Blood Glucose Concentration

- Fasting blood glucose (8-12 hrs)
  70-110 mg/dL

- It rises to 140 mg/dl after meal (post prandial).
The concentration of blood glucose level is maintained constant by the action of two general opposing factors:

- The rate of glucose enterance to the blood
- Rate of removal of blood glucose
Blood Glucose
Fasting 70-110 mg/dl
Postprandial < 140 mg/dl

Production of energy by all tissues
Glycogenolysis
Gluconeogenesis
Diet
Glycogenesis
Lipogenesis
Several factors are important for regulating blood glucose level:

I. Regulation by different tissues and organs
   - Liver and Extrahepatic tissue
     - (Kidney, Gastrointestinal tract, Skeletal muscle, adipose tissue)

II. Hormones
It controls the rate of glucose absorption

It protects the body from sudden and excessive increase in blood glucose by different ways:
The gradual evacuation of gastric contents allows good time for absorption and utilization of glucose.
The secretion of gastro-intestinal hormones, stimulate insulin secretion by B-cells of the pancreas.

Insulin is secreted to portal blood before absorption of glucose, so, glucose given orally stimulates more insulin than intravenous glucose.
Glucose uptake by different tissues

This is mediated through different protein transporter (GLUT4) which is insulin dependent in skeletal muscles, heart and adipose tissues.
The liver is the main organ responsible for glucose homeostatic mechanisms. The uptake or output of glucose by liver cells is directly related to blood glucose level.
Glucose is only metabolized in liver cells when its level in blood is increased.

Due to low affinity of glucokinase to glucose, and its induction by insulin.
If blood glucose level increases, the liver controls this elevation and decreases it through:

- Oxidation of glucose.
- Glycogenesis.
- Lipogenesis.
- Gluconeogenesis.

If blood glucose level decreases, the liver controls this drop and increases it.
Kidney

- All glucose in blood is filtered through the kidneys, it then completely returns to the blood by tubular reabsorption.

So, Normally urine is free from Glucose
Renal threshold > 180 mg/dL
If blood glucose **exceeds** a certain limit (**renal threshold**) or if the **renal threshold** is abnormally low (**renal glucosuria**), it will pass in urine causing **glucosuria**.

- **Renal threshold**: it is the maximum rate of reabsorption of glucose by the renal tubules.
- Normally the renal threshold for glucose is **180 mg/dL**.
Adipose Tissue

They play an important role in glucose homeostatic mechanisms.

If blood glucose level increases, decreases it through

- The uptake of glucose by tissues
- Glucose oxidation
- Lipogenesis.
During fasting or carbohydrate deficiency,

- Glucose uptake and utilization decreases.
- Lipolysis increases, yielding FFA.

FFA are utilized by different tissues for production of energy (spare blood glucose).

Increase oxidation of fatty acids in liver.

+++ gluconeogenesis and --- glycolysis.

Glycerol acts as a substrate for gluconeogenesis.
During carbohydrate feeding,

- the uptake of glucose.
- glucose oxidation
- glycogensis.
During fasting, the muscles can oxidize fatty acids and ketone bodies instead of glucose for production of energy.
The amino acids released from muscles (especially alanine) are utilized as substrates for gluconeogenesis in the glucose-alanine cycle.
Lactate produced during severe muscular exercise is used as substrate for gluconeogenesis in

Cori cycle

Or

glucose – lactate cycle
Hormonal regulating of blood glucose

Glucagon
Adrenalin
Glucocorticoids
GH
Thyroid hormones

Insulin
Tug of war between Insulin & other hormones

- INSULIN
- glucagon
- glucocorticoids
- G.H
- epinephrine
- Thyroid hormones
- catecholamines
Hormonal regulating of blood glucose

**Insulin**: leads to decrease of blood glucose level

- **Gluconeogenesis**
- Glucose entrance to the cells and oxidation.
- **glycogenesis (ms & liver)** --- **Glycogenolysis**
- **Lipogenesis** --- **lipolysis**
- **Protein synthesis**
- **Ketogenesis**
Gluconeogenesis (in the liver only)

Glycogenolysis

Insulin secretion.

Glucagon

Gluconeogenesis (in the liver only)

Glycogenolysis
Glucocorticoids

- ↑ Gluconeogenesis
- Facilitate the action of glucagons, adrenaline and growth H.
Growth hormone

- Glucose uptake by the tissues.
- Lipolysis which FFA leading to glucose utilization (glucose sparing effect)
Variations in normal blood glucose

- **Hyperglycemia**: > 110 mg/dl
- **Hypoglycemia**: < 70 mg/dl
Hyperglycemia

Def. It is the rise of blood glucose level above the normal level.

Causes

- Deficiency of insulin:
  - Diabetes mellitus.
  - Pancreatictomy (total or subtotal).
- **Increase of anti-insulin hormones:**
  - **Adrenaline** as in emotion or in case of pheochromocytoma
  - **Glucocorticoids** as in adrenal tumors and Cushing syndrome.
  - **Thyroxin** as in hyperthyroidism.
  - **Pituitary growth hormone** as in acromegally.
Hypoglycaemia

- **Def.**
  It is the decrease in blood glucose level below the fasting level.

- **Classified into**
  - **Fasting Hypoglycaemia** (occurs as a response to fasting for 12 – 16 hr).
  - **Reactive hypoglycaemia** (Hypoglycaemia due to some other stimuli)
Causes of fasting hypoglycaemia

- Insulinoma
- Non-pancreatic tumours (usually mesodermal)
- Liver disease of various types
- Hypoadrenalism
- Hypopituitarism
- Glycogen storage diseases
- Neonatal hypoglycaemia
- Idiopathic hypoglycaemia of childhood.
Causes of reactive (or stimulative) hypoglycaemia

- **Drug-induced**, due to insulin, oral hypoglycaemic agents (e.g. tolbutamide), also to dietary constituents e.g. alcohol, L-leucine.

- **Essential reactive hypoglycaemia**, in which symptoms occur 2-4 hr after a meal, probably due to an exaggeration of the normal insulin response to carbohydrate ingestion.

- **Galactosaemia**.

- **Hyereditary fructose intolerance**.
Glucosuria

Def.

Presence of detectable amounts of glucose in urine (>30 mg/dL).

Causes:

A. Hyperglycemic glucosuria
B. Normoglycemic or renal glucosuria
Hyperglycemic Glucosuria

- Blood glucose exceeds the renal threshold (180mg/dL).

- It is caused by:
  1. Diabetes mellitus.
  2. Emotional or stress glucosuria (epinephrine glucosuria)

  1. Alimentary glucosuria;

It is due to increased rate of glucose absorption as in cases of gastrectomy or gastrojejunostomy.
Normoglycemic = renal glucosuria

1. **Congenital renal glucosuria**: due to congenital defect in renal tubular reabsorption of glucose.

2. **Acquired renal disease** (e.g. nephritis).

3. **Pregnancy**: due to decreased carbohydrate tolerance and renal threshold in the later months of pregnancy.

4. **Injection of phlorhizin** due to inhibition of the (SGLUT) in renal tubules.
Thank You!

Dr. Manal El Desoky