Carbohydrate Metabolism and blood sugar

Glucose metabolism

- When glucose enters a cell from the bloodstream, it is immediately converted to glucose 6- phosphate.
- Once this phosphate is formed, glucose is trapped within the cell because phosphorylated molecules cannot cross the cell membrane.
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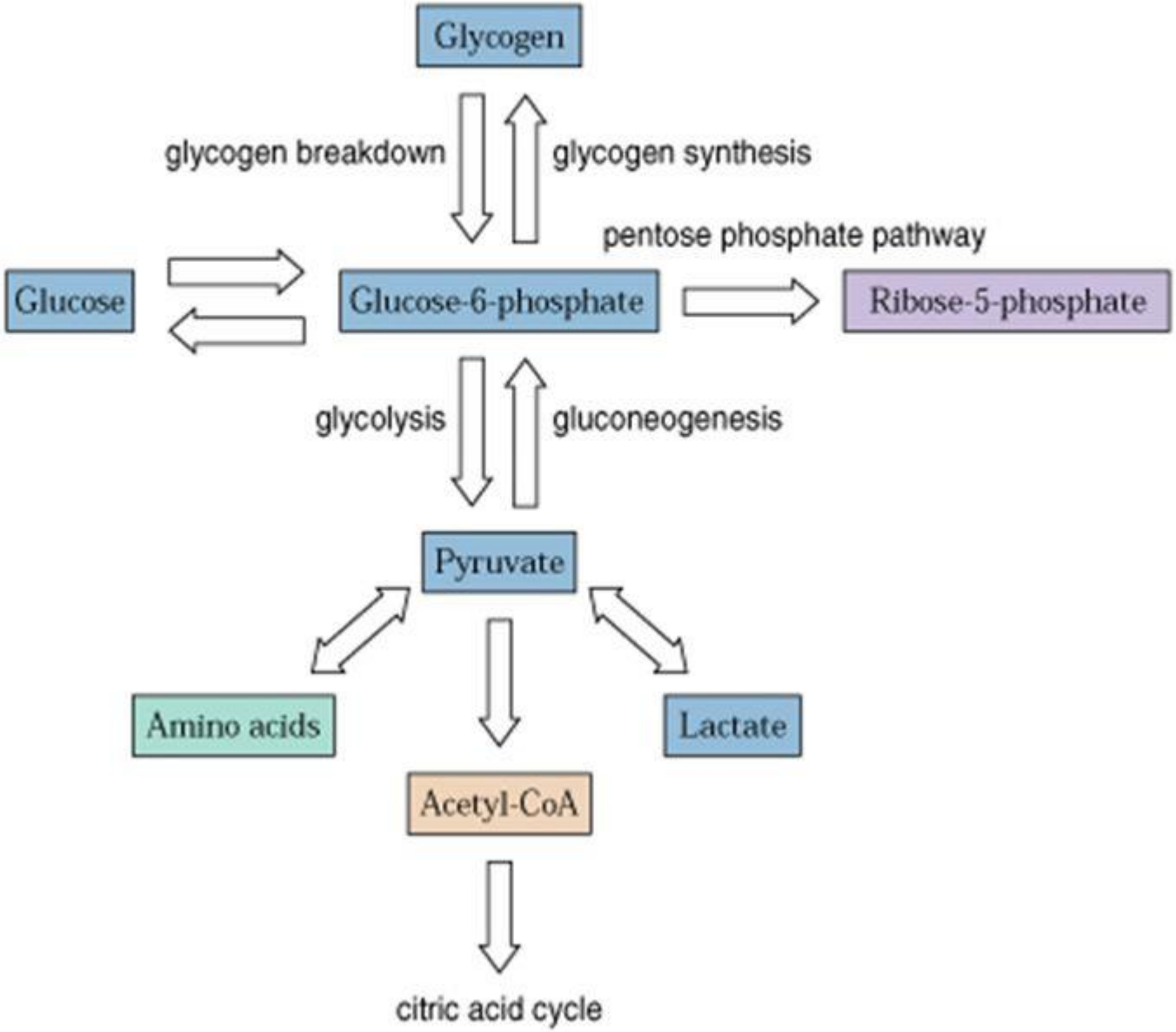
Overview of Glucose Metabolism



glycolysis

- Glycolysis is a series of 10 enzyme-catalyzed reactions that break down glucose molecules.
- When energy is needed, glucose 6-phosphate undergoes glycolysis to pyruvate and then to acetyl-S-coenzyme A, which enters the citric acid cycle.

$C_6H_{12}O_6$ + 2 NAD^+ + 2 ADP + 2 P ——> 2 pyruvic acid, ($CH_3(C{=}O)COOH$ + 2 ATP + 2 NADH + 2 H^+

glycogenesis

- When cells are already well supplied with glucose, the excess glucose is converted to other forms for storage: to glycogen,

Glycogenolysis

Degradtion Of stored Glycogen

occurs in cytosol

triggered by low blood glucose levels

why this pathway occurs?

=When an organism needs energy quickly

=During muscular exercise

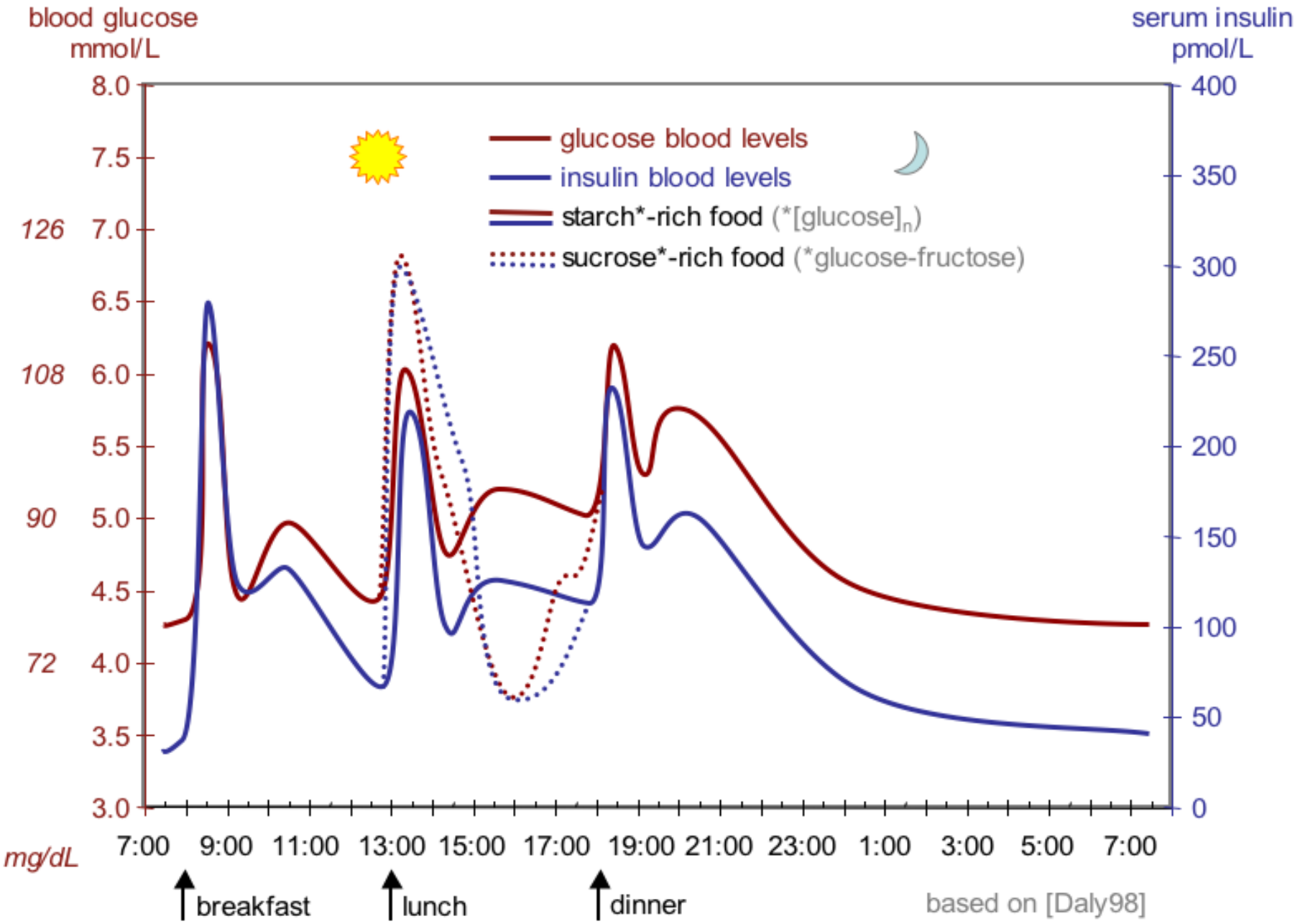
=can do so anaerobically

Gluconeogenesis: an intro

- Defined as biosynthesis of glucose from non-carbohydrate precursors.
- The major non-carbohydrate precursors are lactate, amino acids, glycerol and the carbon skeletons of most amino acids
- Non-carbohydrate precursors of glucose are first converted into pyruvate or as oxaloacetate and DHAP
- When fasting, most of the body's glucose needs must be met by gluconeogenesis
- Occurs mainly in liver and to some extent in kidney
- Responsible for 64% of total glucose production over the first 22 hours of the fast and accounts for almost all the glucose production by 46 hours

Blood Sugar

- The **blood sugar concentration** or **blood glucose level** is the amount of glucose (sugar) present in the blood of a human or animal.


blood glucose
mmol/L
serum insulin
pmol/L
8.0
7.5
126
7.0
6.5
108
6.0
5.5
90
5.0
4.5
72
4.0
3.5
3.0
mg/dL
400
350
300
250
200
150
100
50
0
glucose blood levels
insulin blood levels
starch*-rich food (*[glucose]n)
sucrose*-rich food (*glucose-fructose)
7:00
9:00
11:00
13:00
15:00
17:00
19:00
21:00
23:00
1:00
3:00
5:00
7:00
breakfast
lunch
dinner
based on [Daly98]

Normal B.S

- Fasting blood sugar (FBS) (before-meal) normal sugars are 80–100 mg/dl.
- Random blood sugar (RBS) (between meal) normal sugars are 100–120 mg/dl.

- “Postprandial” sugars taken two hours after meals (2hr pp) should be less than 140 mg/dl.

- Hemoglobin A1c, HbA1c, or just A1C. This test gives your average reading over the last 2–3 months.
- Normal for a person without diabetes is below 5.7%.

- If you have diabetes, the American Diabetes Association (ADA) advises keeping your blood sugar levels before meals from 80–130 mg/dl and your levels 1–2 hours after meals under 180.

- recommended by the ADA are 7.0% or lower if you want tight control.

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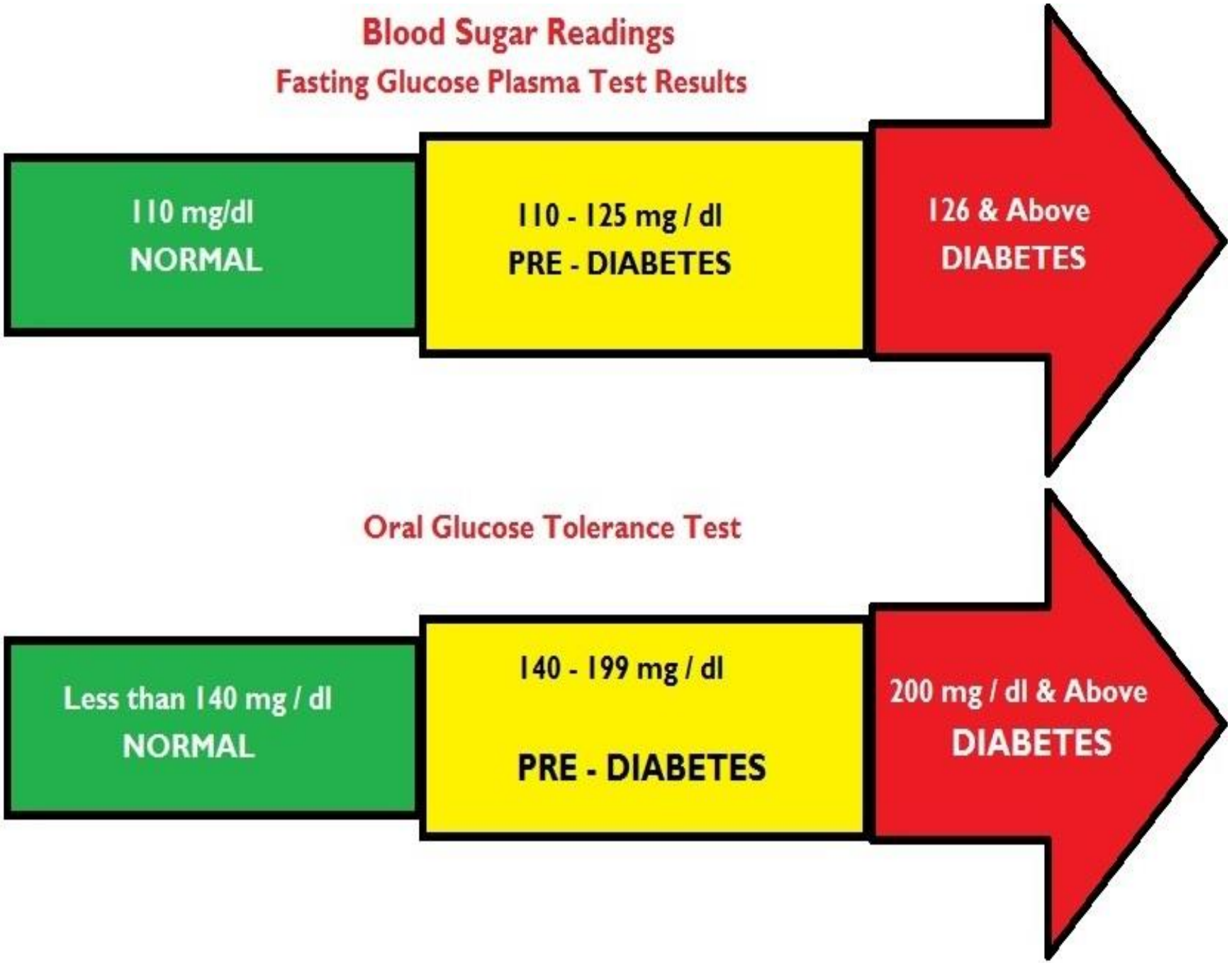
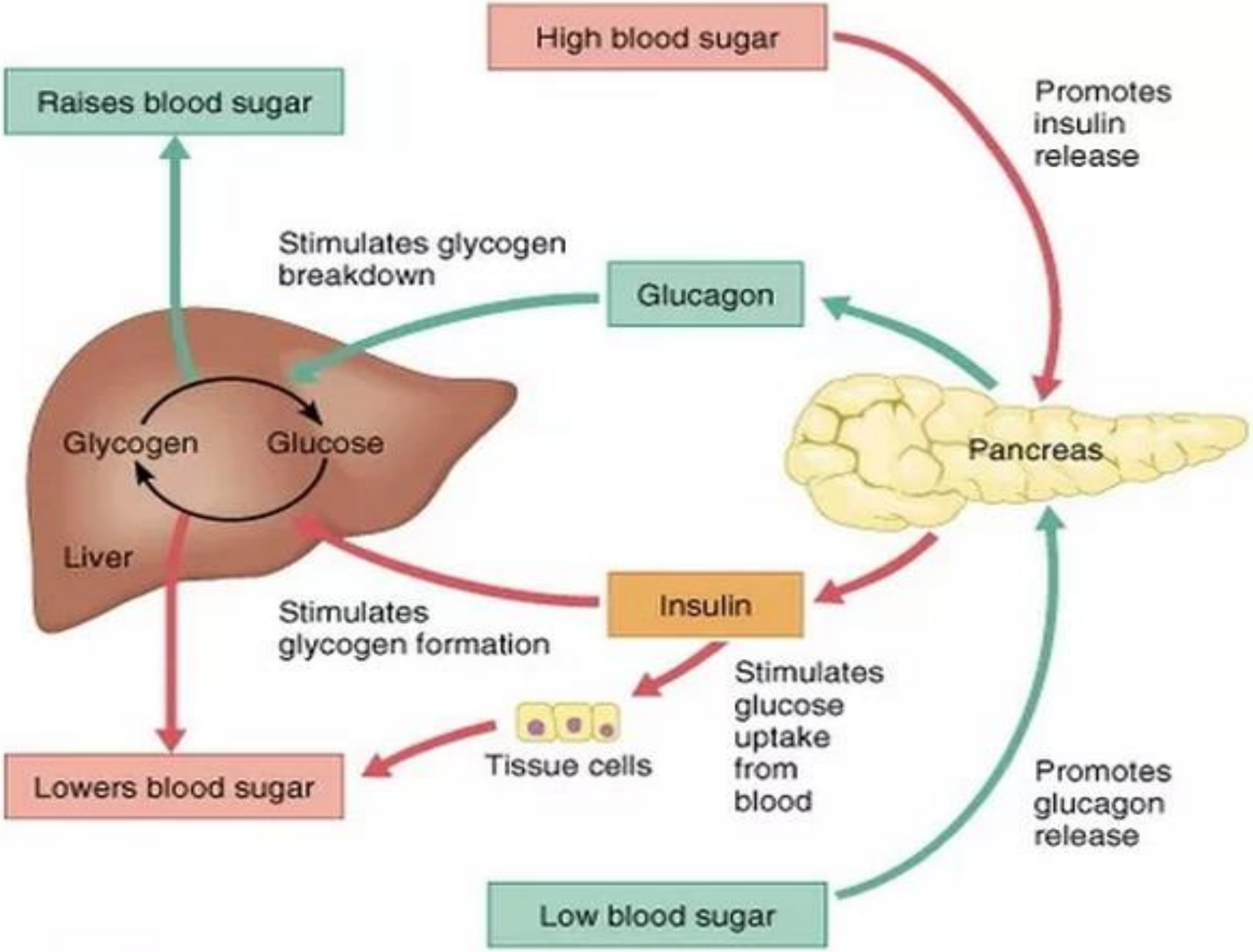

Blood Sugar Readings
Fasting Glucose Plasma Test Results
110 mg/dl
NORMAL
110 - 125 mg / dl
PRE - DIABETES
126 & Above
DIABETES
Oral Glucose Tolerance Test
Less than 140 mg / dl
NORMAL
140 - 199 mg / dl
PRE - DIABETES
200 mg / dl & Above
DIABETES



Hypoglycemia: Signs And Symptoms

DIRE

Diaphoresis

Increased pulse

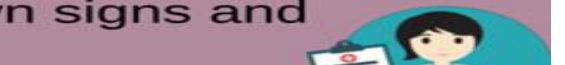
Restless

Extra hungry

Hypoglycemia is a condition characterized by abnormally low blood glucose (blood sugar) levels, usually less than 70 mg/dl.

Hypoglycemia may also be referred to as an insulin reaction, or insulin shock.

Hypoglycemic symptoms are important clues that you have low blood glucose. Each person's reaction to hypoglycemia is different, so it's important that you learn your own signs and symptoms when your blood glucose is low.



Diabetes mellitus

- Diabetes mellitus (DM) is one of the leading

public health problems of the modern era, it is a chronic endocrine disorder affecting the body‘s metabolism and resulting in structural changes affecting the organs of the vascular system

Symptoms of marked hyperglycemia

- include polyuria, polydipsia, weight loss, sometimes with polyphagia, and blurred vision. Impairment of growth

Diabetes can be classified into the following general categories

1. Type 1 diabetes (due to b-cell destruction, usually leading to absolute insulin deficiency)

2. Type 2 diabetes (due to a progressive insulin secretary defect on the back ground of insulin resistance)

T2DM is divided into two subgroups, diabetes with obesity and without obesity

3- Gestational diabetes mellitus (GDM) (diabetes diagnosed in the second or third trimester of pregnancy that is not clearly overt diabetes)

Complications of diabetes

- When glucose levels get higher than normal, they start to cause inflammation in blood vessels and nerves. This is where all the complications of diabetes come from

Micro vascular Complications of Diabetes

- **Diabetic neuropathies**
- **Diabetic Retinopathy**
- **Diabetic nephropathy**
- **Cardiovascular disease**

Macro vascular Complications of Diabetes

Atherosclerosisi

- **Diabetic ketoacidosis (DKA)** is a serious condition that can lead to diabetic coma or even death
- (**DKA**) is a potentially life-threatening complication of diabetes mellitus. Symptoms :
- vomiting, abdominal pain, deep gasping breathing, increased urination, weakness, confusion, and occasionally loss of consciousness.

- person's breath may develop a specific smell. Onset of symptoms is usually rapid. In some cases people may not realize they previously had diabetes.
- DKA happens most often in those with type 1 diabetes, but can also occur in those with other types of diabetes under certain circumstances.

- The primary treatment of DKA is with intravenous fluids and insulin Depending on the severity, insulin may be given intravenously or by injection under the skin. Usually potassium is also needed to prevent the development of low blood potassium. Throughout treatment blood sugar and potassium levels should be regularly checked