

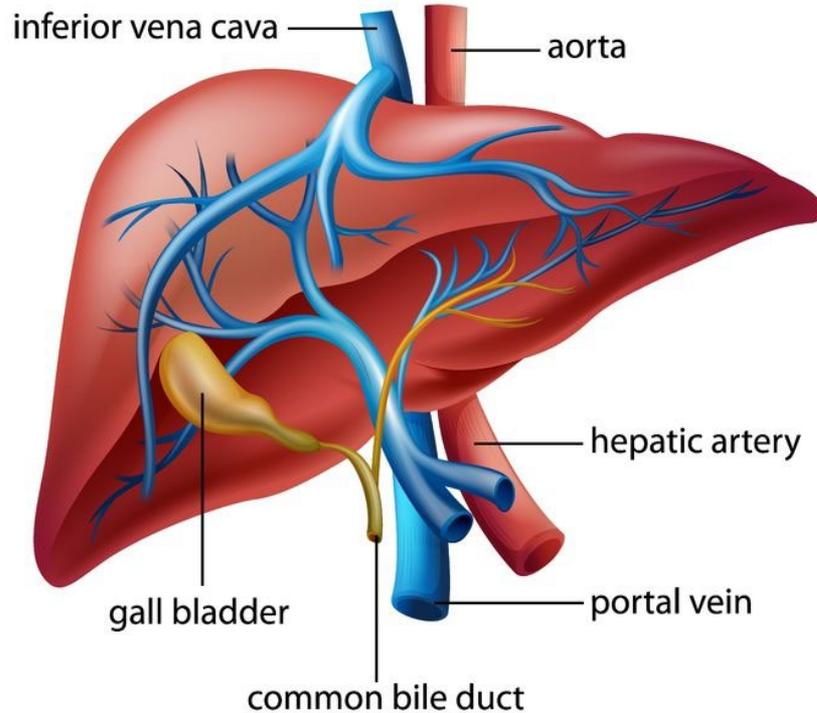
LIVER BASICS

Presented by Ivonne Grabow, PA-C

Objectives

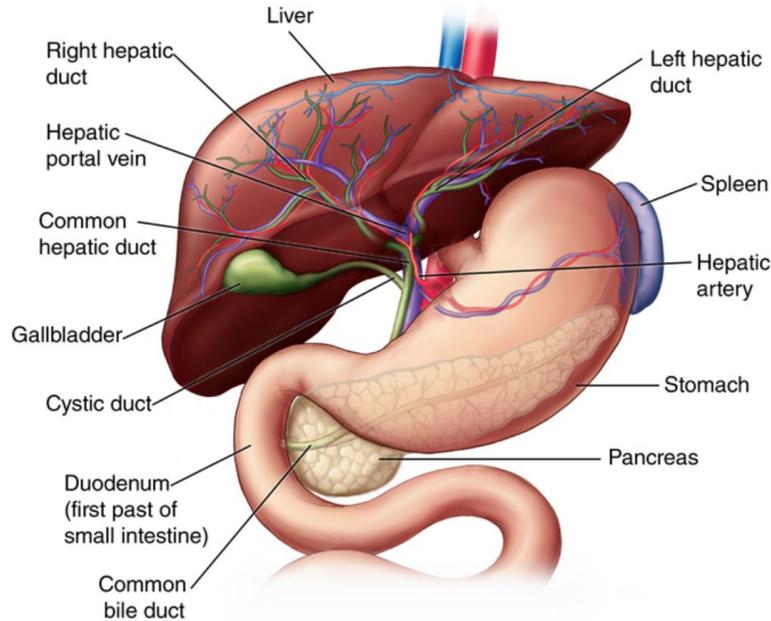
- To identify the basic functions of the liver
- To recognize what occurs when the liver malfunctions
- Basic understanding of the transplant process

Human Liver Anatomy



- Located in the RUQ
- 2nd largest organ
- Weighs around 3lbs
- Capable of Regenerating
- Functions- digestion, metabolism, immunity, storage of nutrients, protein factory

Anatomy of the liver



<https://www.hopkinsmedicine.org/health/conditions-and-diseases/liver-anatomy-and-functions>

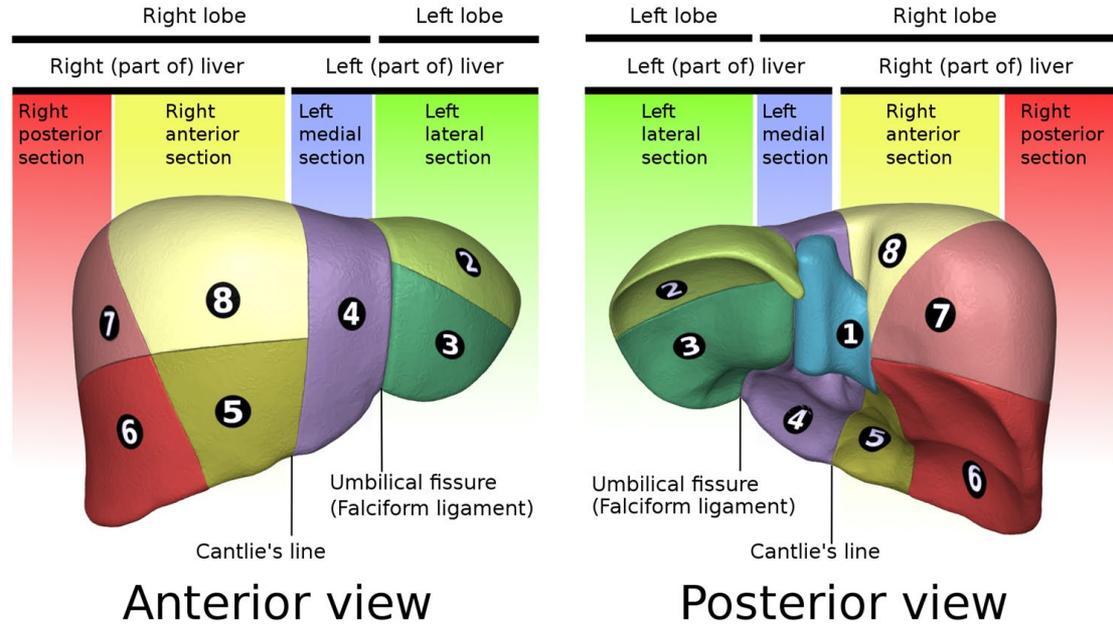
- **Blood Sources**

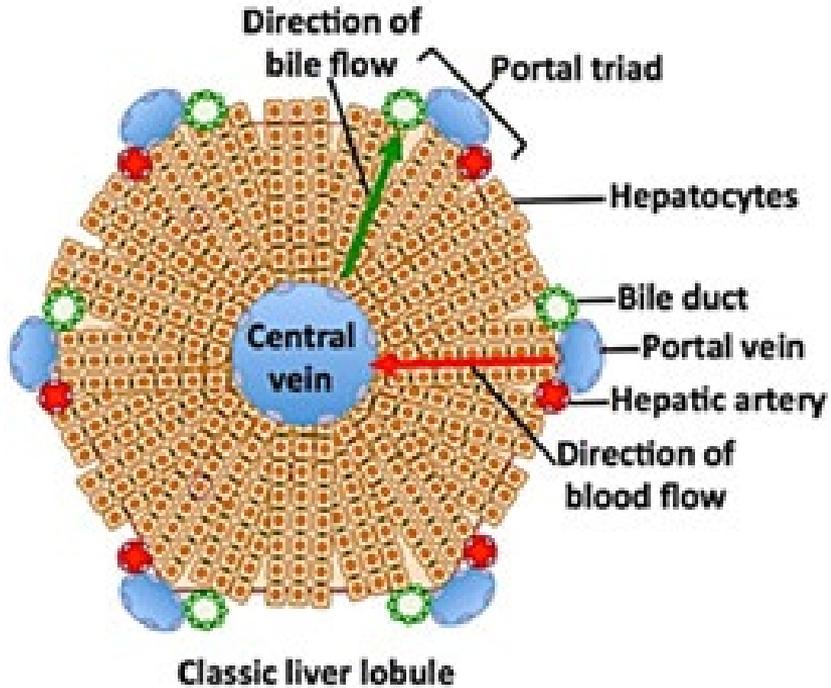
- Oxygenated blood from **Hepatic Artery**
- Nutrient rich blood from **Hepatic Portal Vein** (also contains oxygenated blood as well)

- **Bile Duct** – R/L Hepatic Duct > Common Hepatic Duct + Cystic Duct > Common Bile Duct > Duodenum

Anatomy

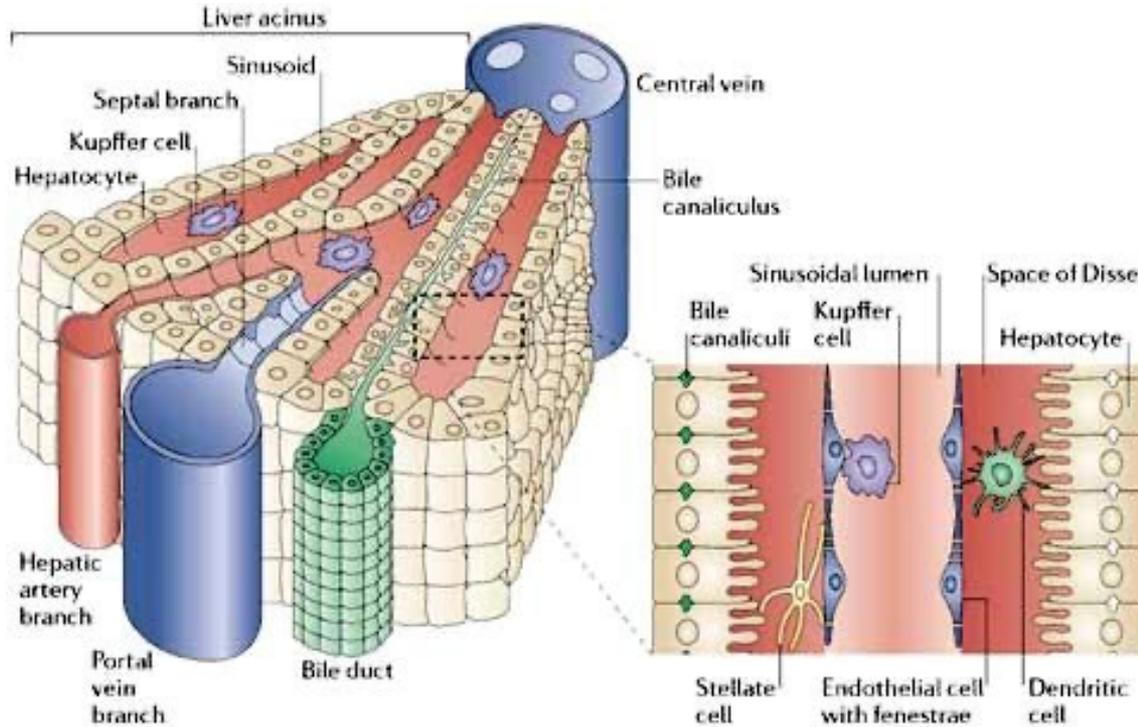
- 8 liver segments





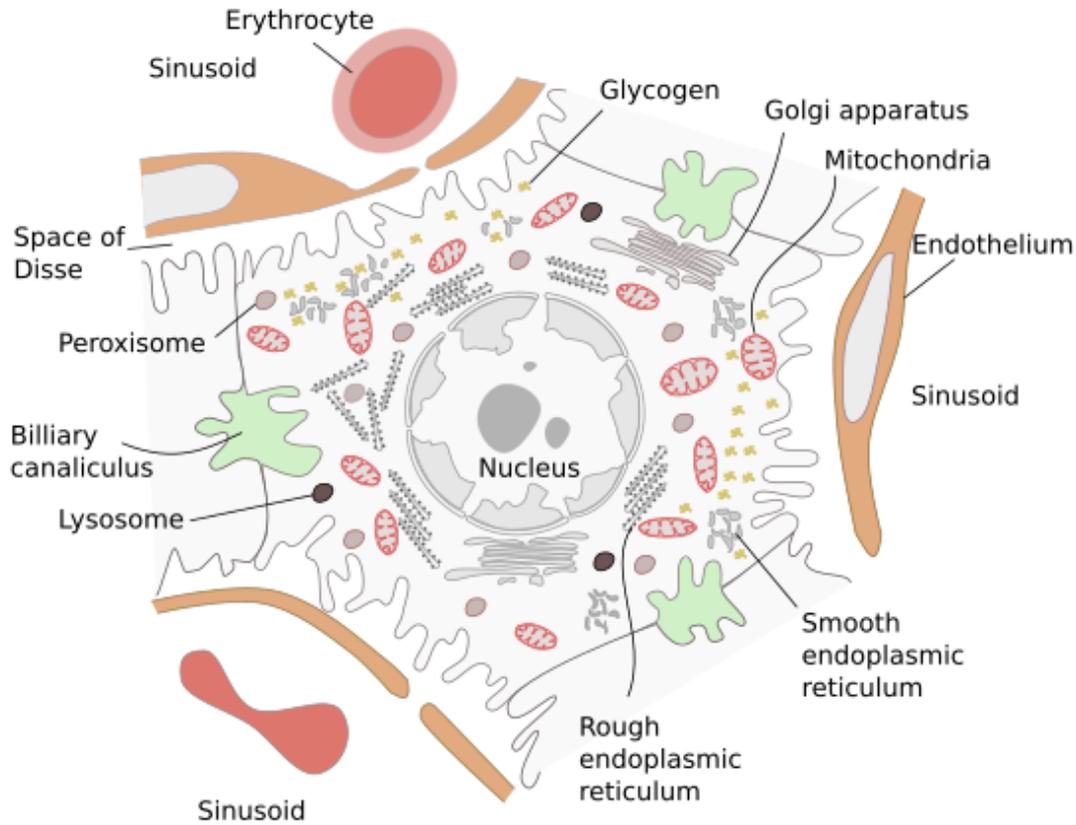
Liver Lobule

- Portal Triad
 - Hepatic Artery
 - Portal Vein
 - Bile Duct



Liver Lobule

- Blood enters from the Hepatic Artery and Portal Veins
- Kupffer cells
Phagocytic cells (filtering cells)
- Space of Disse
- Hepatocytes do most of the work, store nutrients, detox, produce proteins



HEPATOCYTE

Functions of the Liver

- What are the most well commonly known functions of the liver?
 - Detoxification
 - Makes Bile
- More than 500 functions have been identified.
 - We won't cover all of them here.

Functions of the Liver

- Production of bile
- Production of proteins
- Production of cholesterol
- Regulation of glucose
- Regulation of blood levels of amino acids
- Stores Iron and vitamins
- Conversions of ammonia to urea
- Regulates blood clotting factors

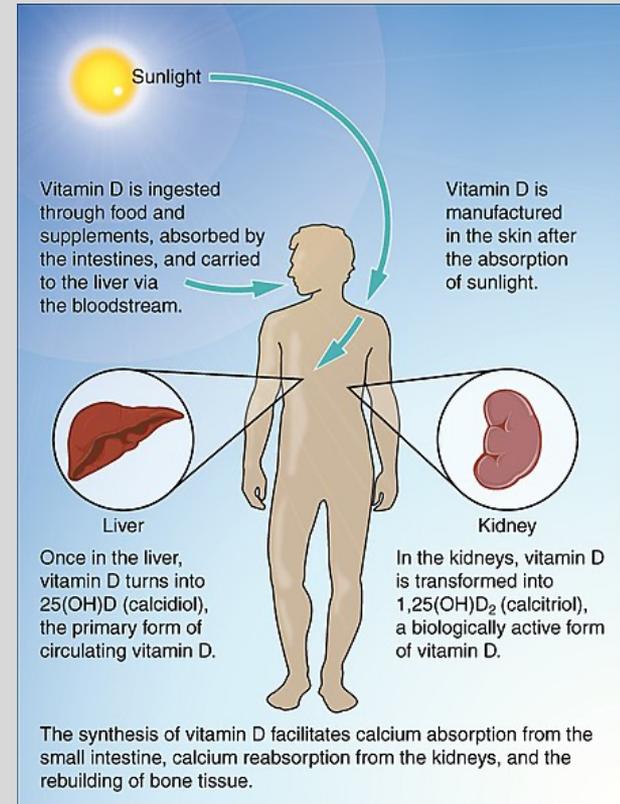
Digestion

Function

- Hepatocytes (Liver Cells) make bile which is stored in the gallbladder.
- When you eat the gallbladder releases bile into the small intestine.
- Helps convert Vitamin D to an active form which helps in calcium absorption

When Things go Wrong

- Vitamin D deficiency- osteopenia, fatigue



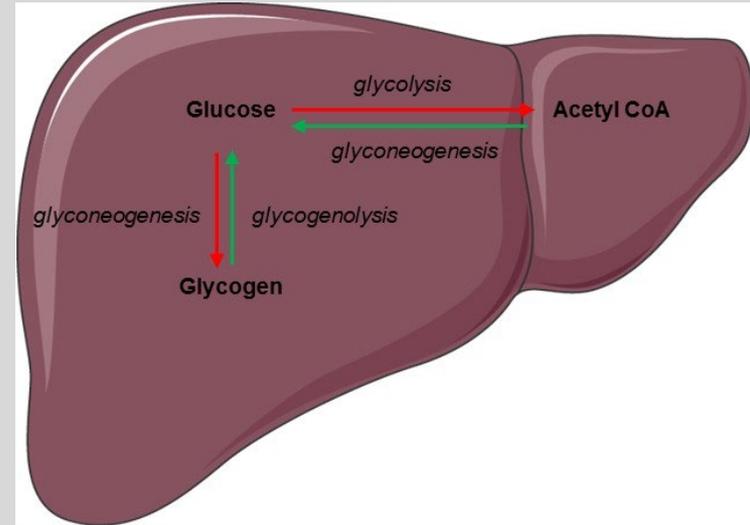
Metabolic Functions

Function

- Carbohydrate, Fat, Protein Metabolism
- Blood Glucose maintenance
- Breakdown protein to amino acids and vice versa
- Synthesis of cholesterol and regulation of cholesterol levels

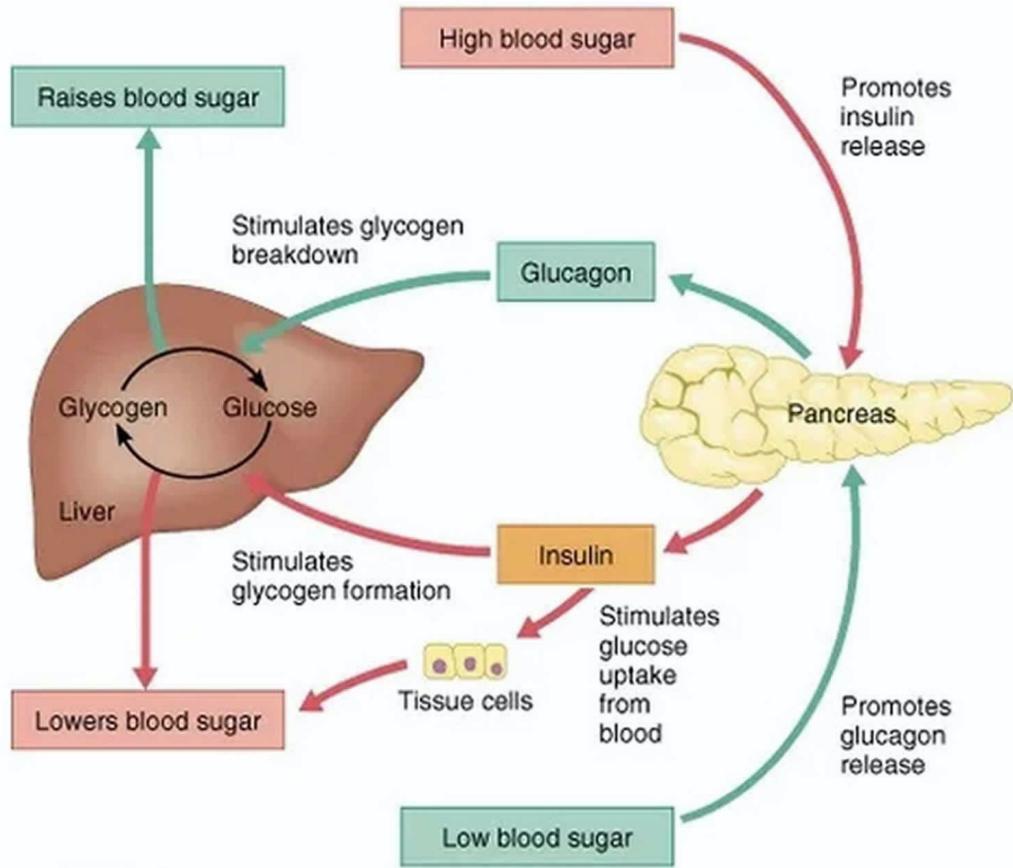
When Things go Wrong

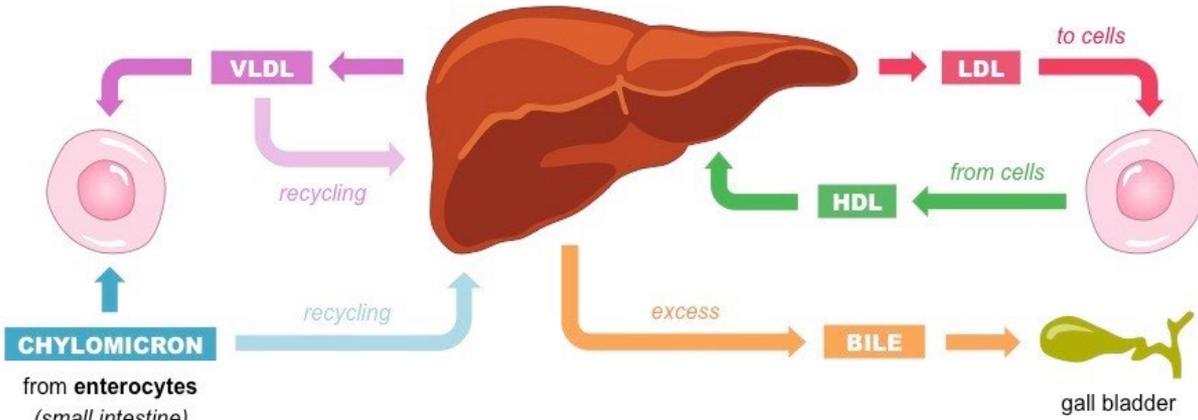
- Low blood sugars especially with liver failure
 - Hence need a drip to keep glucose levels up



<https://www.ncbi.nlm.nih.gov/books/NBK279127/figure/glucagon-physiology.F5/>

BLOOD GLUCOSE REGULATION





TRIGLYCERIDE PATHWAY
 Triglycerides are transported to cells by **VLDL** (from liver) or **chylomicrons** (from intestine) for *energy use or storage* (i.e. adipose tissue)

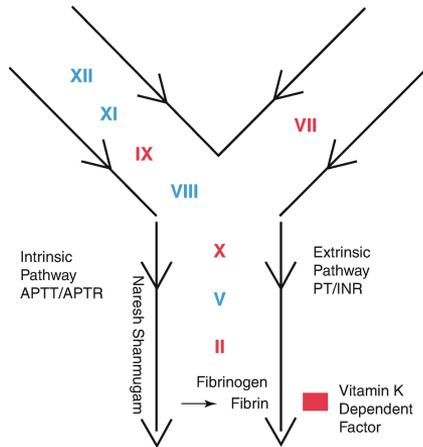
CHOLESTEROL PATHWAY
 Cholesterol is transported to cells by **LDL** for use in *plasma membranes and steroid synthesis*, while excess cholesterol is moved from cells by **HDL** to be converted by liver into bile

Cholesterol Pathway

<https://ib.bioninja.com.au/options/option-d-human-physiology/d3-functions-of-the-liver/nutrient-supply.html>

Table 1
The liver's role in coagulation: coagulation factors synthesized by the liver

Procoagulants	Anticoagulants	Profibrinolysis	Antifibrinolysis
<ul style="list-style-type: none"> • Fibrinogen • Prothrombin • Factor V • Factor VII • Factor VIII • Factor IX • Factor X • Factor XI • Factor XII • Factor XIII • Thrombopoietin 	<ul style="list-style-type: none"> • Protein C • Protein S • Tissue factor pathway inhibitor • Antithrombin 	<ul style="list-style-type: none"> • Factor XIIa • Plasminogen 	<ul style="list-style-type: none"> • Plasminogen activator inhibitor-1 • Alpha-antiplasmin • Tissue activatable fibrinolysis inhibitor



Blood Clotting

- Liver responsible for producing most coagulation factors
- Requires Vit K for synthesis
 - Vit K is a fat soluble vitamin
 - How do you get it? Bile salt essential for intestinal absorption of this
 - And where is bile made? Liver

When things go wrong:

- Pt bleeds!

Proteins

Function

- Liver produces most of the proteins found in blood
- Especially Albumin!
 - Regulates blood volume & distribution of fluids
- Ferritin
 - A protein used to store iron

When Things go Wrong

- Low Albumin levels contribute to LE edema and ascites

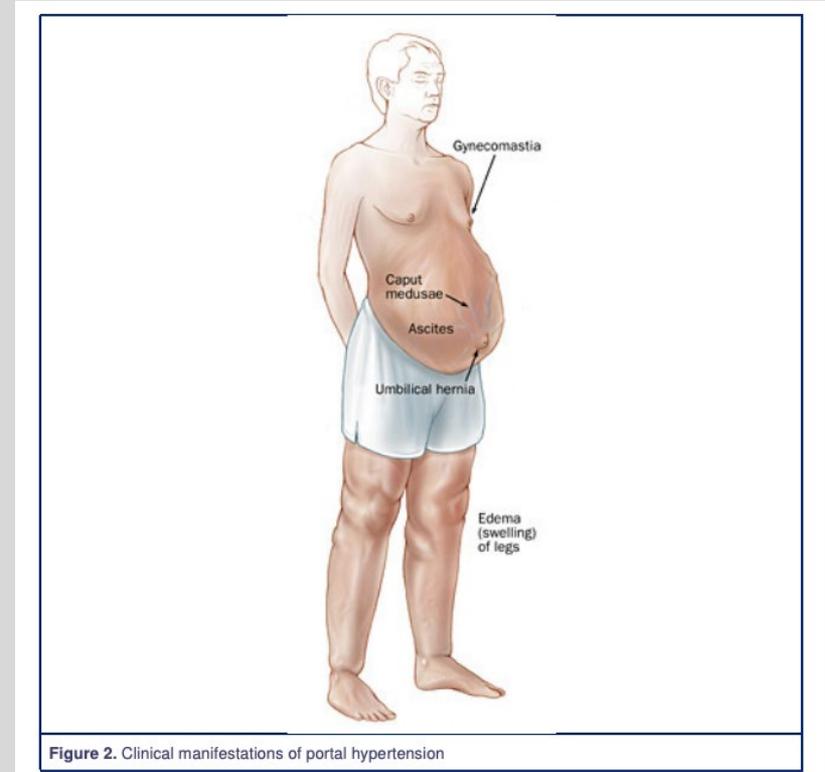


Figure 2. Clinical manifestations of portal hypertension

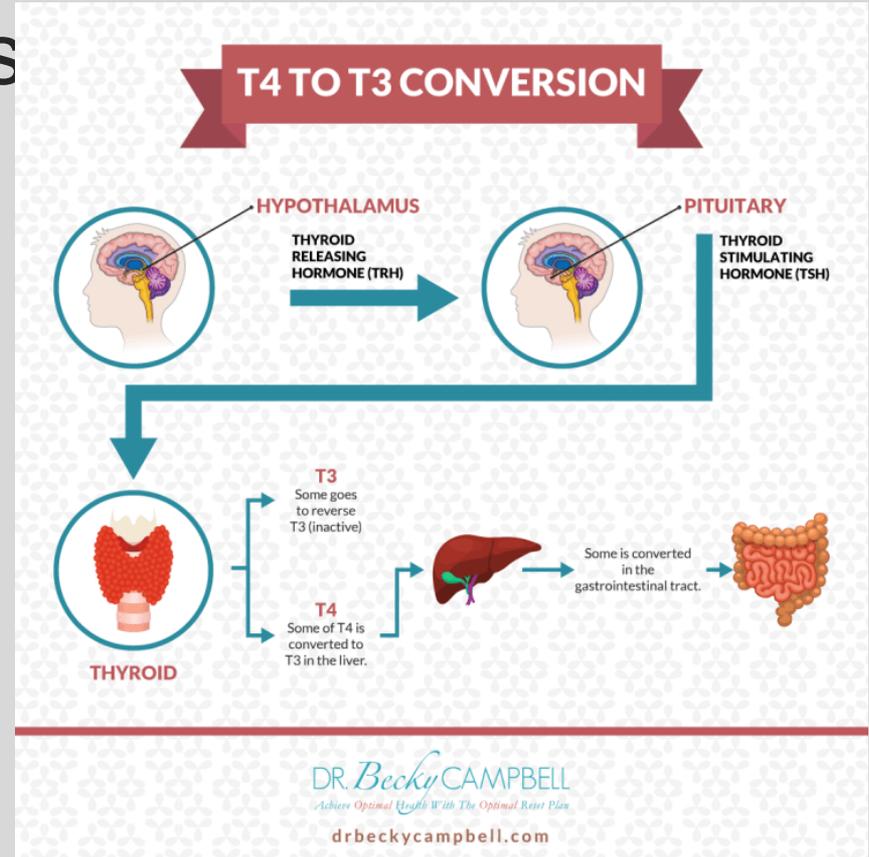
Hormonal Functions

Function

- 60% of Thyroid Hormone T4 is converted to T3 the active form in the liver.
- Secretes IGF-1 (Insulin Growth Factor 1) with promotes cell growth
- Produces Angiotensinogen – regulates sodium and potassium levels, BP control

When Things go Wrong

- Hyponatremia
- Fatigue

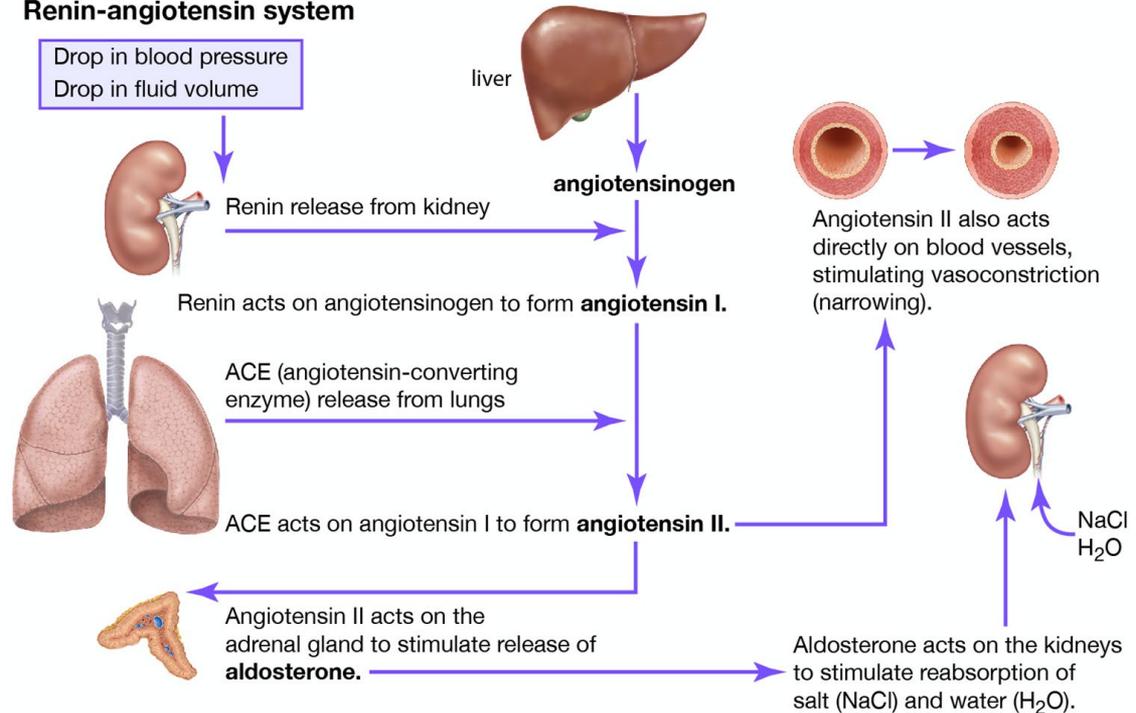


Hormonal Functions

Liver makes
Angiotensinogen

Contributes to
controlling BP via the
Renin-Angiotensin
system

Renin-angiotensin system



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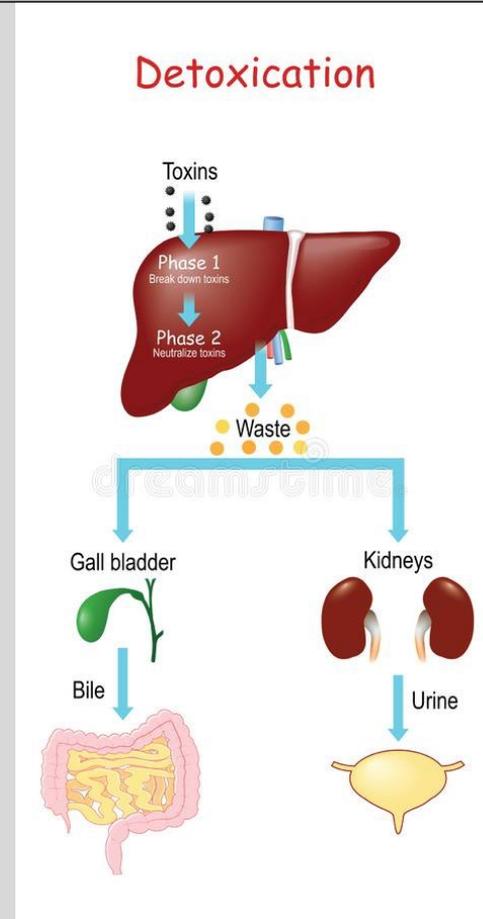
Detoxification

Function

- Degrade old red blood cells into breakdown products
- Breaks down toxic poisons, drugs, alcohol

When Things go Wrong

- Bilirubin builds up- They turn Yellow!
- Build up of toxins – Encephalopathy



Fun Facts



Can lose $\frac{3}{4}$ of the liver then regenerate in a few weeks



Does NOT have pain receptor cells.

When to Transplant?

- Basic Answer: Risk vs benefits analysis
- More in depth answer: When the patient is decompensated enough that short term prognosis is poor in which the risks and cost of surgery are worth considering



Compensated vs Decompensated Cirrhosis

- Decompensated - liver function deteriorates in which the patient develops symptoms
 - Ascites
 - Hepatic Encephalopathy
 - LE Edema
 - Esophageal Varices
 - Jaundice
- Triggers to Decompensation
 - Infection
 - Cancer
 - Hepatotoxic medications
 - ETOH

MELD SCORE

- Originally designed to weigh in the risks of a TIPS procedure
- Takes into account:
 - Na, Cr, INR, Bili
- INR is the largest factor

- MELD score has been modified over the years. 3.0 version coming out this summer

Model for End-Stage Liver Disease (MELD) Score

$$\text{MELD} = 3.78 \times \log_e \text{ serum bilirubin (mg/dL)} + \\ 11.20 \times \log_e \text{ INR} + \\ 9.57 \times \log_e \text{ serum creatinine (mg/dL)} + \\ 6.43 \text{ (constant for liver disease etiology)}$$

MELD Score	Mortality
40 or more	71.3%
30-39	52.6%
20-29	19.6 %
10-19	6.0 %
<9	1.9 %

Transplant Process

Decompensation

- Pt develops signs of decompensation with poor long term recovery
- Typically MELD 15+
- Any absolute contraindications?
- Hepatologist will submit a GOLD FORM to initiate transplant evaluation (outpatient or inpatient)

Insurance

- Staff will send paperwork to insurance.
- Check if in network.
- Wait for approval to start outpatient or inpatient evaluation

Evaluation

- Labs/imaging
- Cardiac Clearance
- Surgical Clearance
- +/- other specialties
- Nutrition/Physical
- Social Work
- Finances
- Psychological Clearance
- Pharmacy
- Outpatient (2-3 days schedule)
- Inpatient (as fast as possible)

Listing

- Case will be presented in committee comprised of hepatologists, surgeons, social work, nutritionist, ID, cardiology, +/- other specialties
- Approve, Deny, More studies/requirements needed
- Awaiting final insurance approval

Offer

- Listed by MELD score, NOT wait time
- Blood type
- Liver size

Questions??



Sources

- [UptoDate](#)
- <https://www.hopkinsmedicine.org/health/conditions-and-diseases/liver-anatomy-and-functions>



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