

Glycogen Metabolism & Gluconeogenesis

Thursday, October 23, 2014
10:25 PM

Outline:

- Glycogen
 - structure
 - synthesis
 - degradation
 - regulation
- Gluconeogenesis
 - rxns
 - precursors
 - regulation
 - diseases

Learning Objectives:

- reactants, products, distribution of glycogenesis & glycogenolysis
- regulation of glycogenesis & glycogenolysis by insulin, glucagon, & catecholamines in liver & muscle
- contribution of glycogenesis & glycogenolysis to blood [glucose] homeostasis during fed, fasting, & exercise
- reactants, products, distribution of gluconeogenesis
- gluconeogenesis vs. glycolysis
- contribution of gluconeogenesis to blood [glucose] homeostasis
- regulation of gluconeogenesis by insulin, glucagon, & catecholamines

GLYCOGEN

GLYCOGEN - multibranched polysaccharide of glucose; resembles Amylopectin (branched starch)
(Muscle > Liver)

GLYCOGENIN - starts a glycogen particle

Glycogenesis

BRANCHING ENZYME - branches glycogen

*branching makes it easier to add/subtract glucose

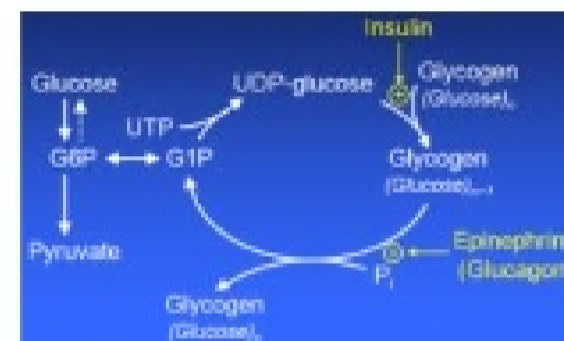
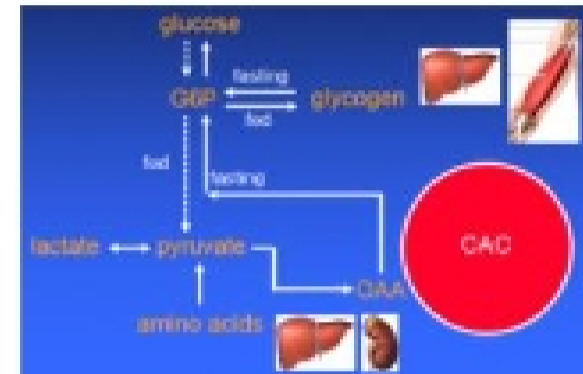
*necessary to avoid cell damage

GLYCOGEN SYNTHASE - rate limiting enzyme in glycogenesis

Glycogenolysis

DEBRANCHING ENZYME - debranches glycogen

GLYCOGEN PHOSPHATASE - rate limiting enzyme in glycogenolysis



INSULIN - builds Glycogen

EPINEPHRINE - degrades Glycogen

Normal:

FED - Glucose is stored in Glycogen (↓ Glucose, ↑ Glycogen)

FASTING - Glycogen is broken down to stabilize blood [glucose] (↓ Glycogen, ↑ Glucose)

With Glycogen Metabolism Defects:

FED - hyperglycemia (cannot put away glucose)

EARLY FASTING - hypoglycemia (stored glucose is unavailable)

G = Glucagon
E = Epinephrine
I = Insulin

Glycolysis	Glucose → 2 Pyruvate + 2 NADH + 2 ATP
Gluconeogenesis	Glucose ← 2 Pyruvate + 2 NADH + 4 ATP + 2 GTP

*Liver auto-regulates Glycogenolysis & Gluconeogenesis
(↓ Glycogen) (↑ Glucose)
(24 hrs) (2-3 days)

		Location	Stimulators	Inhibitors
New Glycogen	GlycoGenesis	LIVER, MUSCLE (exercise)	I	G, E
New Glucose	GlucoNeoGenesis (2-3 days)	LIVER, KIDNEY	G, E	I
Glycogen → Glucose	Glycogenolysis (24 hrs)	LIVER (exercise) (maintains blood [glucose])	G, E	I
		MUSCLE (exercise/early fast) (muscle contractions)	AMP Ca ²⁺	

↑ I	↓ Glucose, ↑ Glycogen
↑ G/E	↑ Glucose, ↓ Glycogen

GlucoNeoGenesis

Enhancers	Reducers
- Diabetes	- Insulin
- Cushing's (↑ Cortisol, ↓ AAs)	- Alcoholism (no food)
- Hyperthyroidism	- ↓ Cortisol, ↓ AAs
	- Hypothyroidism
	- Adrenal Deficiency (Addison)

Summary

GLYCOGEN - branched glucose

GLYCOGEN SYNTHASE - rate-limiting enzyme for GlycoGenesis

GLYCOGEN PHOSPHATASE - rate-limiting enzyme for Glycogenolysis

Liver Glycogen: maintains blood [glucose]

Muscle Glycogen: muscle contraction

GlucoNeoGenesis Precursors: Lactate, Alanine, Glycerol, other AAs

GlucoNeoGenesis Energy: ATPs from OxPhos of FAs

GlucoNeoGenesis Enzymes: PEPCK, F16BPase, G6Pase