

## Chapter 20 Integration of Metabolism

# **I. Metabolic Pathways**

## ***A. Glycolysis***

- 1. Glucose to pyruvate**
- 2. Anaerobic metabolism**
- 3. Cytosol of brain and skeletal muscle**

## ***B. Gluconeogenesis***

- 1. Most is in liver**
- 2. Precursors are pyruvate, lactate, glycerol, Asp, Asn, Ala, etc.**
- 3. Controlled differently from glycolysis**

## ***C. Pentose Phosphate Pathway (phosphogluconate)***

- 1. Make ribose-5-phosphate and NADPH**
- 2. Cytosol of fat and liver mostly**
- 3. Needed for FA synthesis**

## ***D. Beta oxidation***

- 1. Makes dietary fats and TAGs into acetylCoA**
- 2. Produces lots of ATP**
- 3. Mitochondria of skeletal muscle, heart, and fat tissue**

## ***E. FA synthesis***

- 1. Cytosol of liver and fat tissue**
- 2. Makes acetyl CoA into FA**

## ***F. Amino acid metabolism***

- 1. transamination**

## 2. Amidation

### **G. CAC**

1. Make Acetyl CoA into  $\text{CO}_2$  and  $\text{H}_2\text{O}$
2. Place electrons into NADH and  $\text{FADH}_2$
3. Building Blocks for other paths

## **II. Interconnecting Pathways**

### **A. Glucose-6-phosphate**

1. Glycolysis to pyr
2. Glycogen – to G-1-P
3. Pentose Phosphate Pathway – NADPH

### **B. Pyruvate**

1. PDH to Acetyl CoA
2. to lactate in muscle
3. to Alanine via transamination
4. to Gluconeogenesis via Oxaloacetate

### **C. Acetyl CoA**

1. to carbon dioxide and water via CAC
2. FA Synthesis
3. Steroid Synthesis

### **D. Oxaloacetate**

1. to Asp via aminotransferase
2. to malate
3. to citrate

4. to PEP

### **III. Organs**

#### ***A. Brain***

1. Primary fuel is glucose – 100 g per day
2. Under starvation condition the brain can switch to ketone bodies – acetoacetate, acetone, Beta hydroxybutyrate

#### ***B. Skeletal Muscle***

1. Fuels are glucose, fatty acids, and amino acids to lesser extent
2. Quick energy source is phosphocreatine

#### ***C. Heart Muscle***

1. Primarily fatty acids
2. Other energy – glucose, lactate, pyruvate, ketone bodies
3. Blood supply of these nutrients is crucial – no glycogen in heart

#### ***D. Liver***

1. Many roles
2. Syn FA, glucose, amino acids, ketone bodies
3. Stores glycogen for release to other tissues
4. Controls blood glucose levels
5. Contains glucokinase (has lower affinity for glucose than hexokinase).
6. Also has glucose-6-phosphatase – therefore can remove phosphate from glucose-6-phosphate to produce free glucose for delivery to tissues.

### ***E. Adipose Tissue***

1. Long term energy storage via TAGs
2. Can both make and degrade TAGs

## **IV. Communication between Organs**

### ***A. Cori Cycle***

1. in anaerobic muscle metabolism
2. glucose to lactate to blood to liver to glucose via gluconeogenesis

### ***B. Glucose-Alanine Cycle***

1. Also is muscle metabolism
2. Uses Ala aminotransferase
3. Another way to transfer nitrogen to liver than by glutamine or glutamate

## **V. Alternative Energy Sources – Ketone bodies**

### ***A. Starvation, Fasting, Low Carb Diet***

### ***B. FA's are the fuel for heart, muscle, liver***

### ***C. Brain can't use FAs***

### ***D. Excess acetyl CoA from FA breakdown used to make ketone bodies – show overhead.***

### ***E. The ketone bodies can be converted to acetyl CoA by enzymes found in brain***

### ***F. Under starvation conditions oxaloacetate is limited by excess of acetyl CoA***

## **VI. Hormones and their Actions**

***See summary on pages 566-568***

**VII. Conditions of Stress and Affects on Metabolism –  
see pages 568-571.**

***A. Starvation/Fasting***

***B. Diets***

***C. Diabetes***

***D. Exercise***