying approximately 75% of the liver's blood supply, the hepatic portal vein carries venous blood drained from the spleen, gastrointestinal tract, and its associated organs. The hepatic arteries supply arterial blood to the liver, accounting for the remainder of its blood flow. Oxygen is provided from both sources; approximately half of the liver's oxygen demand is met by the hepatic portal vein, and half is met by the hepatic arteries. Blood flows through the liver sinusoids and empties into the central vein of each lobule. The central veins coalesce into hepatic veins, which leave the liver (Benjamin *et al.*, 2008).

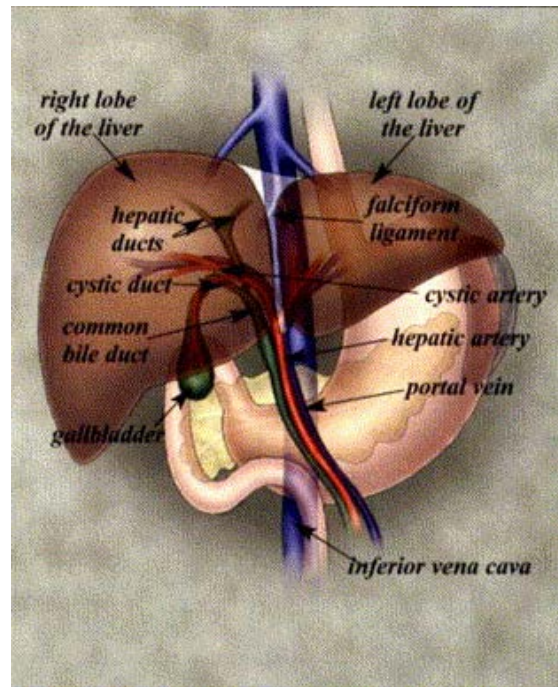


Fig. (3): Blood Flow of the Liver (**Benjamin et al., 2008**).

Biliary flow

The bile produced in the liver is collected in bile canaliculi, which merge to form bile ducts. Within the liver, these ducts are called *intrahepatic* bile ducts, and once they exit the liver they are considered *extrahepatic*. The intrahepatic ducts eventually drain into the right and left hepatic ducts, which merge to form the common hepatic duct. The cystic duct from the gallbladder joins with the common hepatic duct to form the common bile duct (Figure 4).

Bile can either drain directly into the duodenum via the common bile duct, or be temporarily stored in the gallbladder

via the cystic duct. The common bile duct and the pancreatic duct enter the second part of the duodenum together at the ampulla of Vater (**Benjamin *et al.*, 2008**).

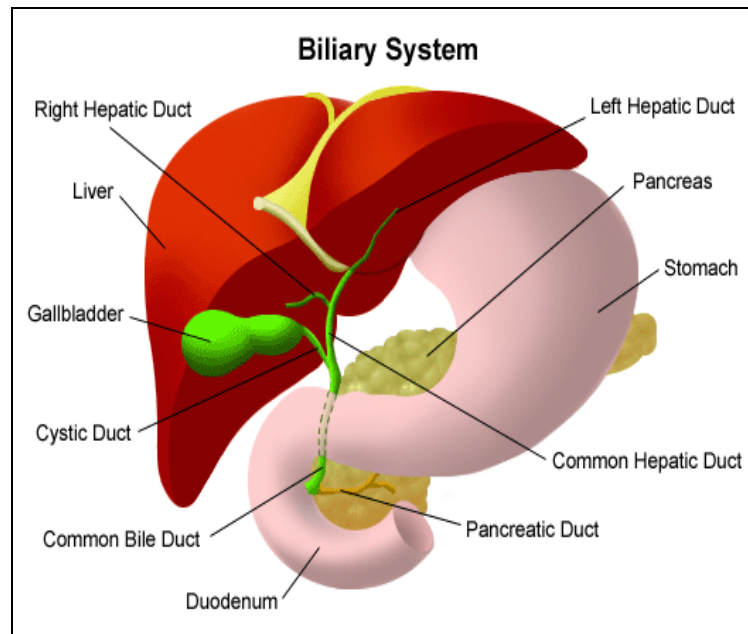


Fig. (4): Biliary System (Benjamin *et al.*, 2008).

Surface anatomy

Peritoneal ligaments

Apart from a patch where it connects to the diaphragm (the so-called "bare area"), the liver is covered entirely by visceral peritoneum, a thin, double-layered membrane that reduces friction against other organs. The peritoneum folds back on itself to form the falciform ligament and the right and left triangular ligaments. These "lits" are in no way related to the true anatomic ligaments in joints, and have essentially no

known functional importance, but they are easily recognizable surface landmarks. An exception to this is the falciform ligament, which attaches the liver to the posterior portion of the anterior body wall (**Cotran *et al.*, 2005**).

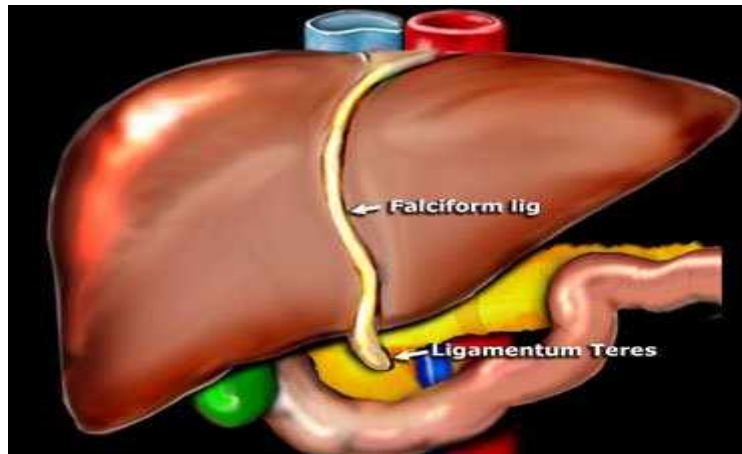


Fig. (5): Peritoneal Ligaments (**Cotran *et al.*, 2005**).

Lobes

Traditional gross anatomy divided the liver into four lobes based on surface features. The falciform ligament is visible on the front (anterior side) of the liver. This divides the liver into a left anatomical lobe, and a right anatomical lobe (Figure 6).

If the liver is flipped over, to look at it from behind (the visceral surface), there are two additional lobes between the right and left. These are the caudate lobe (the more superior) and the quadrate lobe (the more inferior).

From behind, the lobes are divided up by the ligamentum venosum and ligamentum teres (anything left of these is the left lobe), the transverse fissure (or *portahepatis*) divides the caudate from the quadrate lobe, and the right sagittal fossa, which the inferior vena cava runs over, separates these two lobes from the right lobe.

Each of the lobes is made up of lobules; a vein goes from the centre, which then joins to the hepatic vein to carry blood out from the liver.

On the surface of the lobules, there are ducts, veins and arteries that carry fluids to and from them (**Lori *et al.*, 1998**).

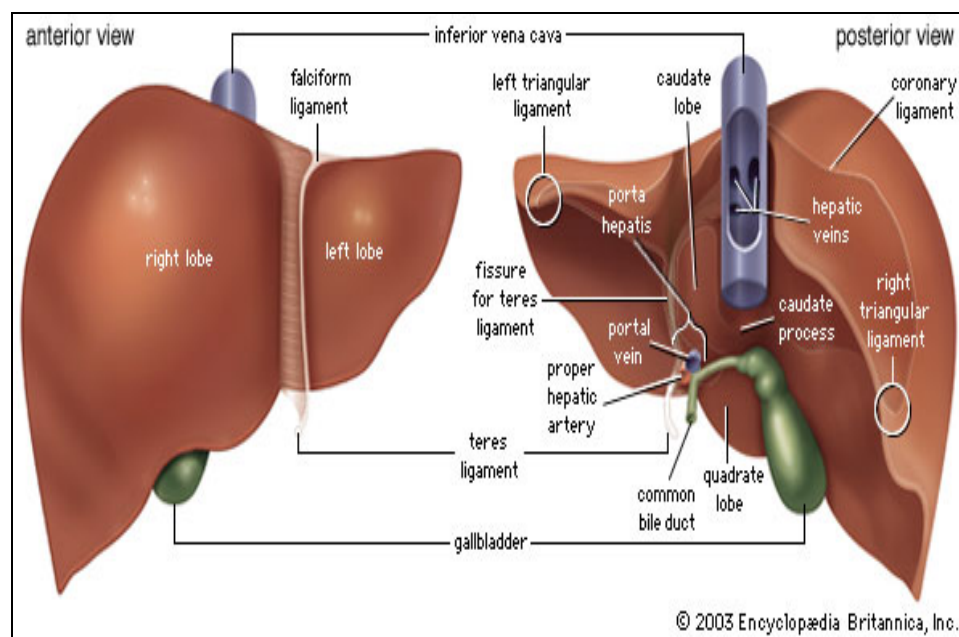


Fig. (6): Lobes of the Liver (anterior view and posterior view)
(**Lori *et al.*, 1998**).

Functional anatomy

Table (1) Correspondence between anatomic lobes and Couinaud segments (**Lori *et al.*, 1998**).

Segment*	Couinaud segments
Caudate	1
Lateral	2, 3
Medial	4a, 4b
Right	5, 6, 7, 8
* or lobe, in the case of the caudate lobe Each number in the list corresponds to one in the table. 1. Caudate 2. Superior subsegment of the lateral segment 3. Inferior subsegment of the lateral segment 4a. Superior subsegment of the medial segment 4b. Inferior subsegment of the medial segment 5. Inferior subsegment of the anterior segment 6. Inferior subsegment of the posterior segment 7. Superior subsegment of the posterior segment 8. Superior subsegment of the anterior segment	

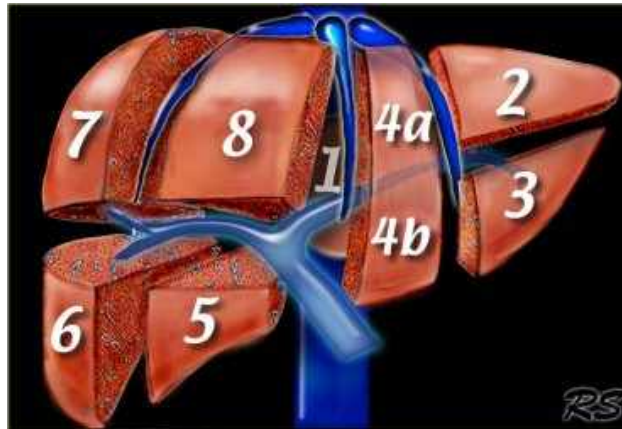


Fig. (7): Segmental anatomy according to Couinaud
(Lori *et al.*, 1998).

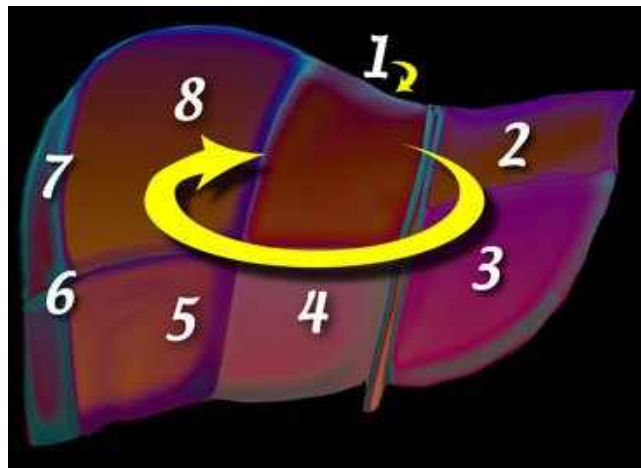


Fig. (8): Clockwise numbering of the segments
(Lori *et al.*, 1998).

The central area where the common bile duct, hepatic portal vein, and hepatic artery proper enter is the hilum or "portahepatis". The duct, vein, and artery divide into left and right branches, and the portions of the liver supplied by these branches constitute the functional left and right lobes.

The functional lobes are separated by an imaginary plane joining the gallbladder fossa to the inferior vena cava. The plane separates the liver into the true right and left lobes. The middle hepatic vein also demarcates the true right and left lobes. The right lobe is further divided into an anterior and posterior segment by the right hepatic vein. The left lobe is divided into the medial and lateral segments by the left hepatic vein. The fissure for the ligamentum teres also separates the medial and lateral segments. The medial segment is also called the quadrate lobe. In the widely used Couinaud (or "French") system, the functional lobes are further divided into a total of eight subsegments based on a transverse plane through the bifurcation of the main portal vein. The caudate lobe is a separate structure which receives blood flow from both the right- and left-sided vascular branches (**Romer *et al.*, 2009**).

PHYSIOLOGICAL CONSIDERATIONS OF THE LIVER

The liver is a vital organ present in vertebrates and some other animals. It has a wide range of functions, including detoxification, protein synthesis, and production of biochemical necessary for digestion. The liver is necessary for survival; there is currently no way to compensate for the absence of liver function long term, although liver dialysis can be used short term (**Maton *et al.*, 2003**).

This organ plays a major role in metabolism and has a number of functions in the body, including glycogen storage, decomposition of red blood cells, plasma protein synthesis, hormone production, and detoxification. It lies below the diaphragm in the abdominal-pelvic region of the abdomen. It produces bile, an alkaline compound which aids in digestion via the emulsification of lipids. The liver's highly specialized tissues regulate a wide variety of high-volume biochemical reactions, including the synthesis and breakdown of small and complex molecules, many of which are necessary for normal vital functions (**Maton *et al.*, 2003**).

The various functions of the liver are carried out by the liver cells or hepatocytes. Currently, there is no artificial organ or device capable of emulating all the functions of the liver.

Some functions can be emulated by liver dialysis, an experimental treatment for liver failure. The liver is thought to be responsible for up to 500 separate functions, usually in combination with other systems and organs (**Maton *et al.*, 2003**).

Functions of the liver

1- Synthesis:

- A large part of amino acid synthesis.
- The liver performs several roles in carbohydrate metabolism:
 - *Gluconeogenesis* (the synthesis of glucose from certain amino acids, lactate or glycerol).
 - *Glycogenolysis* (the breakdown of glycogen into glucose).
 - *Glycogenesis* (the formation of glycogen from glucose)(muscle tissues can also do this).
- The liver is responsible for the mainstay of protein metabolism, synthesis as well as degradation.
- The liver also performs several roles in lipid metabolism:
 - *Cholesterol synthesis*.
 - *Lipogenesis*, the production of triglycerides (fats).
 - A bulk of the lipoproteins is synthesized in the liver.