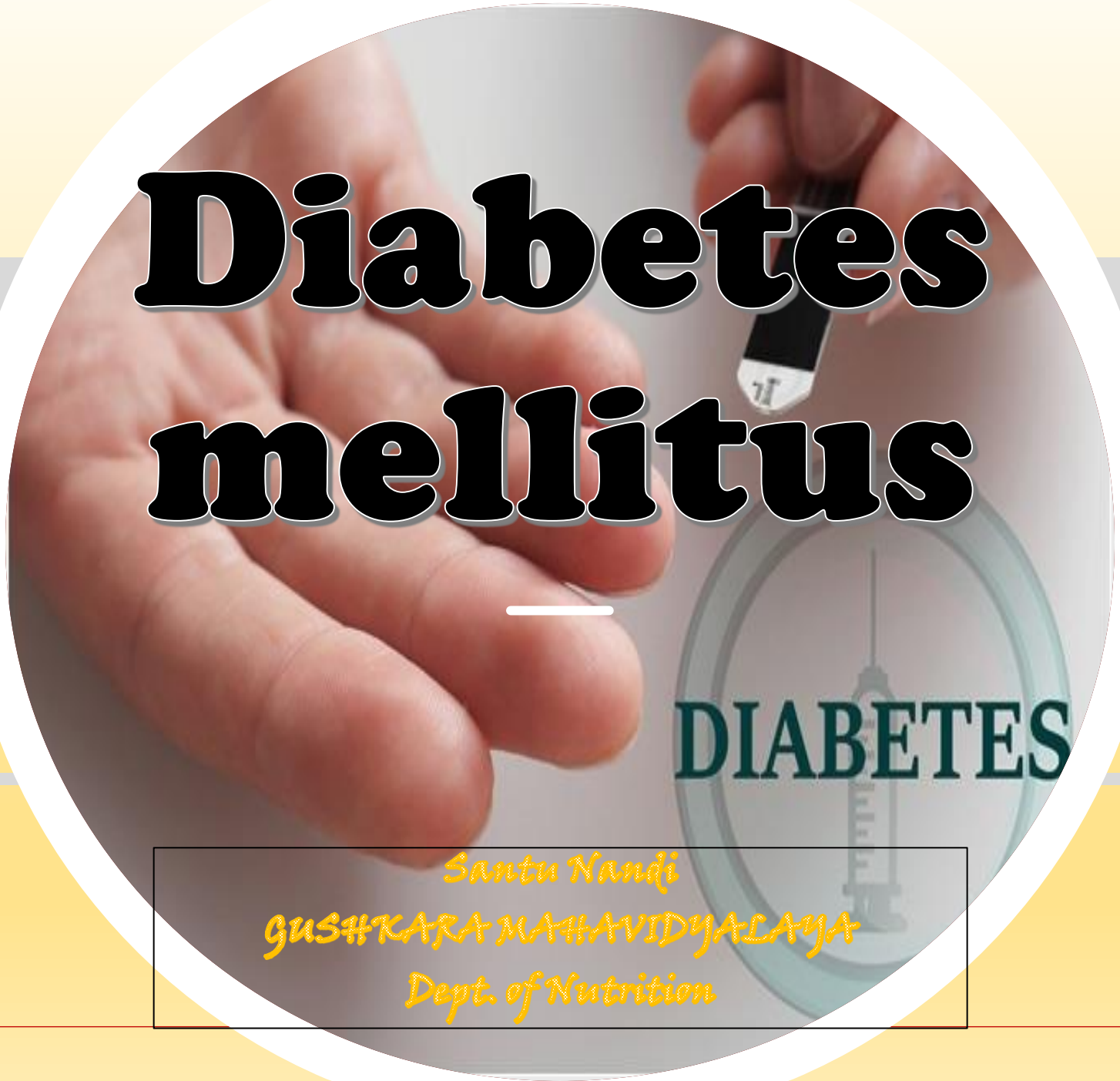
Diabetes mellitus



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Definition:-

❖ **DIABETES: Flow Through,**

❖ **MELL: Honey**

- ✓ Diabetes mellitus is a chronic metabolic disorder, with a strong hereditary basis, that prevents the body to utilize glucose completely or partially.
- ✓ It is characterized by raised glucose concentration in the blood and alternations in carbohydrate, protein and fat metabolism.

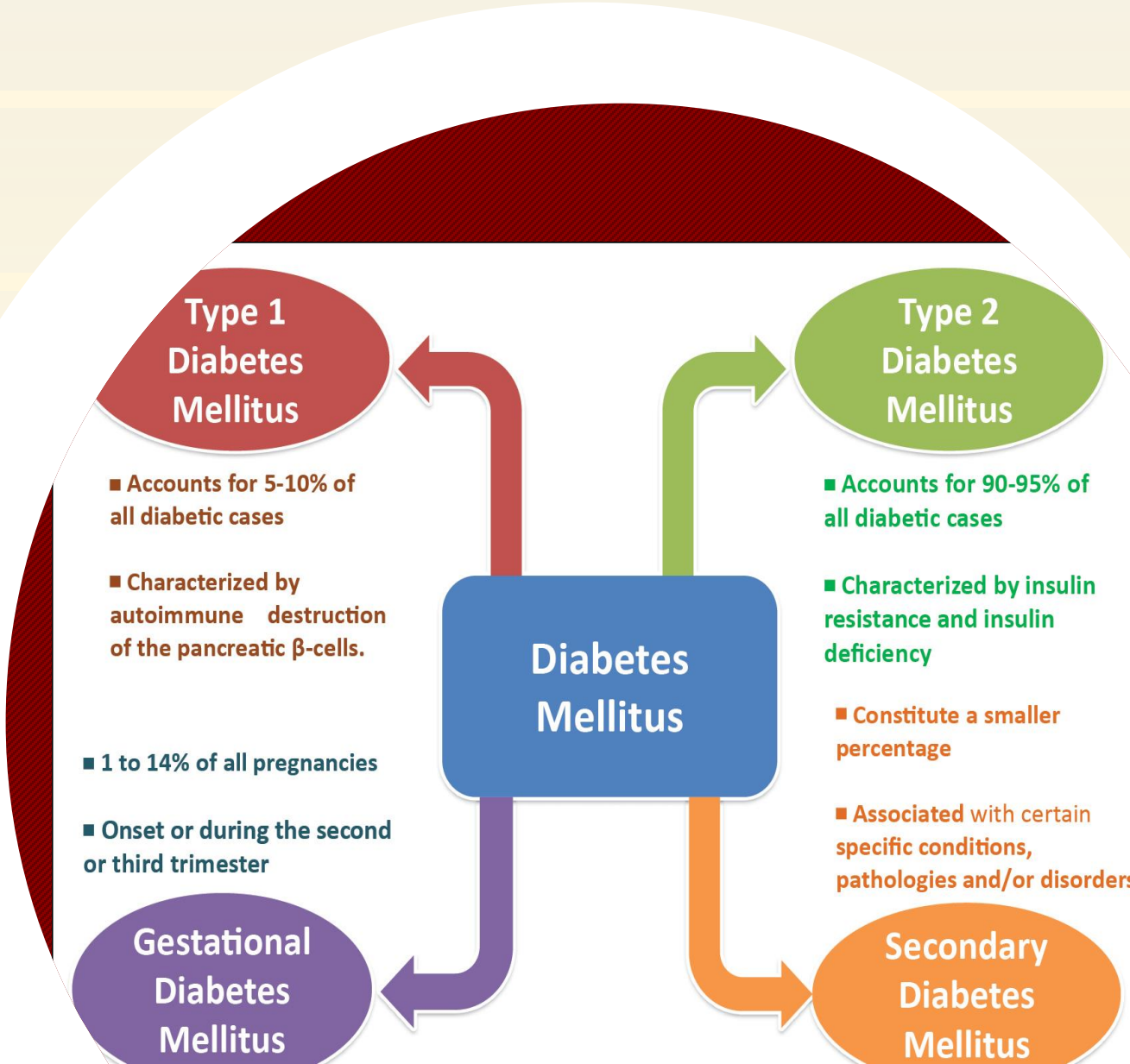
Prevalence of Diabetes

- *According to the IDF, the number of diabetics in the world stands at 365 million people, representing around 8.5% of the global population.*
- *India today leads the world with the largest number of people with diabetes in any given country. ICMR study showed a prevalence of 2.5% in urban and 1.8% in the rural population above the age of 15 years. One in every eight individuals in India is a diabetic.*
- *The revised WHO figures for the year 2025 is 57.2 million diabetics in India.*

History of diabetes:-

- *The history of diabetes started in approximately 1550 BC. An Egyptian papyrus mentions a rare disease that causes the patient to lose weight rapidly and urinate frequently. This is thought to be the first reference to the disease.*

Types of Diabetes Mellitus



Types of diabetes mellitus

❑ Type-1: (IDDM):

❑ Insulin Dependent Diabetes Mellitus:

- Type 1 diabetes, also known as juvenile-onset diabetes or insulin-dependent diabetes, is an autoimmune disorder that occurs when the body's immune system attacks and destroys the insulin-producing cells in the pancreas. The body cannot produce insulin, and glucose levels in the blood rise to dangerous levels.
- Type 1 diabetes is usually diagnosed in children and young adults and requires lifelong insulin therapy to manage blood sugar levels .
- The child is usually underweight. Acidosis is fairly common.

❑ Type-2: (NIDDM):

❑ Non Insulin Dependent Diabetes Mellitus:

- Type 2 diabetes, also known as adult-onset diabetes or noninsulin dependent diabetes, is a condition where the body becomes resistant to the effects of insulin or does not produce enough insulin to meet the body's needs.
- This type of diabetes is often associated with lifestyle factors, such as obesity, a sedentary lifestyle, and poor dietary choices.
- Insulin may be produce by pancreas but the action is impaired.
- The majority of the patients improves with weight loss and is maintained on diet therapy.
- It is usually managed with lifestyle changes, medications, and sometimes insulin therapy.

Types of diabetes mellitus

❑ Gestational Hyperglycemia and Diabetes:-

- ❑ Gestational diabetes is carbohydrate intolerance resulting in hyperglycemia of variable severity with onset or first recognition during pregnancy.
- ❑ Gestational diabetes occurs during pregnancy when hormonal changes affect insulin sensitivity.
- ❑ The condition usually resolves after giving birth, but women with gestational diabetes are at higher risk of developing type 2 diabetes later in life.

❑ Malnutrition related diabetes mellitus (MRDM) :-

- ❑ Malnutrition related diabetes mellitus (MRDM) is rare type of diabetes associated with long term malnutrition .
- ❑ Clinical features include characteristic leanness with sub-normal body mass, moderate to severe increase in blood glucose, the requirement of large doses of insulin to achieve normalcy in blood glucose, and a frequent history of malnutrition in early childhood.

Types of diabetes mellitus

❑ Prediabetes:-

- ❑ Prediabetes is a condition when a person have a higher than normal blood sugar level.
- ❑ But It's not high enough to be considered type 2 diabetes yet.
- ❑ But without lifestyle changes, adults and children with prediabetes are at high risk to develop type 2 diabetes.

❑ Secondary Diabetes:-

- ❑ A minority of the cases of diabetes occur as the result of disease which destroy the pancreas and live to impaired secretion of insulin.
- ❑ Example, Pancreatitis, Hemochromatosis, Cystic fibrosis, Carcinoma of the pancreas, Cancer of the pancreas.

Diabetes: Type 1 vs. Type 2

Diabetes is on the climb — but there is a difference between Type 1 and Type 2. Do you know it?

Type 1 Diabetes		Type 2 Diabetes
Your body is no longer able to produce insulin	Why	Your body still produces insulin, but it doesn't make enough of it or it doesn't use it efficiently
Usually develops during childhood, but can develop at any age	Age	Can develop at any age but is most common in adults over 45
Family history	Risk Factor	- Overweight and/or inactive - Family history - High blood pressure
- Bedwetting - Blurry vision - Frequent urination - Increased appetite and thirst - Mood changes and irritability - Tiredness and weakness - Unexplained weight loss	Symptoms	- Increased appetite and thirst - Dark patches on armpits/neck - Frequent urination - Blurry vision - Tiredness and weakness - Unexplained weight loss
No known prevention methods	Prevention	Healthy lifestyle
Insulin injections	Treatment	Healthy living, possible insulin support

CAUSES

Causes of Diabetes Mellitus

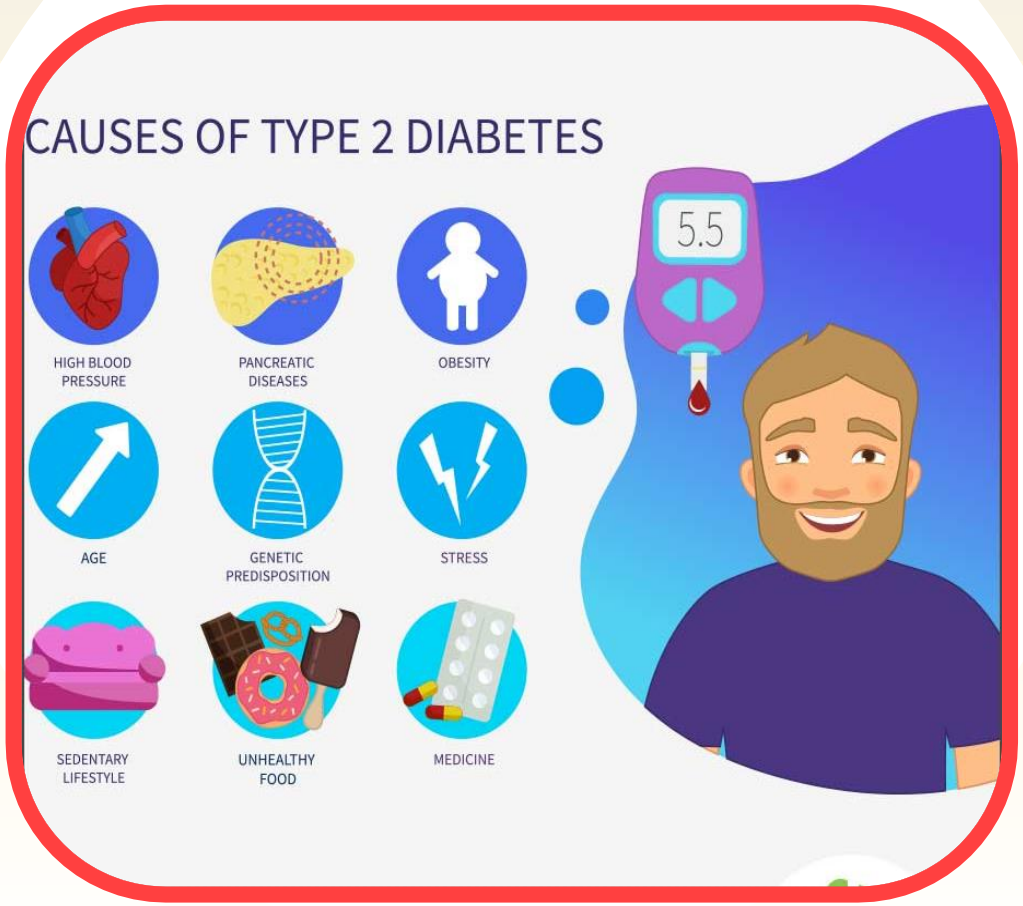
Causes of different types diabetes mellitus

- *Causes of Type 1 Diabetes Mellitus*

- *Genetic Factor*
- *Environmental factors*
  - *Age*
  - *Autoimmunity*
  - *Infection*
  - *Acute Stress*

- *Causes of Type 2 Diabetes Mellitus*

- *Genetic Factor*
- *Environmental factors*
  - *Age*
  - *Obesity*
  - *Gestational diabetes*
  - *Life style*
  - *Insulin resistance*



Causes of Type 1 diabetes mellitus

1. Genetics :

- The inheritance of human IDDM is polygenic.
- It has been estimated that over 50% of the heritability is contributed by the HLA class 2 genes (chromosome 6).

2. Environmental:

a. Age:

- IDDM is usually sudden onset in the younger age group.

b. Infection:

- Type 1 Diabetes mellitus can also result from inflammation of the islet tissue of the pancreas, leading to destruction of the beta cells.
- This can occur in viral infections such as mumps, coxsackie B virus or cytomegalovirus infection, chickenpox, infectious mononucleosis, German measles, and viral hepatitis.

c. Autoimmunity:

- T1DM is an organ-specific autoimmune disease that affects the insulin-producing pancreatic beta cells, after an inflammatory process leads to a chronic deficiency of insulin in genetically susceptible individuals.
- Markers of the immune destruction of the beta-cells include
  a. Islet cells autoantibodies,
  b. Autoantibodies to insulin,
  c. Autoantibodies to glutamic acid decarboxylase (GAD65) (a protein on the surface of the beta-cells), and
  d. Autoantibodies to the tyrosine phosphatases IA-2 and IA-2 beta.

d. Acute Stress

- The normal glucose open is maintained within the body by a constant interplay of several hormones.
- During stress condition, the body release adrenaline noradrenaline and cortisol that raise the blood sugar level to provide a quick source of energy to cope stress.
- So physical and emotional stress can precipitate type 1 diabetes mellitus.

Causes of Type 2 diabetes mellitus

1. Genetics :

- NIDDM represents a combination of major and minor genes affecting insulin secretion, insulin action and obesity.

2. Environmental:

a. Age:

- NIDDM is principally a disease of the middle aged and elderly.

b. Obesity:

- People with a high waist/hip ratio indicating that fat is largely in the abdominal cavity have a greater risk of diabetes than the people with a similar amount of fat distributed peripherally.
- This probably relate to the insulin insensitivity which is caused by a high flux of free fatty acids in the portal circulation, since intra abdominal fat cells can release fatty acid very rapidly.

c. Gestational diabetes :

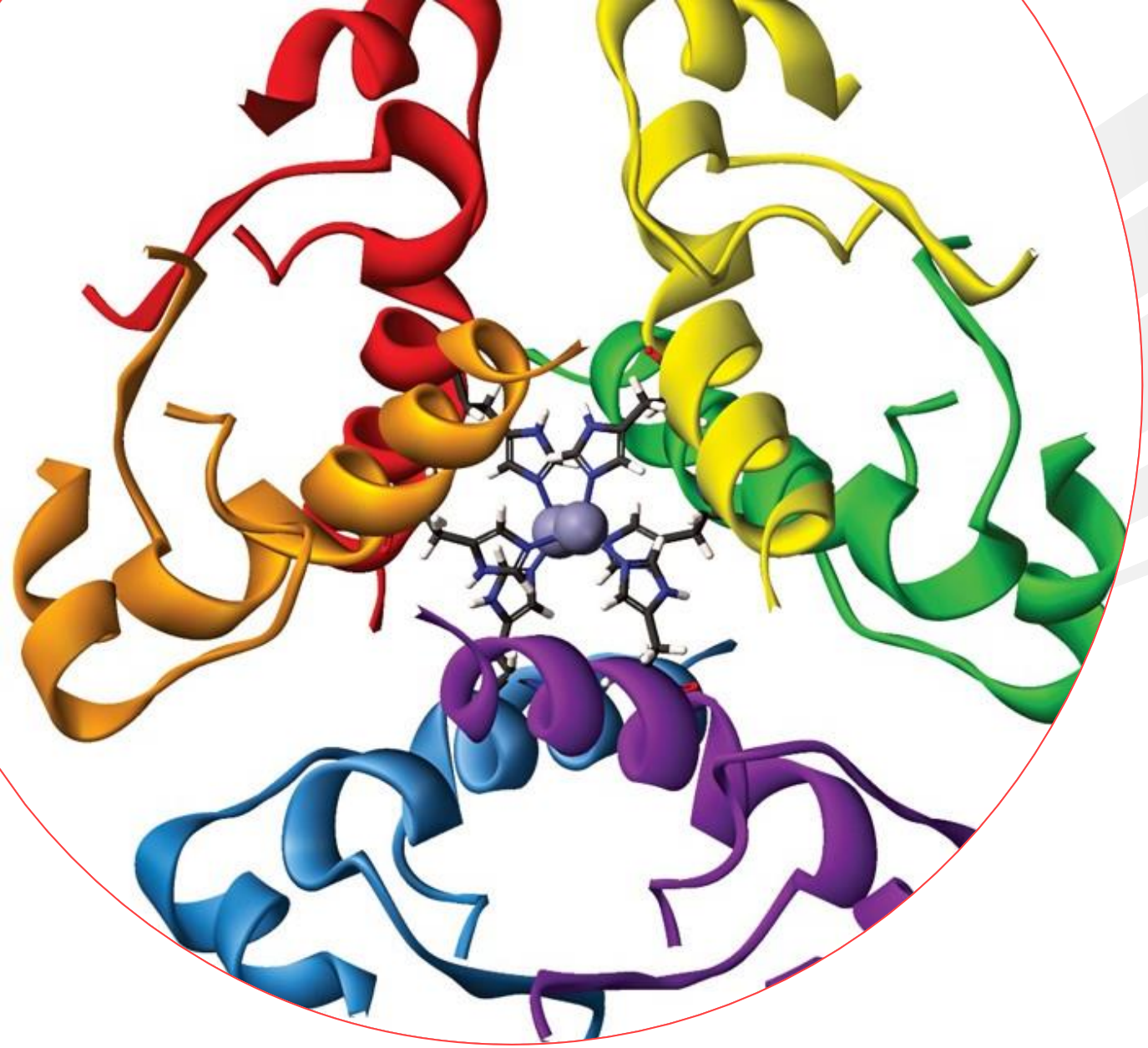
- In normal pregnancy the plasma insulin level is increased due to the action of placental hormones creating a burden on the pancreatic beta cells.
- If this demand is not met Gestational diabetes may occur.
- Woman with gestational diabetes may develop permanent type 2 diabetes in later life.

d. Life style:

- Type 2 diabetes mellitus usually occur in people who are obese and physically inactive.
- Higher intake of refined grains which have high Glycemic Index (GI) combined with fatty food intake & Sedentary lifestyle could be major reasons for the incidence of central obesity and which result type 2 diabetes.

e. Insulin resistance:

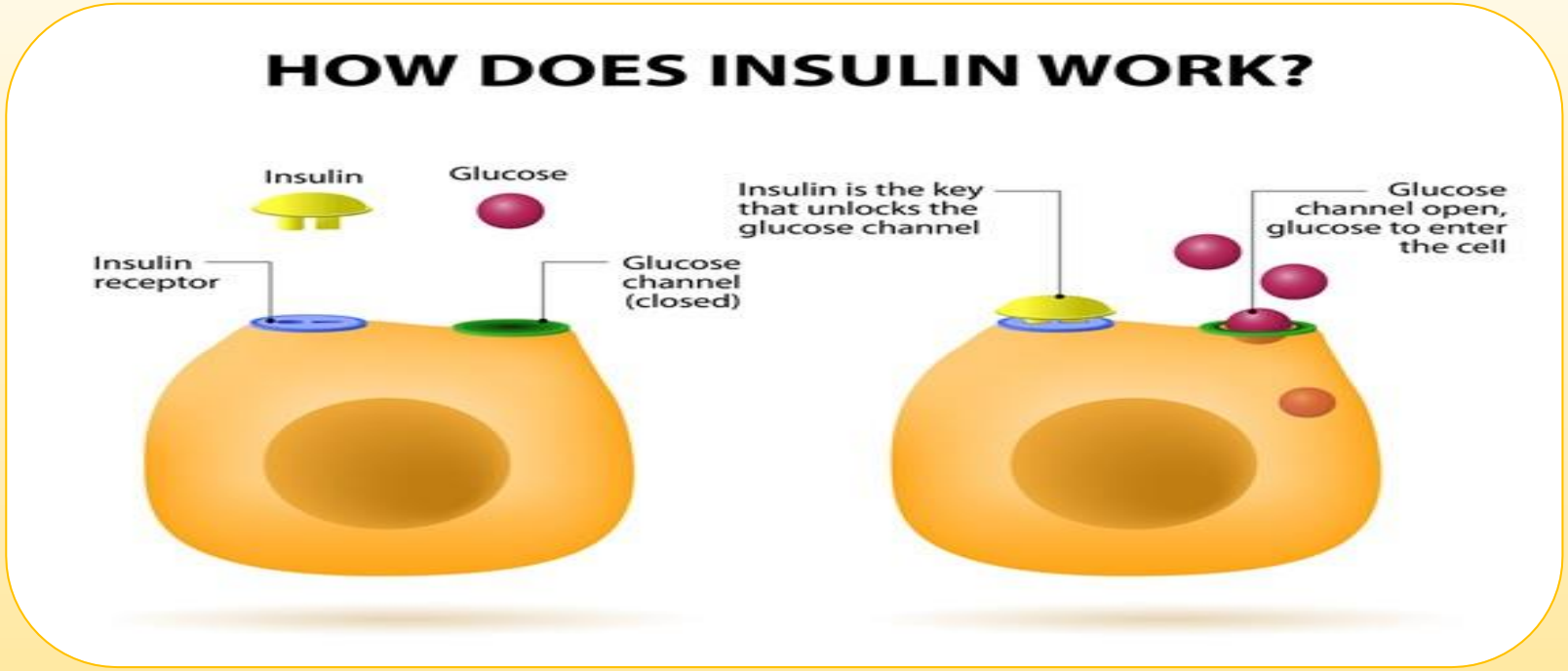
- T2DM is characterized by a combination of insulin resistance and beta-cell failure.
- Insulin resistance (IR) is an impaired biological response or sensitivity to either exogenous or endogenous insulin.
- In persons with insulin resistance glucose build up the blood instead of being absorbed by the cells which result prediabetes or type 2 diabetes mellitus.

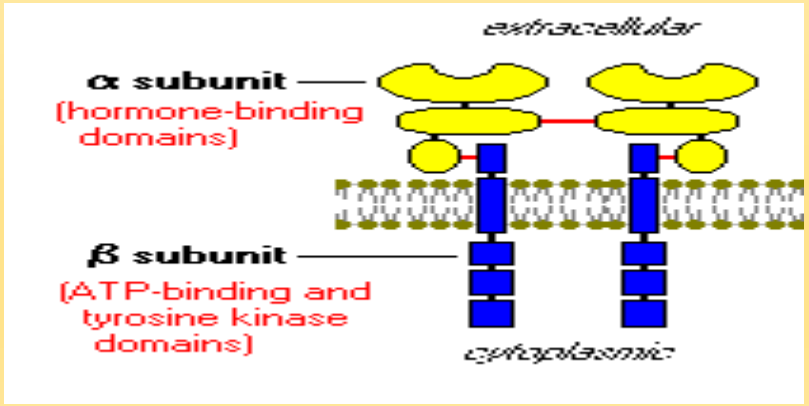


Insulin's Role in the Human Body

Insulin's Role in the Human Body

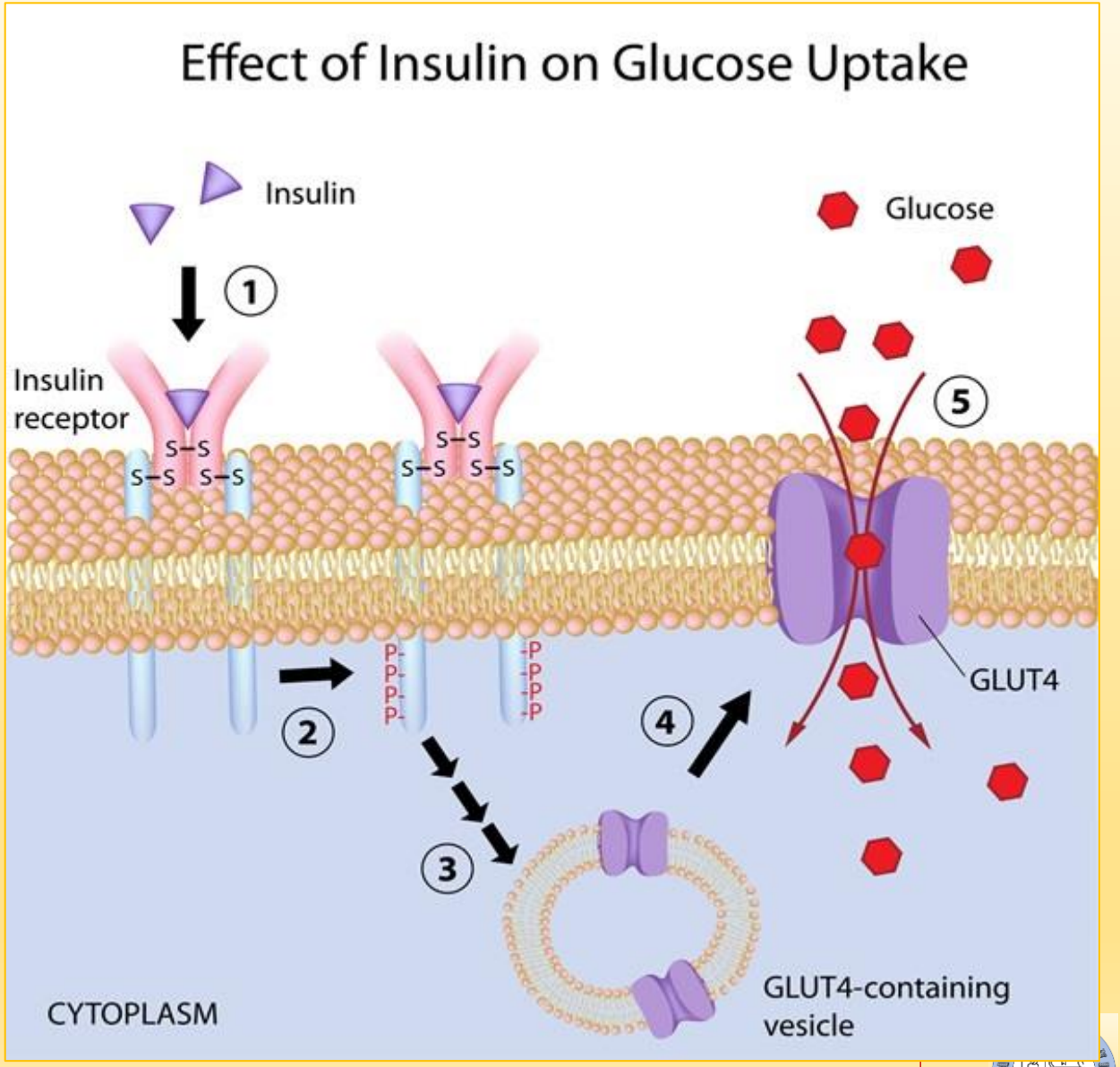
- *Insulin is a hormone produced by the pancreas that has a number of important functions in the human body, particularly in the control of blood glucose levels and preventing hyperglycaemia. Insulin also has an effect on several other areas of the body, including the synthesis of lipids and regulation of enzymatic activity.*



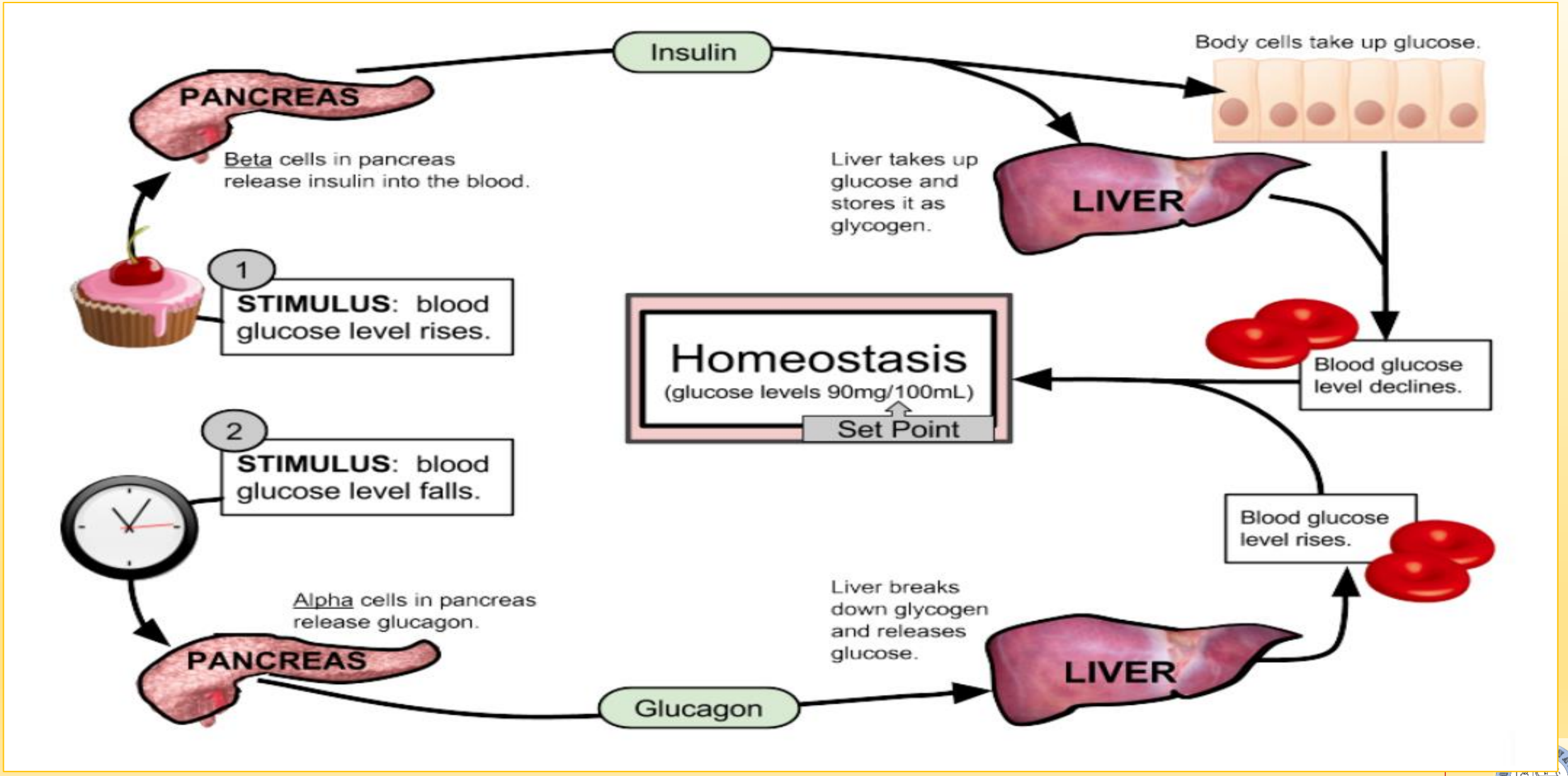


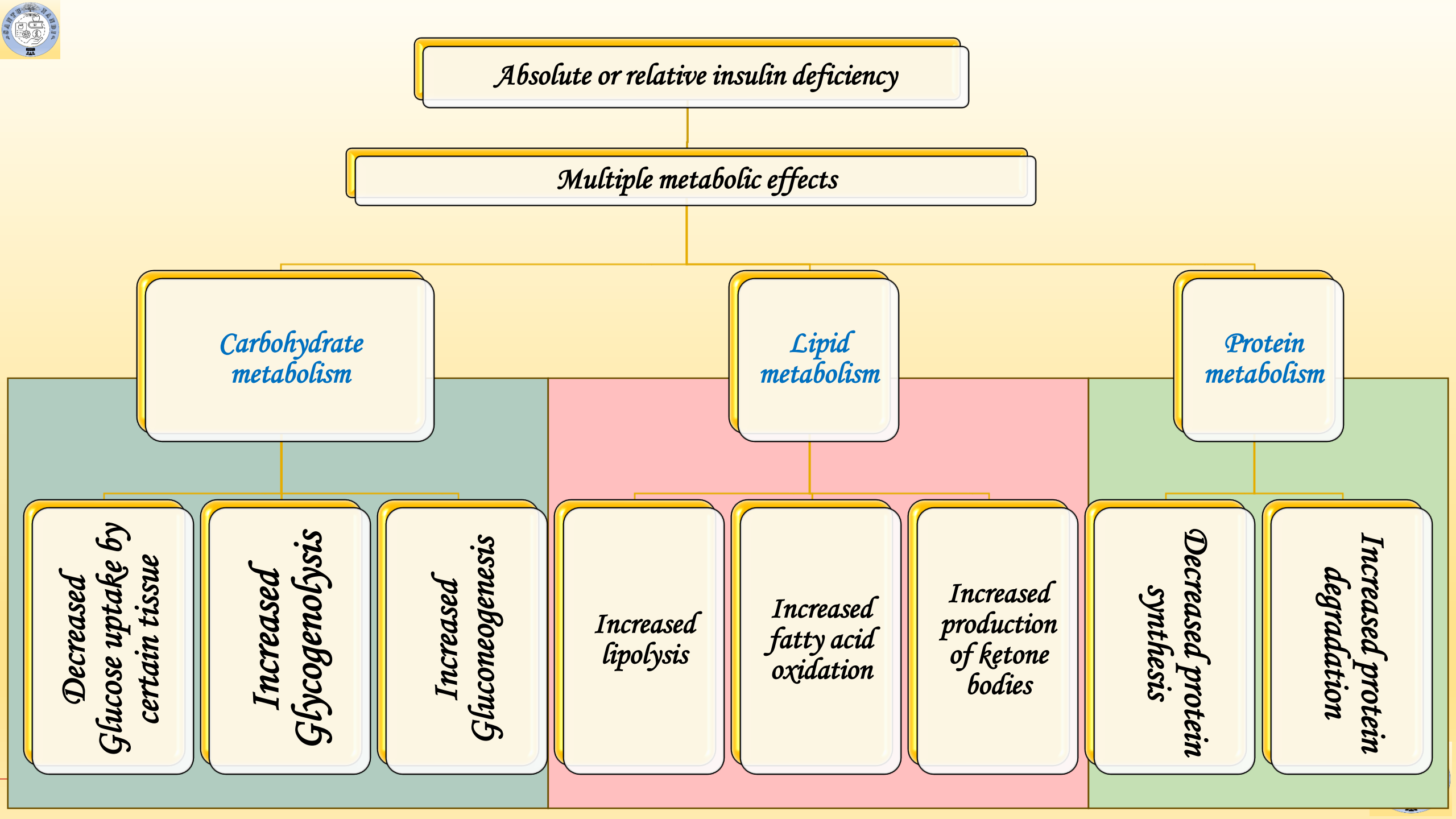
Insulin's Role in the Human Body

- *The most important role of insulin in the human body is its interaction with glucose to allow the cells of the body to use glucose as energy.*
- *The pancreas usually produces more insulin in response to a spike in blood sugar levels, as occurs after eating a meal, for example. This is because insulin acts as a "key" to open up the cells in the body to allow for glucose to be used as an energy source.*
- *Additionally, when there is excess glucose in the bloodstream, which is a condition known as hyperglycemia, insulin encourages the storage of glucose as glycogen in the liver, muscle, and fat cells.*
- *These stores can then be used at a later date when energy requirements are higher. As a result of this, there is less insulin in the bloodstream, and normal blood glucose levels are restored.*
- *Insulin stimulates the synthesis of glycogen in the liver; however, when the liver is saturated with glycogen, an alternative pathway takes over. This involves the uptake of additional glucose into adipose tissue, leading to the synthesis of lipoproteins.*

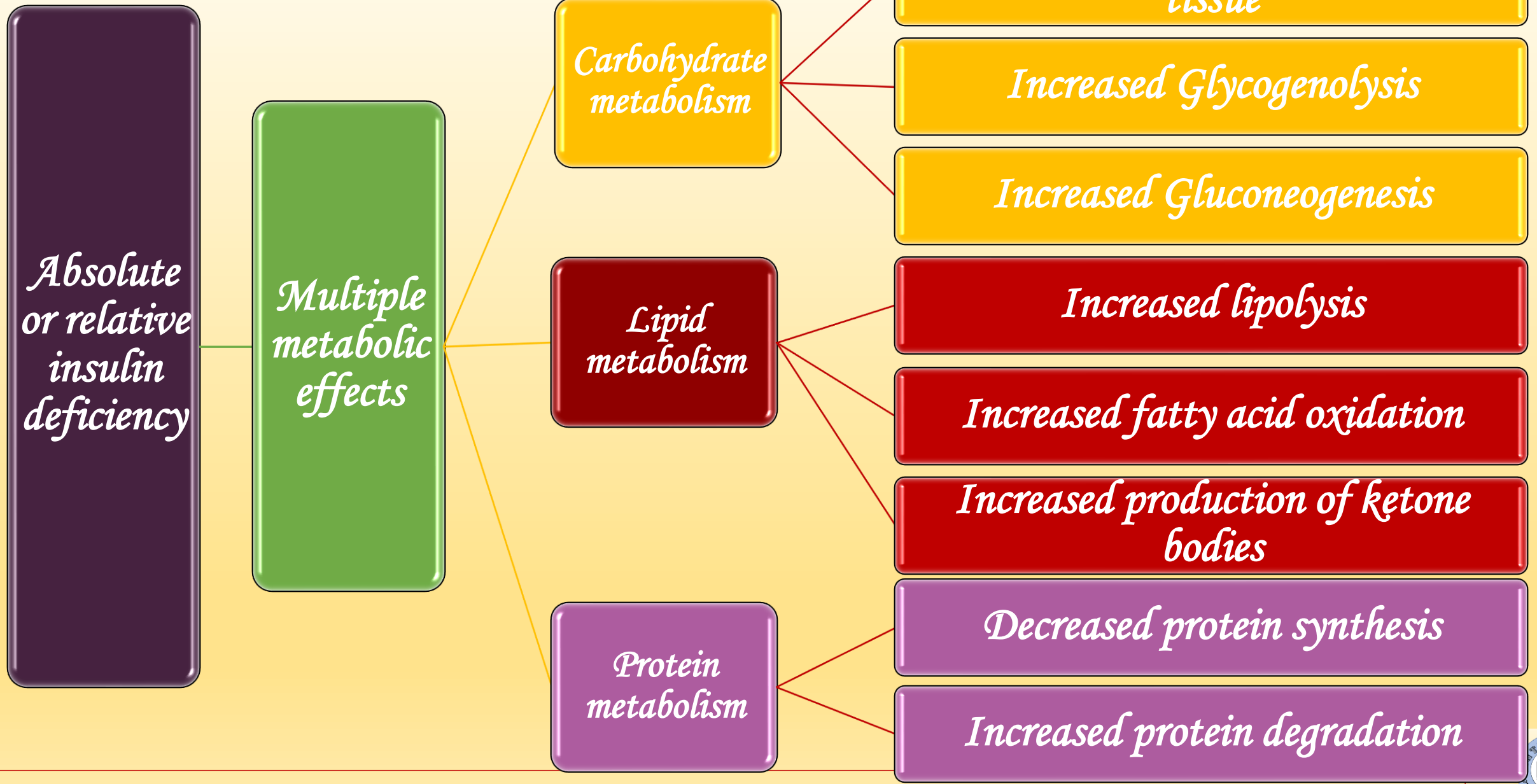


Blood Glucose level Homeostasis




Absolute or relative insulin deficiency
Multiple metabolic effects
Carbohydrate metabolism
Lipid metabolism
Protein metabolism
Decreased Glucose uptake by certain tissue
Increased Glycogenolysis
Increased Gluconeogenesis
Increased lipolysis
Increased fatty acid oxidation
Increased production of ketone bodies
Decreased protein synthesis
Increased protein degradation

Major Metabolic Changes in Diabetes Mellitus



Pathophysiology of Diabetes Mellitus

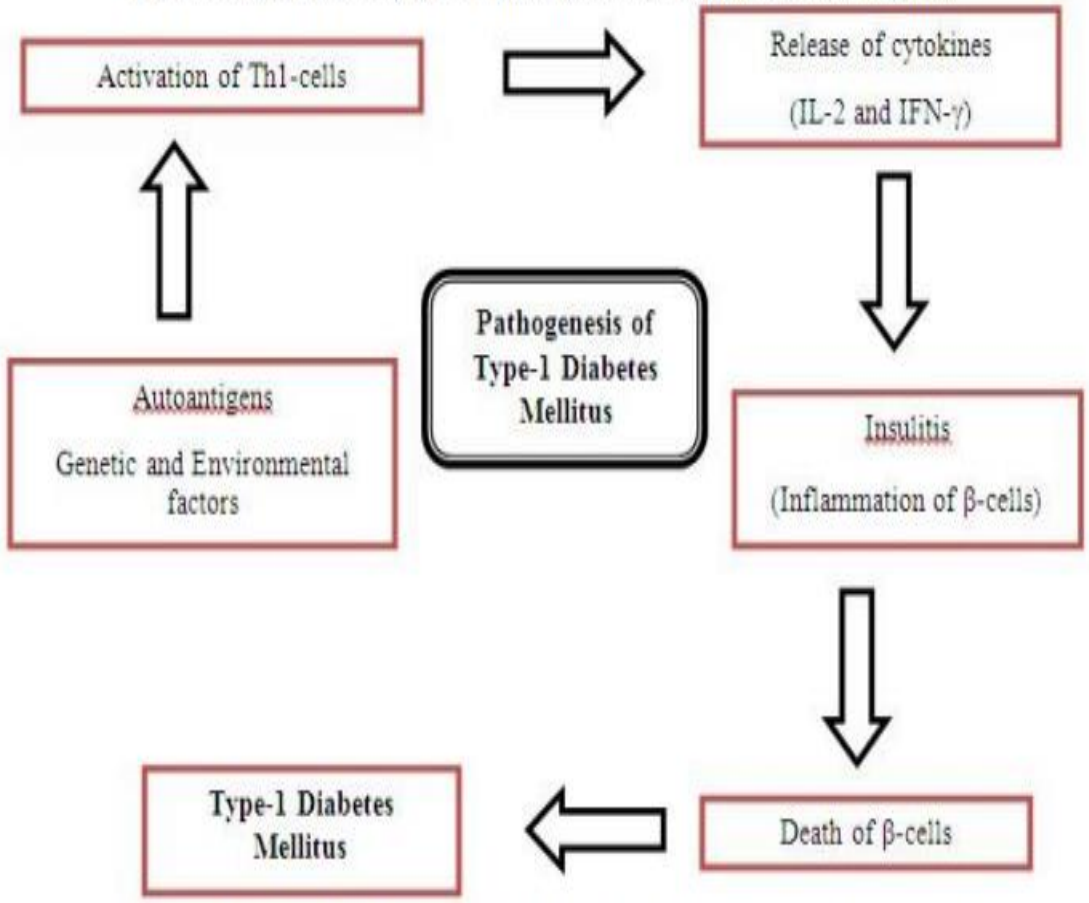
Pathophysiology of diabetes mellitus

- *The principal hormone that regulates the uptake of glucose from the blood into most cells of the body, especially liver, muscle, and adipose tissue is insulin.*
- *Hence its deficiency or the tactlessness of its receptors depicts a vital task in the entire type of diabetes mellitus. Beta cells (β-cells), found in the islets of Langerhans in the pancreas, release insulin into the blood in response to rising levels of blood glucose, typically after eating.*
- *About two third of the body's cells use insulin for glucose absorption from the blood for use as fuel, for conversion to other needed molecules, or for storage.*
- *Decreased insulin release from the beta cells and the breakdown of glycogen to glucose is an outcome of lower glucose levels.*

- *The hormone glucagon primarily controls this process, which acts in the converse manner to insulin.*
- *If the amount of insulin available is insufficient, if cells respond poorly to the effects of insulin (insulin insensitivity or insulin resistance), or if the insulin itself is defective, then glucose will not be absorbed properly by the body cells that require it, and it will not be stored appropriately in the liver and muscles.*
- *The net result is steadily elevated intensity of blood glucose, reduced protein synthesis, plus additional metabolic derangements, such as acidosis. while the glucose concentration in the blood vestiges elevated above time, the kidneys will achieve a portal of reabsorption, excretion in the urine (glycosuria).*

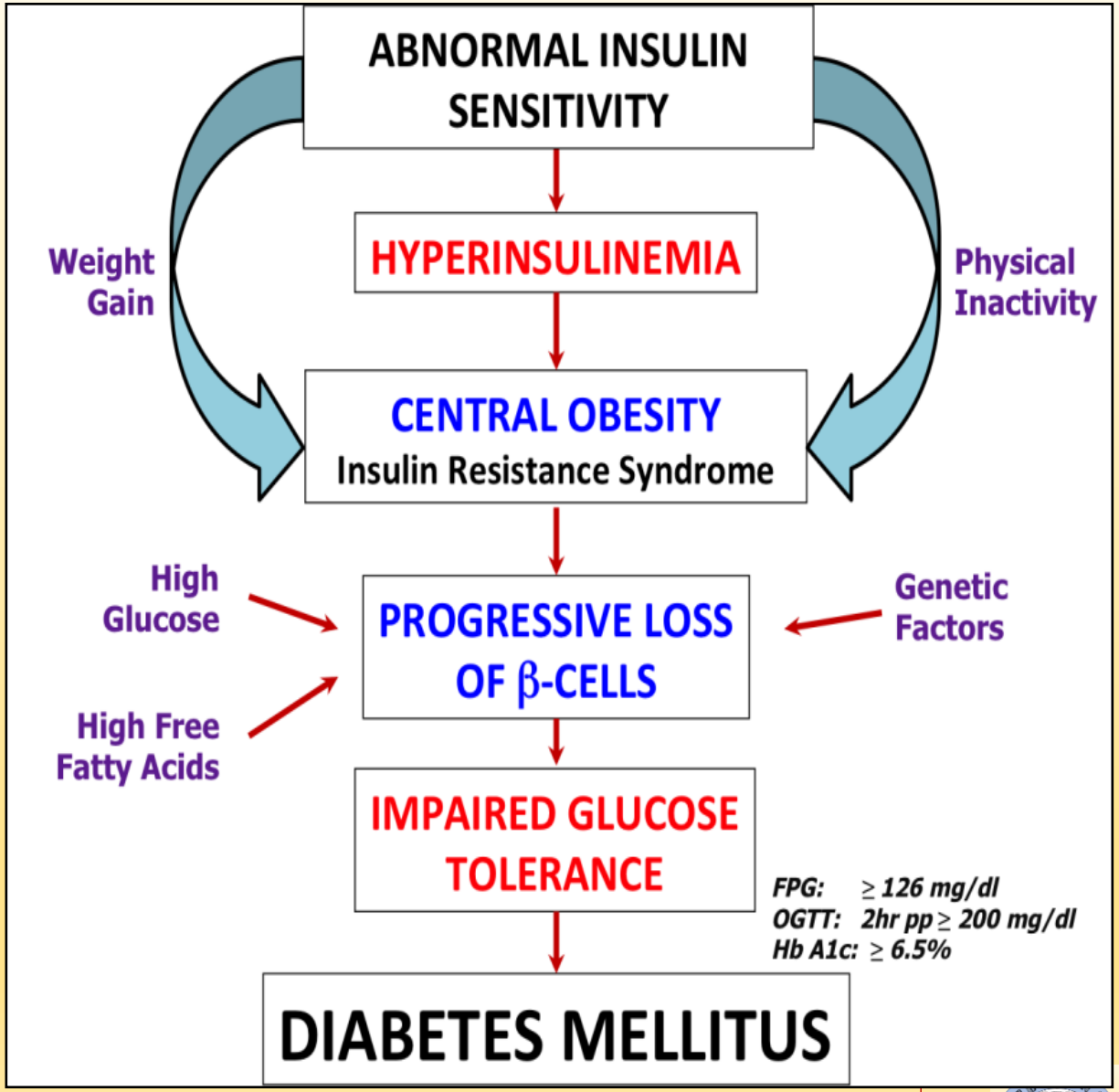
Pathophysiology of Type 1 diabetes mellitus

Fig 1. A schematic diagram for pathogenesis of Type-1 Diabetes Mellitus

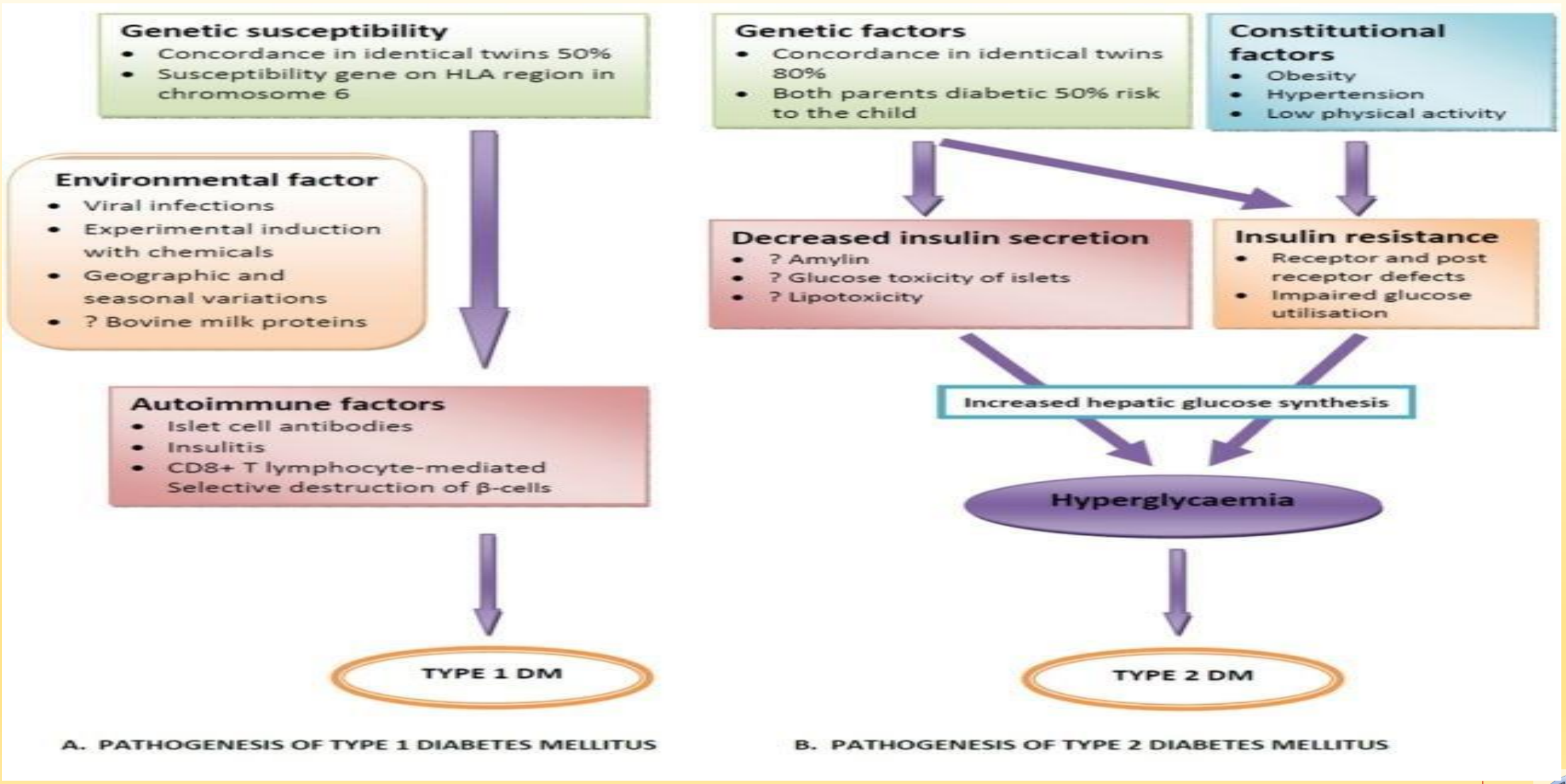


Abbreviations: Th1, T helper cells; IL-2, Interleukin-2; IFN-γ, Interferon-gamma.

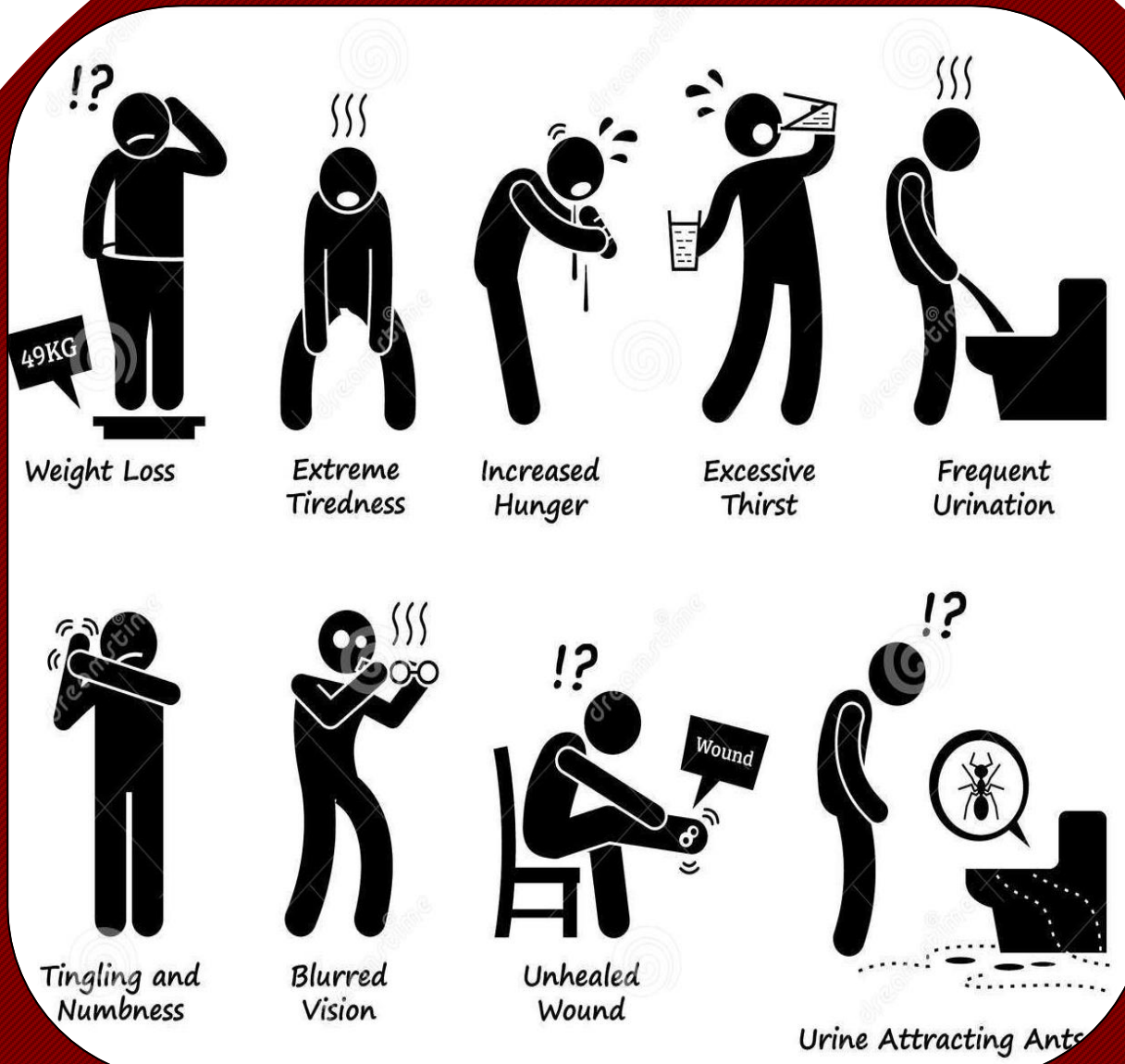
Pathophysiology of Type 2 diabetes mellitus



Pathophysiology of Type 1 & Type 2 diabetes mellitus



Symptoms of diabetes mellitus



Symptoms of diabetes mellitus

Hyperglycemia:

- **Hyperglycemia is the technical term for high blood glucose (blood sugar). High blood glucose happens when the body has too little insulin or when the body can't use insulin properly.**
- When insulin is not being produced or is ineffective, the formation of glycogen is decreased and the utilisation of glucose in the peripheral tissues is reduced.
- As a consequence, the glucose that enters the circulation from various sources is **removed more slowly** & hyperglycemia follows.
- This is further accentuated by gluconeogenesis.

Glycosuria:

- **Glycosuria is a term that defines the presence of reducing sugars in the urine, such as glucose, galactose, lactose, fructose, etc.**
- Normally kidneys absorb the sugar from any liquid passing through them, but with glycosuria, the kidneys don't absorb it all before the urine is released. Because the blood glucose level exceeds the renal threshold level i.e., 160 to 180 mg per 100 ml, so excess amount of glucose pass out through urine.

Fluid and electrolyte imbalance:

- An electrolyte imbalance occurs when there are too much or not enough of certain minerals in body. The loss of glucose in the urine represents a wastage of energy and entails an increased elimination of water and sodium.

Symptoms of diabetes mellitus

- ***Acidosis:***
- ***Acidosis is a process causing increased acidity in the blood and other body tissues***
- *With a deficiency of insulin, lipogenesis decreases and lipolysis is greatly increased, these effects being of both immediate and long-range consequences.*
- *The fatty acids released from adipose tissue or available by adsorption from the intestinal tract are oxidized by the liver to form ketone bodies including acetoacetic acid, B-hydroxybutyric acid and acetone.*
- *The liver utilises only limited quantities of ketones and releases them to circulation.*
- *In diabetes mellitus the ketones are produced at a rate that far exceeds the ability of tissues to utilise them and the concentration in blood is greatly increased.*
- *Acetone is excreted by the lungs and gives the characteristic fruity odour to breath.*
- *Acetoacetic acid and B-hydroxy butyric acid are excreted in the urine (ketonuria).*
- ***Being fairly strong organic acids these ketones combine with base so that the alkaline reserve is depleted and acidosis results.***

Symptoms of diabetes mellitus

Polyuria and Nocturia:

- **Polyuria has generally been defined as a urine output exceeding 3 L/day in adults and 2 L/m2 in children.**
- *In diabetes high blood glucose increases the osmolality of the glomerular filtrate and thus prevents the reabsorption of water as the filtrate passes down the renal tubules.*
- *In this way the volume of urine is markedly increased in diabetes and polyuria and nocturia (Excessive urination in night) occur.*

Polydipsia and Polyphagia:

- *Polydipsia is a medical name for the feeling of extreme thirstiness.*
- *Polyuria leads to loss of water and electrolytes which results in extreme thirst or polydipsia.*
- *Polyphagia, also called hyperphagia, is the medical term for a feeling of extreme, insatiable hunger.*
- *In diabetes mellitus patient feels excess hunger because glucose is lost in urine and tissues are starved of glucose.*

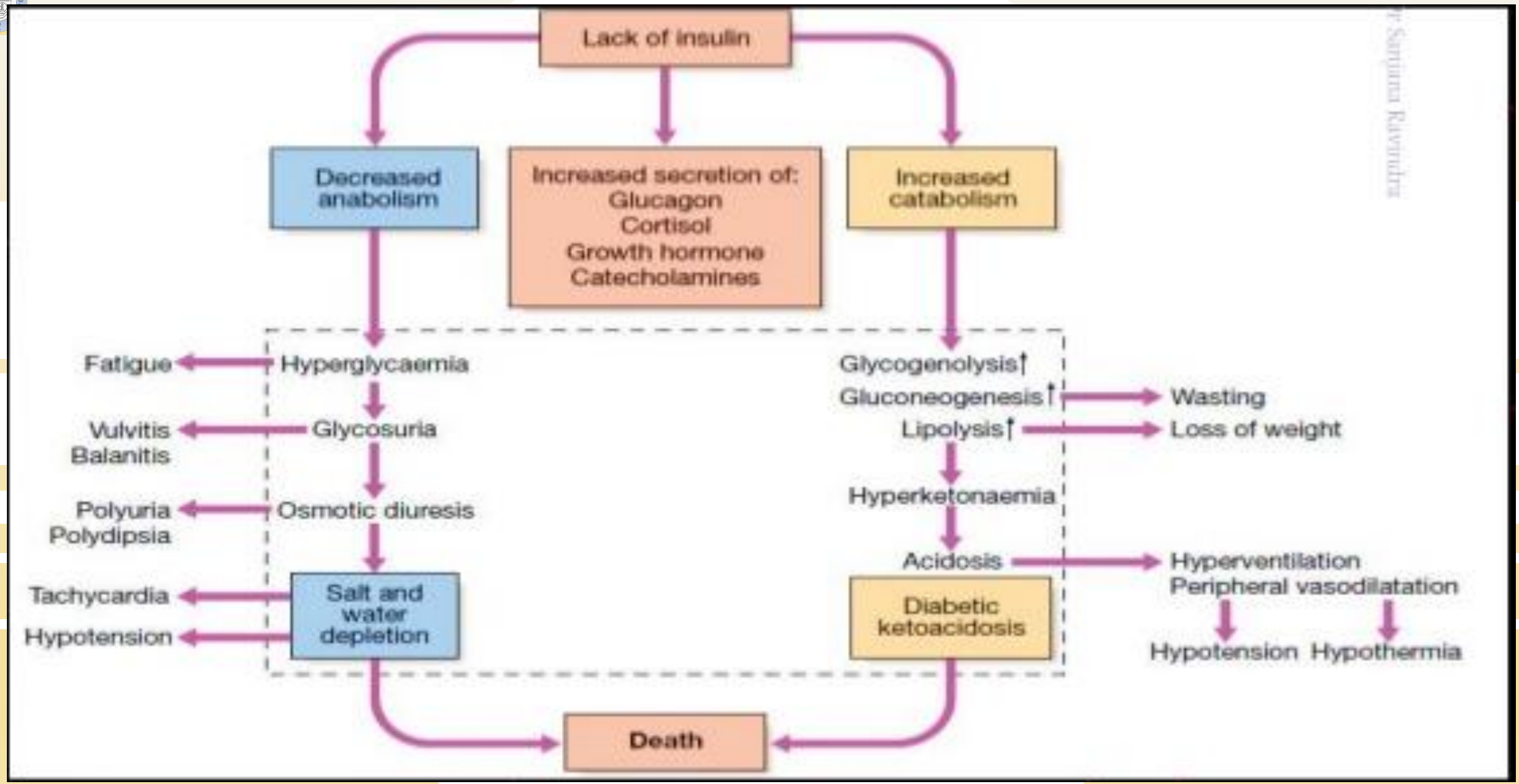
Symptoms of diabetes mellitus

Dehydration:

- **Dehydration is a condition caused by the loss of too much fluid from the body.**
- *In diabetes mellitus, as the blood glucose rises, the extracellular fluid becomes hypertonic and water leaves the cells.*
- *If the loss of water and electrolytes continue, depletion of extracellular fluid leads to the clinical features of severe dehydration.*

Fatigue & Loss of weight:

- **Fatigue is a lack of energy and motivation.**
- *In diabetes mellitus, Impaired utilization of carbohydrate results in a sense of fatigue and two compensatory mechanisms operate to provide alternative metabolic substrate.*
- *Both lead to loss of body tissue and wasting may occur inspite of a normal or even increased intake of food.*



Pathophysiological basis of the symptoms and signs of untreated or uncontrolled diabetes mellitus.

Diagnosis

Diagnosis of diabetes mellitus

Glycosuria:

- The present of an abnormal amount of sugar in the urine, is an evidence of diabetes until prove otherwise. It is necessary to observe the following procedure to detect early diabetes:
  1. Urine is voided just before the meal.
  2. Breakfast or lunch is taken with usual helpings of carbohydrate reach foods such as Bread, Chapattis, rice, fruits and sweets.
  3. Two or three hours after the meal urine is voided and examined for sugar.

Colour:	Approximate Sugar in-		
	Report:	Urine g% :	Blood mg%:
Green discolouration:	0 to trace	_	<200
Green precipitate:	+	0.25	200-250
Greenish-yellow precipate:	++	0.5	250-300
Yellowish-orange precipate:	+++	1.0	300-350
Brick red precipate:	++++	>2.0	>350

Diagnosis of diabetes mellitus

Ketonuria:

- The amount of ketone bodies normally execrated by healthy persons is not detected by routine methods.
- High amounts excreted can be detected in the urine by the Nitroprusside reaction which is conveniently carried out using Acetest tables or Ketostix paper sticks (Ames and Co).

Ketone bodies level in urine			
Urine value	Designation	Approximate serum concentration	
		mg/dl	mmol/dl
0	Negative	0.5-3.0	0.05-0.29
1+		5	0.5
2+	Ketonuria	7	0.7
3+		30	3
4+	Severe Ketonuria	-	-

Diagnosis of diabetes mellitus

Fasting Blood Sugar Test:

- Fasting blood sugar is a measurement of your blood sugar after not eating for 8-12 hours.
- This test is normally included with a CBC (complete blood chemistry) blood test. A CBC is a test often ordered by doctors when doing a complete health evaluation. Fasting blood sugars are evaluated as follows:

Fasting blood sugars after 8-12 without food:	
Normal blood sugar range:	between 60- 100 mg/dL
Pre -Diabetic range:	between 101- 126 mg /dL
Diabetic range:	more than 126 mg/dL on two different blood test occasions

Diagnosis of diabetes mellitus

Oral Glucose Tolerance Test (OGTT):

- An oral glucose tolerance test is used to test the body's ability to metabolize a specific amount of glucose, clear it from the blood stream and return blood sugar levels to normal.
- The patient is asked to eat normally for several days before the test.
- No food should be taken for 8-10 hours before the test, and there is no eating during the test.
- To begin the test, a fasting blood sugar is taken. Then the patient drinks a sweet liquid which contains approximately 75 grams of sugar in the form of glucose.
- The drink must be finished in 5 minutes.
- After sitting quietly for one to two hours, the patient's blood sugar is re-tested and evaluated as follows on this blood sugar level chart:

1999 WHO Diabetes criteria - Interpretation of Oral Glucose Tolerance Test								
Glucose levels	NORMAL		Impaired Fasting Glycaemia (IFG)		Impaired Glucose Tolerance (IGT)		Diabetes Mellitus (DM)	
Venous Plasma	Fasting	2hrs	Fasting	2hrs	Fasting	2hrs	Fasting	2hrs
(mmol/L)	<6.1	<7.8	≥ 6.1 & <7.0	<7.8	<7.0	≥7.8	≥7.0	≥11.1
(mg/dL)	<110	<140	≥110 & <126	<140	<126	≥140	≥126	≥200

Diagnosis of diabetes mellitus

Gestational Diabetes Screening:

- Gestational diabetes (GDM) is a condition in which blood sugar control gets worse during a woman's pregnancy.
- The test for GDM is generally given between the 24th and 28th week of pregnancy.
- The screening test most commonly used in the United States is an initial 50-gram 1-hour glucose challenge test (GCT).
- If the result on the GCT is abnormal (greater than 140 mg/dL after one hour), the patient will be given a 100-gram 3-hour oral glucose tolerance test (OGTT). Two or more abnormal values on the OGTT are considered a diagnosis of GDM.

Blood values for a 100-gram gestational oral glucose tolerance test:	Measurements indicative of diabetic range:
Fasting	95 mg/dL or higher
One hour measurement:	180 mg/dL or higher
Two hour measurement:	155 mg/dL or higher
Three hour measurement:	140 mg/dL or higher

Diagnosis of diabetes mellitus

Glycosylated Hemoglobin or Hemoglobin A1C (HbA1C):

- This test reflects average blood sugar levels over the previous 2-3 months.
- The formula use to calculate the average blood glucose level from the HbA1C test is as follows:
- HbA1C level x 33.3 – 86 = average blood glucose level for the past 90 days. HbA1C can be helpful to track diabetic control over time.
  - Example: If your HbA1c level is 5.9, the formula would be (5.9 x 33.3)-86 and would tell you that your average blood sugar was 110 over the past 90 days or so.

HbA_1c Test Results:	
Normal range:	less than 5.7%
Pre-diabetic range:	between 5.7% to 6.4%
Diabetic range:	greater than 6.5%

A1C %	Estimated Average Glucose (eAG) mg/dL
7	154
8	183
9	212
10	240

FPG tests vs HbA1c tests

- FPG tests and HbA1c tests differ in their preparation steps and what they measure.
- Advantages of HbA1c test are-
  a. HbA1c reflects average plasma glucose over the previous eight to 12 weeks.
  b. It can be performed at any time of the day and does not require any special preparation such as fasting.
  c. FPG is more sensitive to illnesses or acute stress than an HbA1c test.
- These properties have made it the preferred test for assessing glycaemic control in people with diabetes.

Diagnosis of diabetes mellitus

The C-Peptide ELISA Assay:

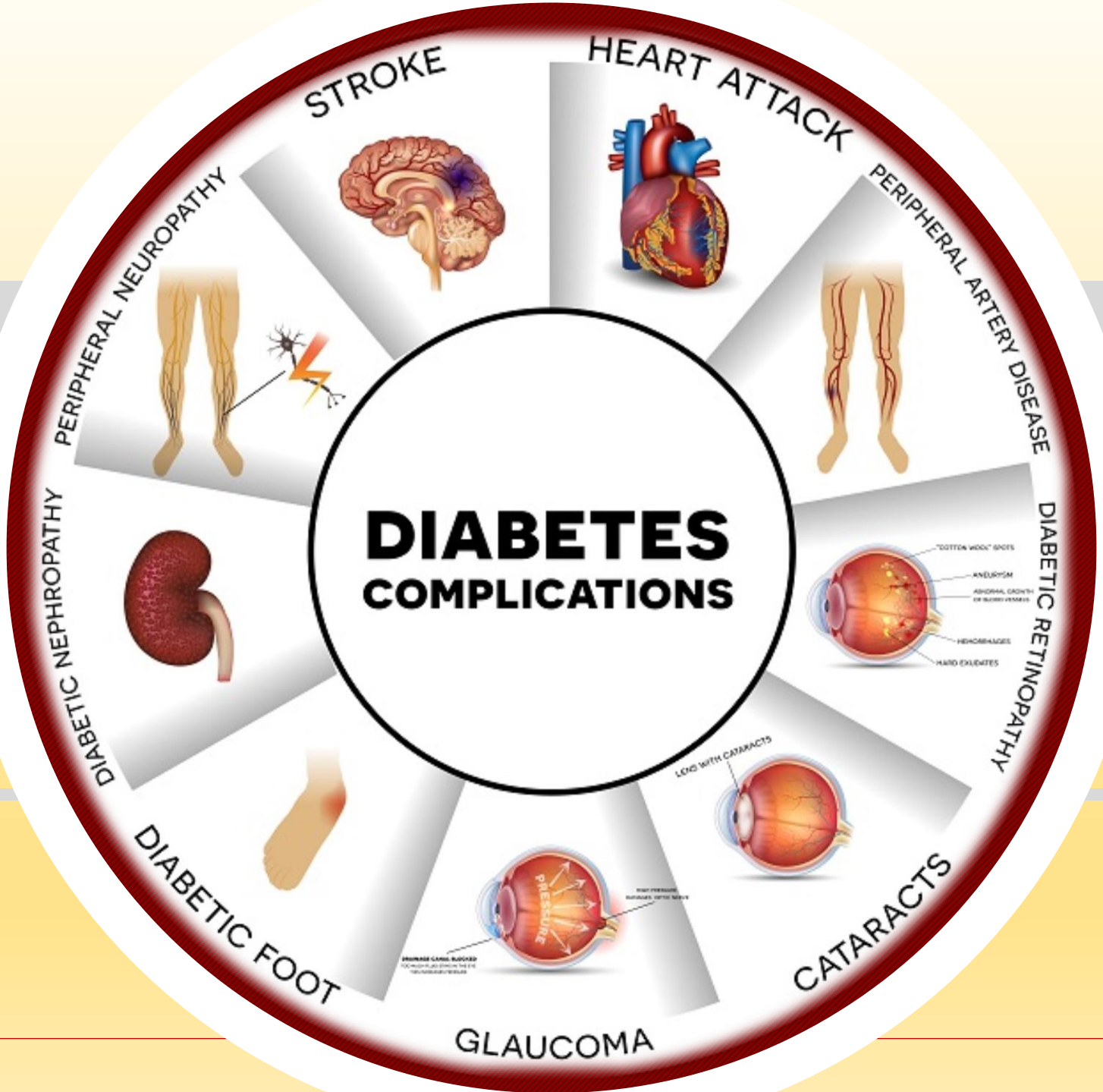
- The C-Peptide ELISA (enzyme-linked immunosorbent assay) kit is intended for the quantitative determination of human C-peptide levels in human serum.
- The C-Peptide ELISA kit is a solid phase direct sandwich ELISA method.
- The C-Peptide ELISA kit is intended for the quantitative determination of human C-peptide levels in human serum.

FPG tests vs HbA1c tests

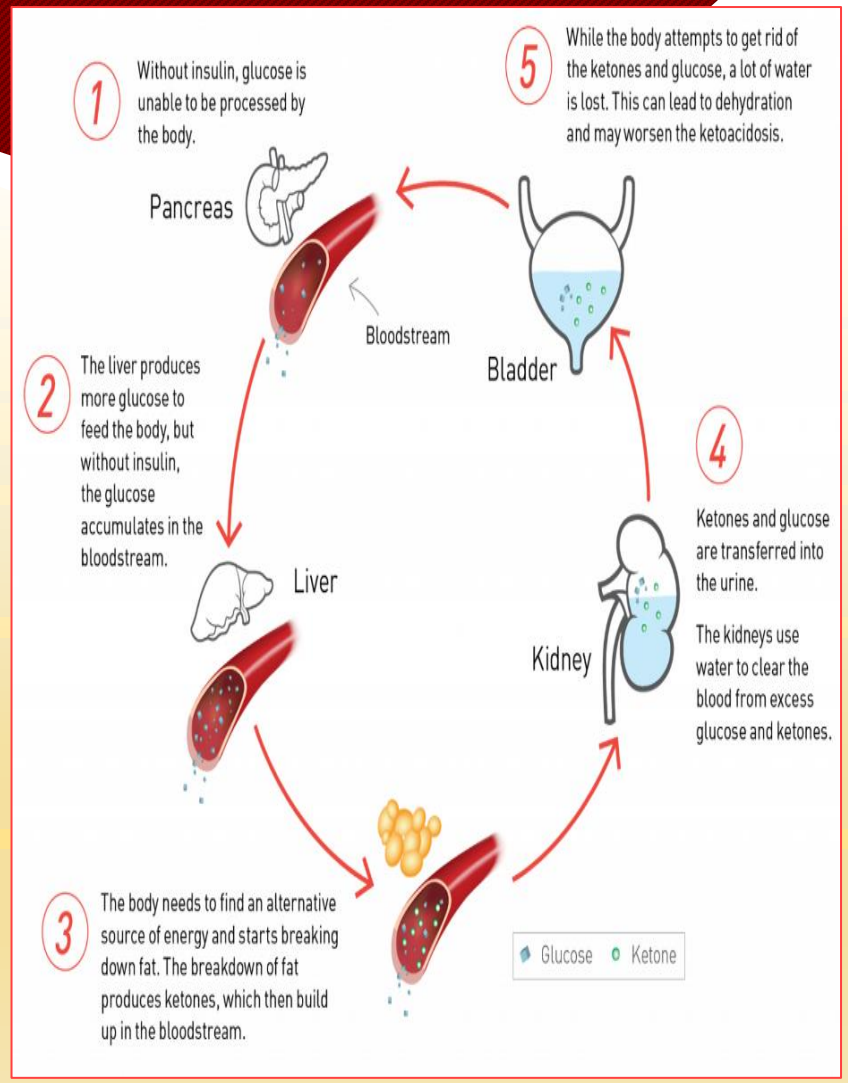
- Expected Values It is recommended that each laboratory establish its own range of normal C-Peptide level. The normal range of values observed with C-Peptide ELISA kit with normal adult males and females are as follows:

	n	Mean±2 SD
Adult (Serum)	30	0.5–3.0 ng/ml

- C-Peptide levels have been shown to increase after intake of glucose by 100–600 %.


DIABETES
COMPLICATIONS
STROKE
HEART ATTACK
PERIPHERAL ARTERY DISEASE
DIABETIC RETINOPATHY
CATARACTS
GLAUCOMA
DIABETIC FOOT
DIABETIC NEPHROPATHY
PERIPHERAL NEUROPATHY

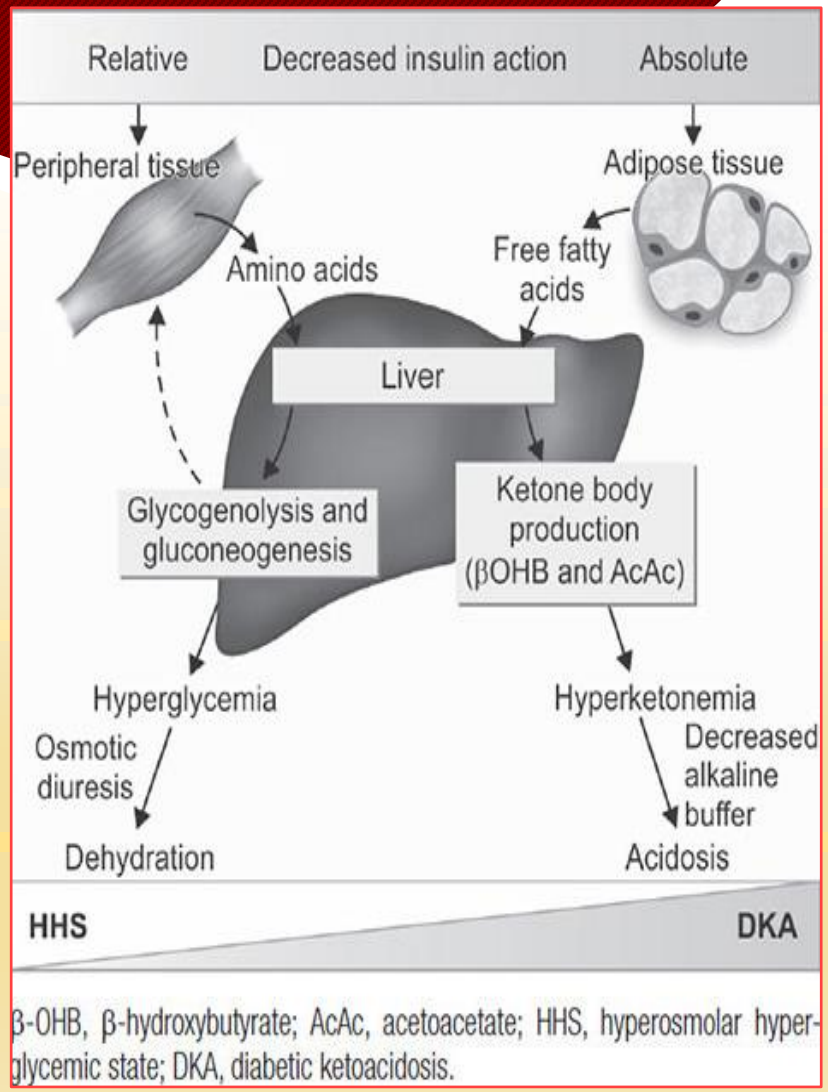
Acute Complications



❑ Diabetic ketoacidosis:

- ❑ *Diabetic ketoacidosis (DKA) is an acute and dangerous complication that is always a medical emergency.*
- ❑ *In Diabetes Mellitus low insulin levels cause the liver to turn to ketone for fuel (i.e., ketosis); ketone bodies are intermediate substrates in that metabolic sequence.*
- ❑ *This is normal when periodic, but can become a serious problem if sustained.*
- ❑ *Elevated levels of ketone bodies in the blood decrease the blood's pH, leading to DKA.*
- ❑ *Possible complications of diabetic ketoacidosis are-*
  - ❑ *Low levels of potassium (hypokalemia)*
  - ❑ *Swelling inside the brain (cerebral edema)*
  - ❑ *Fluid inside the lungs (pulmonary edema)*
  - ❑ *Damage to kidney or other organs from fluid loss.*

Acute Complications

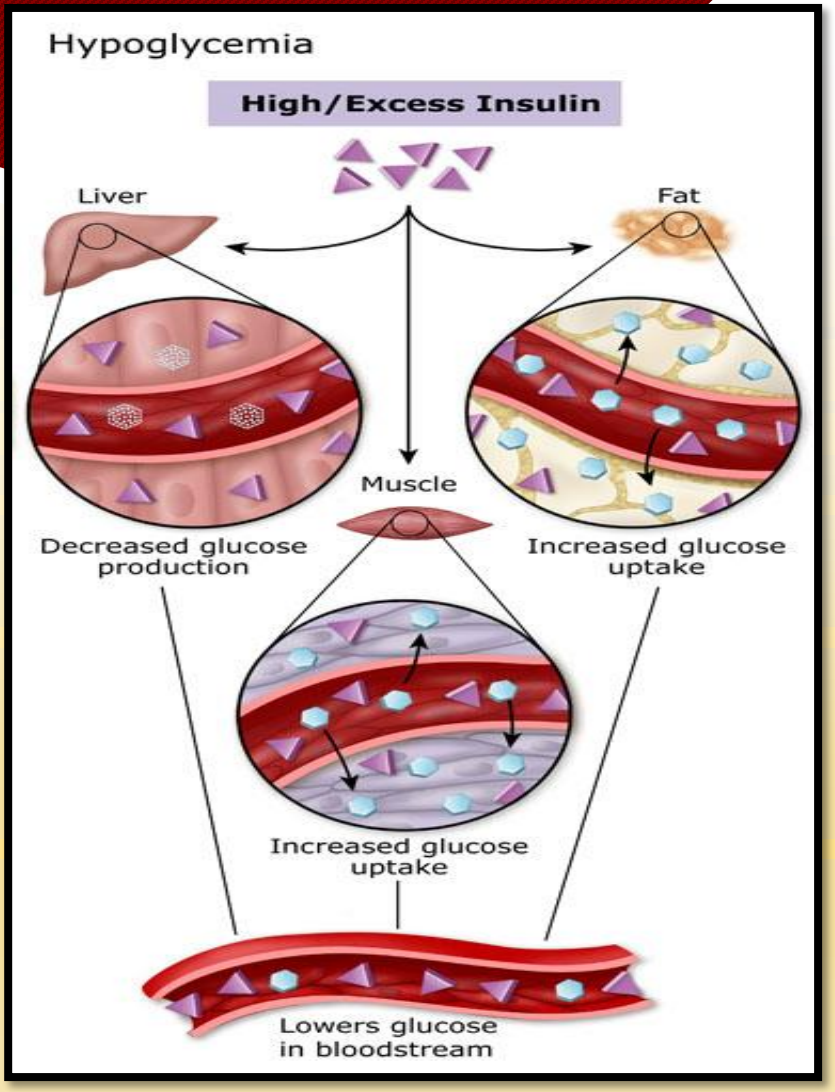


β-OHB, β-hydroxybutyrate; AcAc, acetoacetate; HHS, hyperosmolar hyperglycemic state; DKA, diabetic ketoacidosis.

Hyperglycemia hyperosmolar state:

- *Hyperglycemia is the technical term for high blood glucose (blood sugar).*
- *A person with very high (usually considered to be above 300 mg/dl (16 mmol/L)) blood glucose levels, water is osmotically drawn out of cells into the blood and the kidneys eventually begin to dump glucose into the urine.*
- *This results in loss of water and an increase in blood osmolarity.*
- *If fluid is not replaced (by mouth or intravenously), the osmotic effect of high glucose levels, combined with the loss of water, will eventually lead to dehydration.*
- *The body's cells become progressively dehydrated as water is taken from them and excreted. Electrolyte imbalances are also common and are always dangerous.*

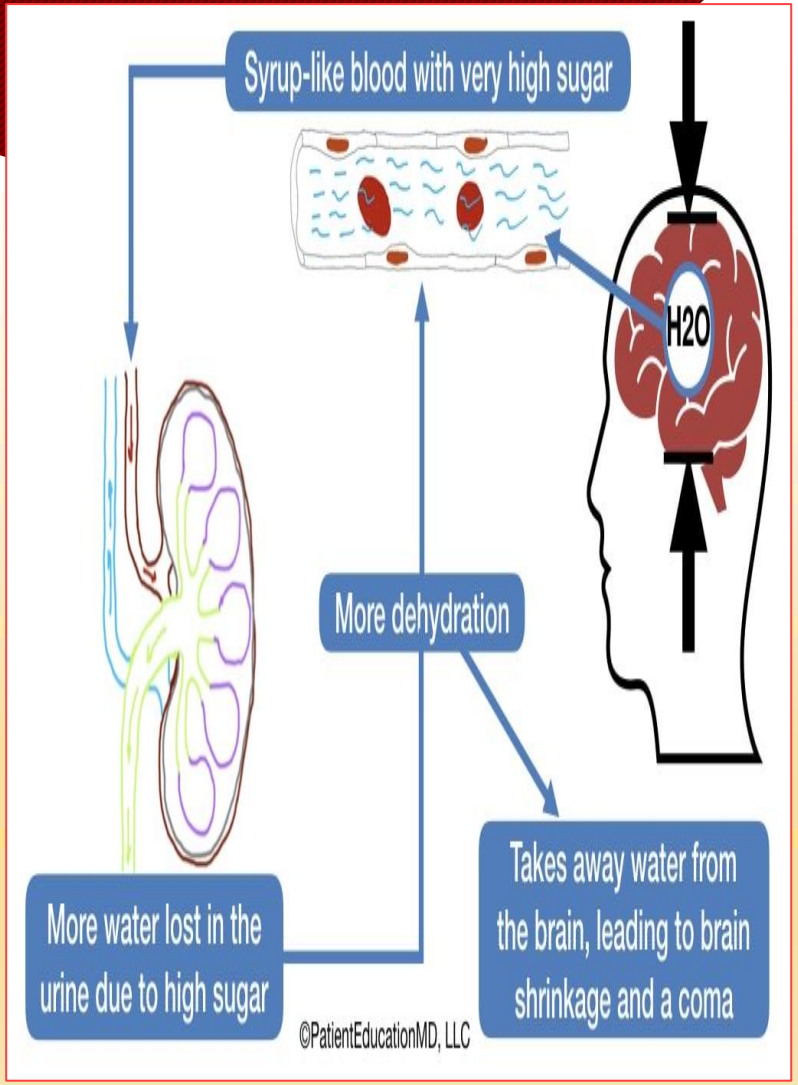
Acute Complications



Hypoglycemia

- *Hypoglycemia, or abnormally low blood glucose, is an acute complication of several diabetes treatments.*
- *The patient may become agitated, sweaty, weak, and have many symptoms of sympathetic activation of the autonomic nervous system resulting in feelings akin to dread and immobilized panic.*
- *In patients with diabetes, this may be caused by several factors, such as too much or incorrectly timed insulin, too much or incorrectly timed exercise (exercise decreases insulin requirements) or not enough food (specifically glucose containing carbohydrates).*

Acute Complications



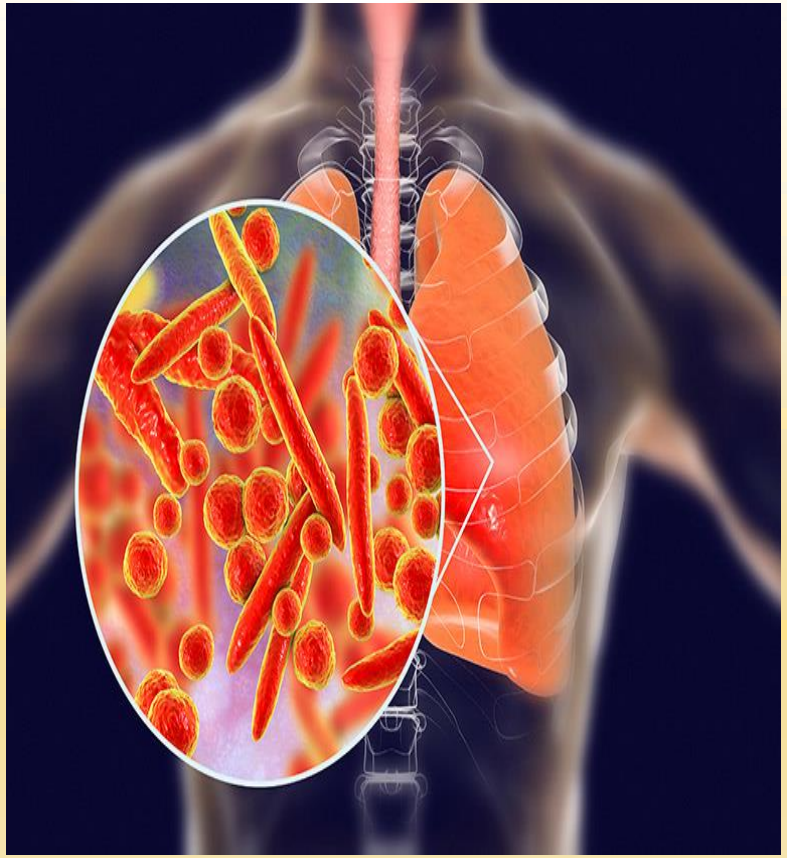
❑ Diabetic coma:

❑ *Diabetic coma is a medical emergency in which a person with diabetes mellitus is comatose (unconscious).*

❑ *Diabetic coma is caused by -*

1. *Severe diabetic hypoglycemia.*
2. *Diabetic ketoacidosis advanced enough to result in unconsciousness from a combination of severe hyperglycemia, dehydration and shock, and exhaustion.*
3. *Hyperosmolar nonketotic coma in which extreme hyperglycemia and dehydration alone are sufficient to cause unconsciousness.*

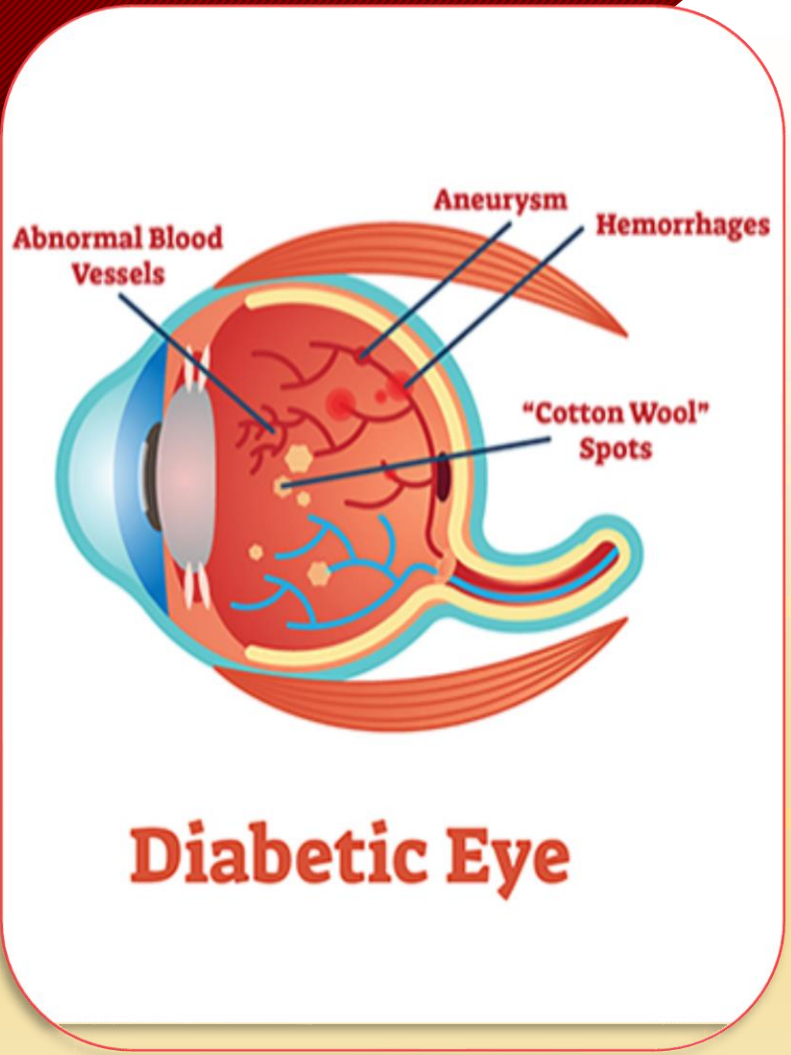
Acute Complications



Respiratory infections:

- Respiratory infections are considered one of the major severe infections associated with diabetes.
- The immune response is impaired in individuals with diabetes mellitus.
- Hyperglycemia both reduces the function of immune cells and increases inflammation.
- The vascular effects of diabetes also tend to alter lung function, all of which leads to an increase in susceptibility to respiratory infections such as pneumonia and influenza among individuals with diabetes.

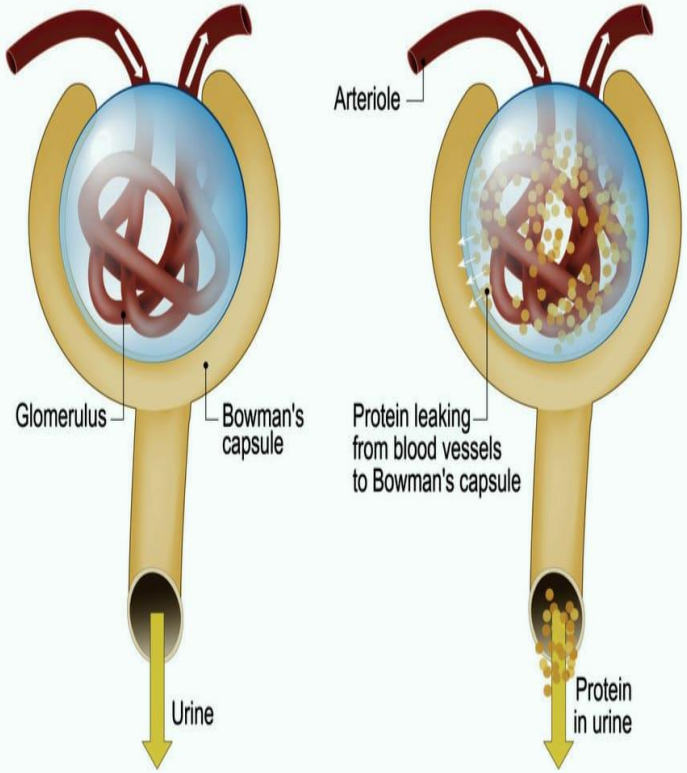
Chronic Complications



❑ Diabetic retinopathy:

- ❑ *Diabetic retinopathy is an eye condition that can cause vision loss and blindness in people who have diabetes. It affects blood vessels in the retina (the light-sensitive layer of tissue in the back of eye).*
- ❑ *Etiology;-*
  - ❑ *It is caused by small blood vessel damage to the back layer of the eye, the retina, leading to progressive loss of vision, even blindness.*
- ❑ *Symptoms:-*
  - ❑ *Usually the patient complains of blurred vision, although other visual symptoms may also be present.*

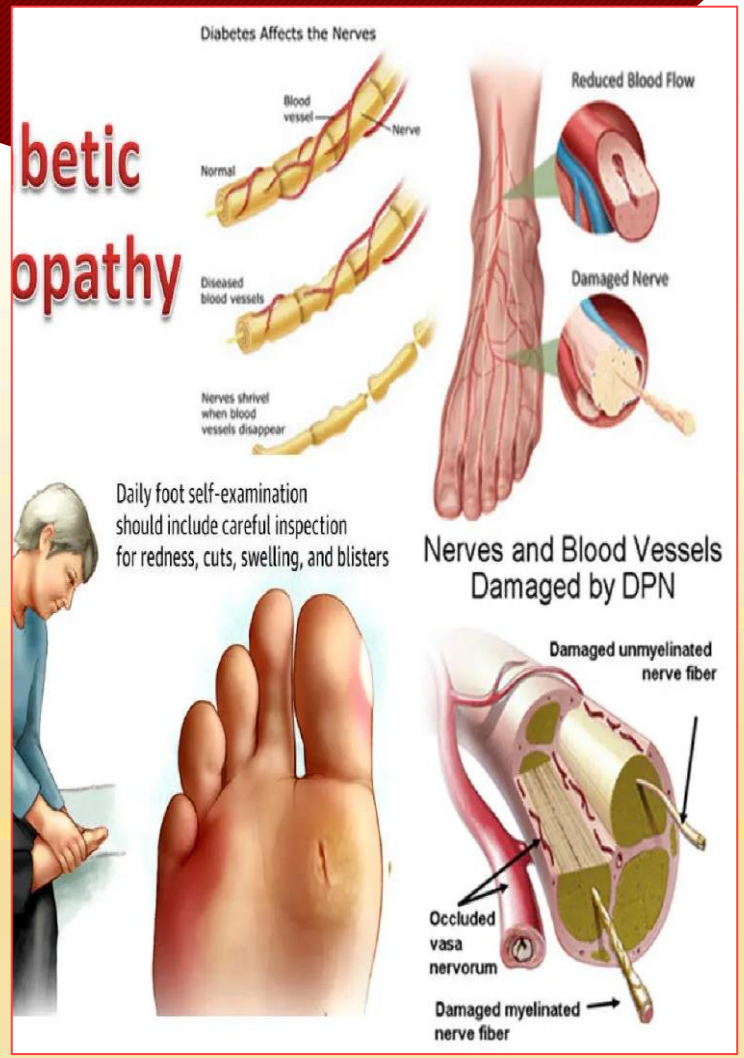
Chronic Complications



Nephropathy (kidney disease)

- *Nephropathy is the deterioration of kidney function.*
- *Etiology:*
  - *Hypertension, or high blood pressure, is a complication of diabetes that is the most common cause of diabetic nephropathy.*
- *Symptoms:*
  - *Patients usually have no symptoms early on, but as the disease progresses, they may feel tired, become anemic, not think clearly, worsening blood pressure control. protein in the urine and even develop dangerous electrolyte imbalances.*

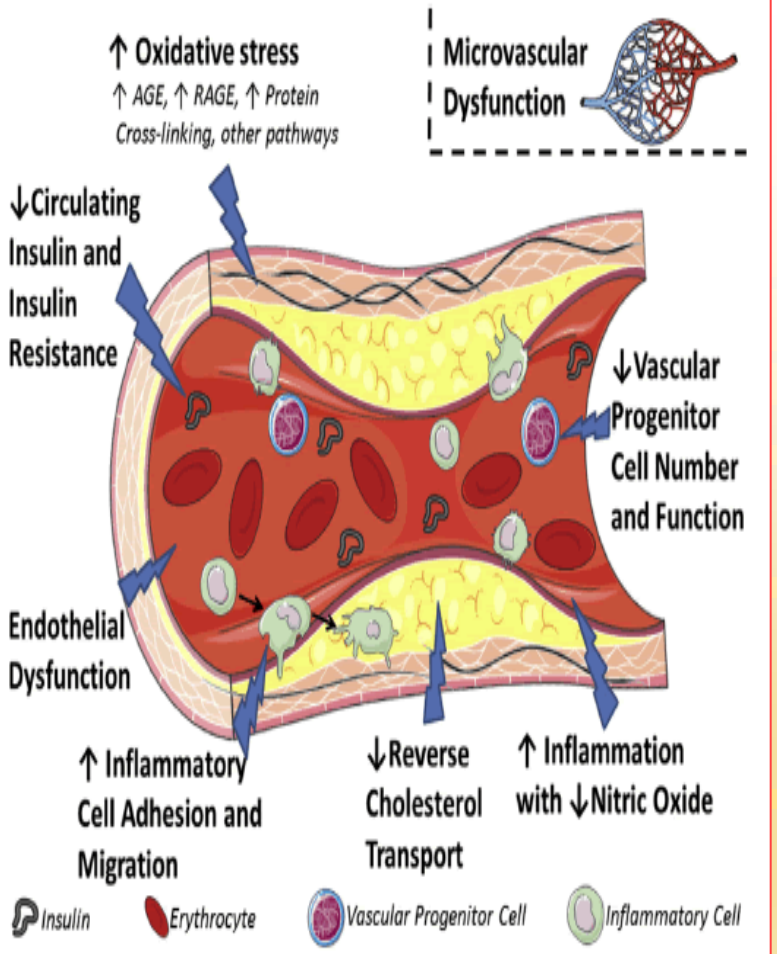
Chronic Complications



❑ Neuropathy (nerve disease):

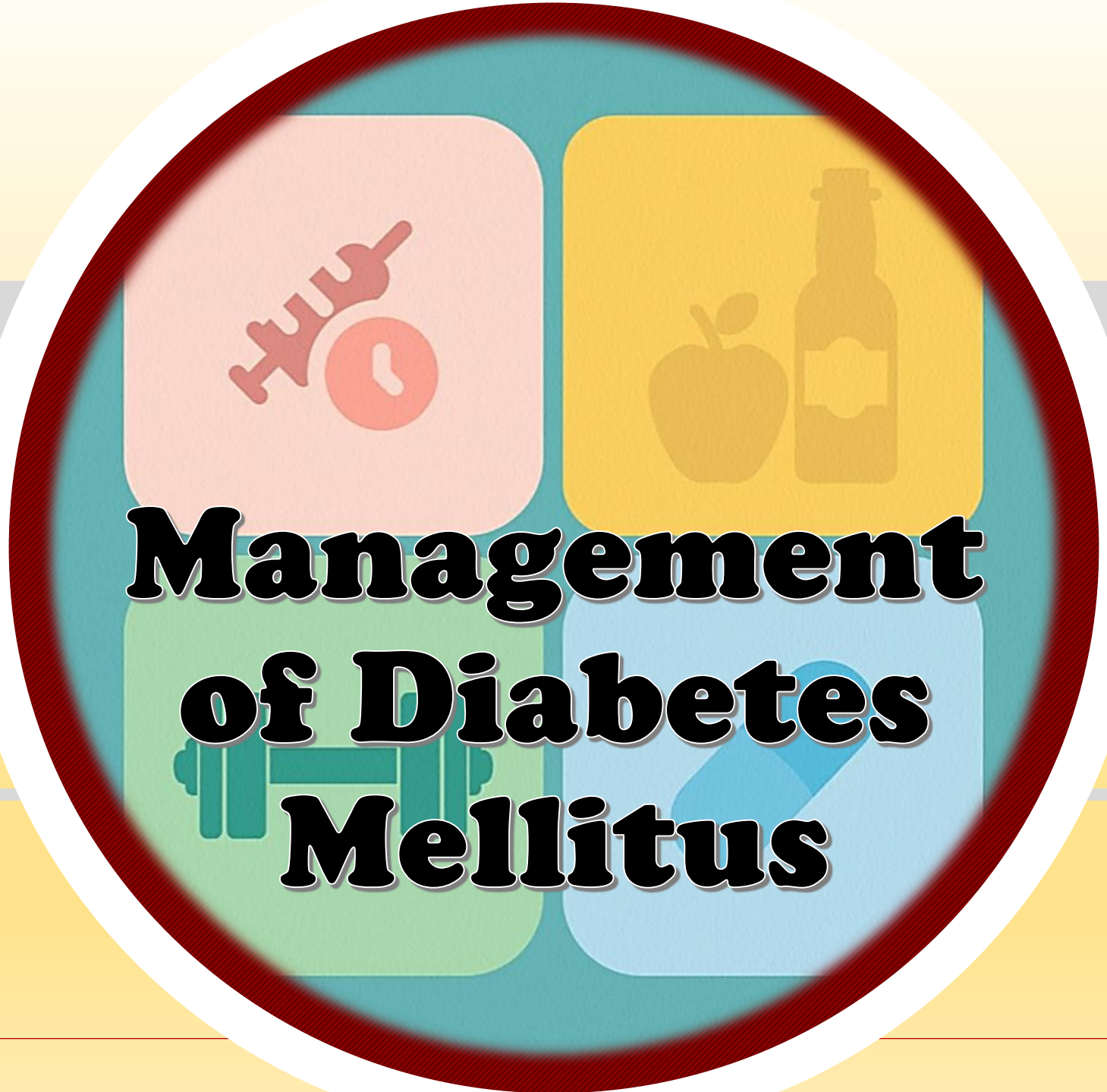
- ❑ *Diabetic neuropathy is nerve damage that can occur in people with diabetes*
- ❑ *Etiology:*
  - ❑ *Diabetes causes nerve damage through different mechanisms, including direct damage by the hyperglycemia and decreased blood flow to nerves by damaging small blood vessels.*
  - ❑ *This nerve damage can lead to sensory loss, damage to limbs, and impotence in diabetic men. It is the most common complication of diabetes.*
- ❑ *Symptoms:*
  - *Numbness or reduced ability to feel pain or temperature changes.*
  - *Tingling or burning feeling.*
  - *Sharp pains or cramps.*
  - *Muscle weakness.*
  - *Extreme sensitivity to touch — for some people, even a bedsheet's weight can be painful.*
  - *Serious foot problems, such as ulcers, infections, and bone and joint damage.*

Chronic Complications



Cardiovascular disease

- Diabetes also can cause cardiomyopathy, characterised by impaired left ventricular diastolic function and congestive heart failure.
- Etiology:
  - Hyperglycemia damages blood vessels through a process called "atherosclerosis", or clogging of arteries. This narrowing of arteries can lead to decreased blood flow to heart muscle (causing a heart attack), or to brain (leading to stroke), or to extremities (leading to pain and decreased healing of infections).
- Symptoms:
  - The symptoms of these different conditions are varied: ranging from chest pain to leg pain, to confusion and paralysis.


Management
of Diabetes
Mellitus

Objectives:

- ✓ To improve blood glucose and lipid level.
- ✓ To promote consistence day to day intake for people with insulin dependent diabetes & weight management for people with non insulin dependent type.
- ✓ To encourage healthy eating habits

Management of Diabetes Mellitus:

A. Medical Treatment

B. Nutrition Therapy

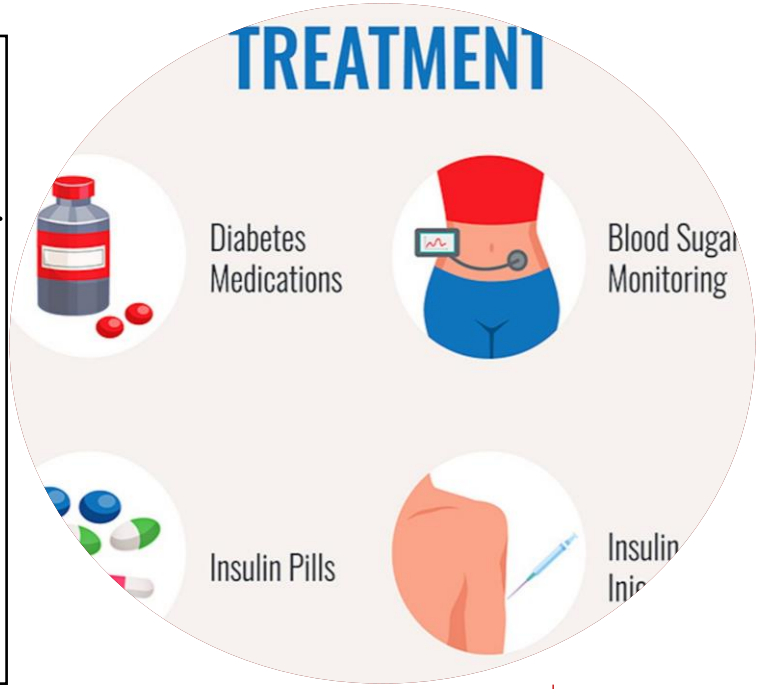
C. Life-style Modification

Medical Treatment of Diabetes Mellitus

Medical Treatment of Diabetes Mellitus

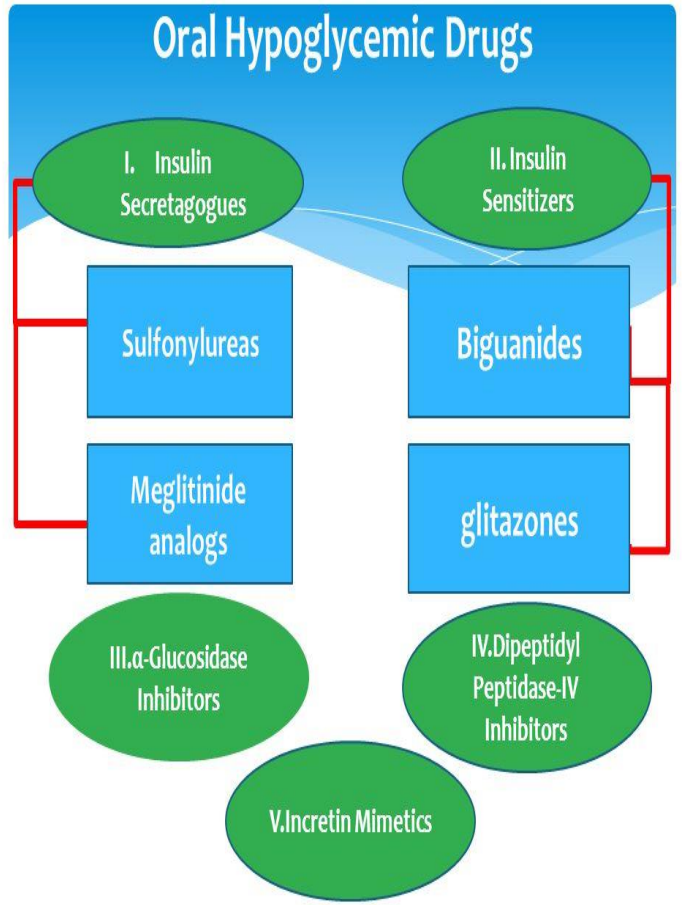
- *The goal for diabetes management is*
  - *to avoid or minimize chronic diabetic complications,*
  - *to avoid acute problems of hyperglycemia or hypoglycemia, blindness, heart disease and limb amputation.*

- *Patients with type I diabetes mellitus require direct injection of insulin as their bodies cannot produce enough (or even any) insulin.*
- *For type II diabetics, diabetic management consists of a combination of diet, exercise, and weight loss, in any achievable combination depending on the patient.*
- *Patients who have poor diabetic control after lifestyle modifications are typically placed on oral hypoglycemics. Some type II diabetics fail to respond to these and must proceed to insulin therapy*



The Role of Glucose-lowering Agents in Management of Diabetes Mellitus: Oral Hypoglycemic Drugs

- *Pharmacological or Medical treatment of diabetes mellitus is indicated when fasting glucose level exceeds 1600mg/L.*
- *The oral glucose-lowering drugs are used for management of type II diabetes mellitus. Conventionally, oral therapy is indicated in any type II diabetic in whom diet and exercise fail to achieve acceptable glycaemic control.*
- *These oral hypoglycaemic agents are discussed here below:*



Oral Hypoglycemic Drugs:

- ***Sulphonylureas:*** *These agents reduce blood glucose by increasing insulin secretion from pancreatic β-cells in patients with residual β-cell function.*
  - *They include chlorpropamide (Diabinese), glyburide (DiaBeta, Micronase, PresTab, or Glynase), glimepiride (Amaryl).*
- *They all cause mild hypoglycaemia but severe hypoglycaemia is less common*

- ***Biguanides:*** *These agents increase the sensitivity of insulin by decreasing hepatic gluconeogenesis (primary effect), increasing skeletal muscle glucose uptake, reducing plasma triglycerides and LDL-Cholesterol levels and increasing peripheral insulin sensitivity (secondary effect).*
  - *They include metformin (phenformin)*
- *They do not increase insulin levels or cause weight gain. Taken alone, they do not cause hypoglycemia.*

Oral Hypoglycemic Drugs:

- *α-Glucosidase Inhibitors (α-Gis):* They inhibit the action of α-glucosidase, the enzyme responsible for digesting carbohydrates, in the intestine, thus delaying and attenuating postprandial blood glucose peaks.
  - They include Acarbose (Precose) and Miglitol (Glyset).
- Their major side effects are gas, bloating and diarrhoea.

- *Thiazolidinediones:* Thiazolidinediones are a unique drug class of "insulin sensitizers" that promote skeletal muscle glucose uptake. They improve insulin sensitivity in muscles and in the liver, decreasing plasma triglyceride levels
  - They include such drugs as Troglitazone, rosiglitazone and pioglitazone.
- They increase weight and an increase in LDL-cholesterol levels. They are very expensive agents.

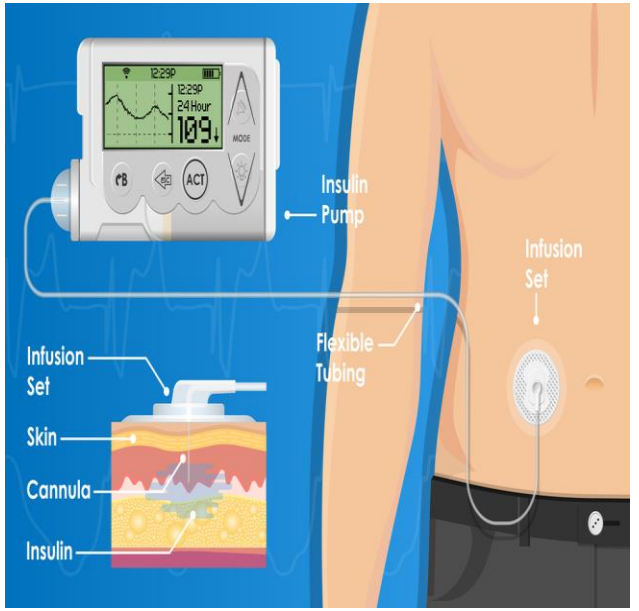
- *Meglitinides:* These agents are short-acting insulin secretagogues. They act on the ATP dependent potassium channels in pancreatic β-cells, allowing opening of calcium channels and increased insulin release.
  - They include the drug repaglinide (Prandin).
- They all cause mild hypoglycaemia but severe hypoglycaemia is less common.

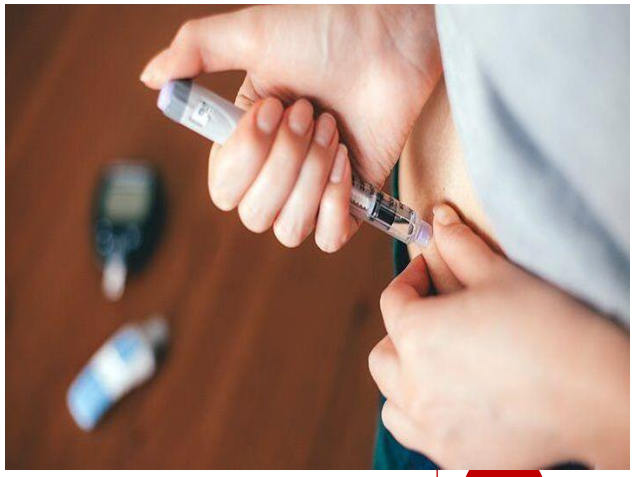
Summary

Medication	Mechanism of Action	Side Effects	Contraindications
Biguanides Metformin	Reduce gluconeogenesis, increase glucose uutilisation	Lactic acidosis, anorexia, Vit B12 deficiency, nausea, diarrhoea, GI dyscomfort	Hepatic or renal impairment, alcoholism, advanced age
Sulphonyl ureas Glibenclamide glimepride Glipizide Gliclazide	Stimulates release of endogenous insulin	Significant hypoglycaemia, nausea, GI dyscomfort	Hepatic or renal impairement
Thiazolidinediones	Increase peripheral	Increased TG,	Liver disease
Rosiglitazone Pioglitazone	insulin sensitivity, reduce gluconeogenesis	weight gain, hepatotoxicity, anemia	Congestive heart failure
Meglitinides Repaglinide	Stimulate release of endogenous insulin	Less frequent hypoglycemia	Hypersensitivity Diabetid ketoacidosis
Alpha glucosidase inhibitors Acarbose	Decrease the absorption of carbohydrates	Flatulence, abdominal cramping, diarrhoea	Hypersensitivity, DKA, IBD

The Role of Glucose-lowering Agents in Management of Diabetes Mellitus: Insulin Therapy

- *Insulin therapy replaces the insulin the body would normally make. People with type 1 diabetes must take insulin every day.*
- *People with type 2 diabetes need to take insulin when other treatments and medicines fail to control blood sugar levels.*
- *Insulin doses are given in two main ways:*
  - *Basal dose - provides a steady amount of insulin delivered all day and night. This helps maintain blood glucose levels by controlling how much glucose the liver releases (mainly at night when the time between meals is longer).*
  - *Bolus dose - provides a dose of insulin at meals to help move absorbed sugar from the blood into muscle and fat. Bolus doses can also help correct blood sugar when it gets too high. Bolus doses are also called nutritional or meal-time doses.*





Insulin Therapy:

❑ *Below are the different types of insulin:*

1. *Rapid-acting or fast-acting insulin starts working within 15 minutes, peaks in 1 hour, and lasts for 4 hours. It is taken right before or just after meals and snacks. It is often used with longer-acting insulin.*
2. *Regular or short-acting insulin reaches the bloodstream 30 minutes after use, peaks within 2 to 3 hours, and lasts 3 to 6 hours. This is taken a half-hour before meals and snacks. It is often used with longer-acting insulin.*
3. *Intermediate-acting insulin starts working within 2 to 4 hours, peaks in 4 to 12 hours, and lasts 12 to 18 hours. This is taken mostly either twice a day or once at bedtime.*
4. *Long-acting insulin starts to work a few hours after injection and works for about 24 hours, sometimes longer. It helps control glucose throughout the day. It is often combined with rapid- or short-acting insulin as needed.*
5. *Premixed or mixed insulin is a combination of 2 different types of insulin. It has both a basal and bolus dose to control glucose after meals and throughout the day.*
6. *Inhaled insulin is a rapid-acting breathable insulin powder that starts working within 15 minutes of use. It is used just before meals.*

Insulin Therapy:

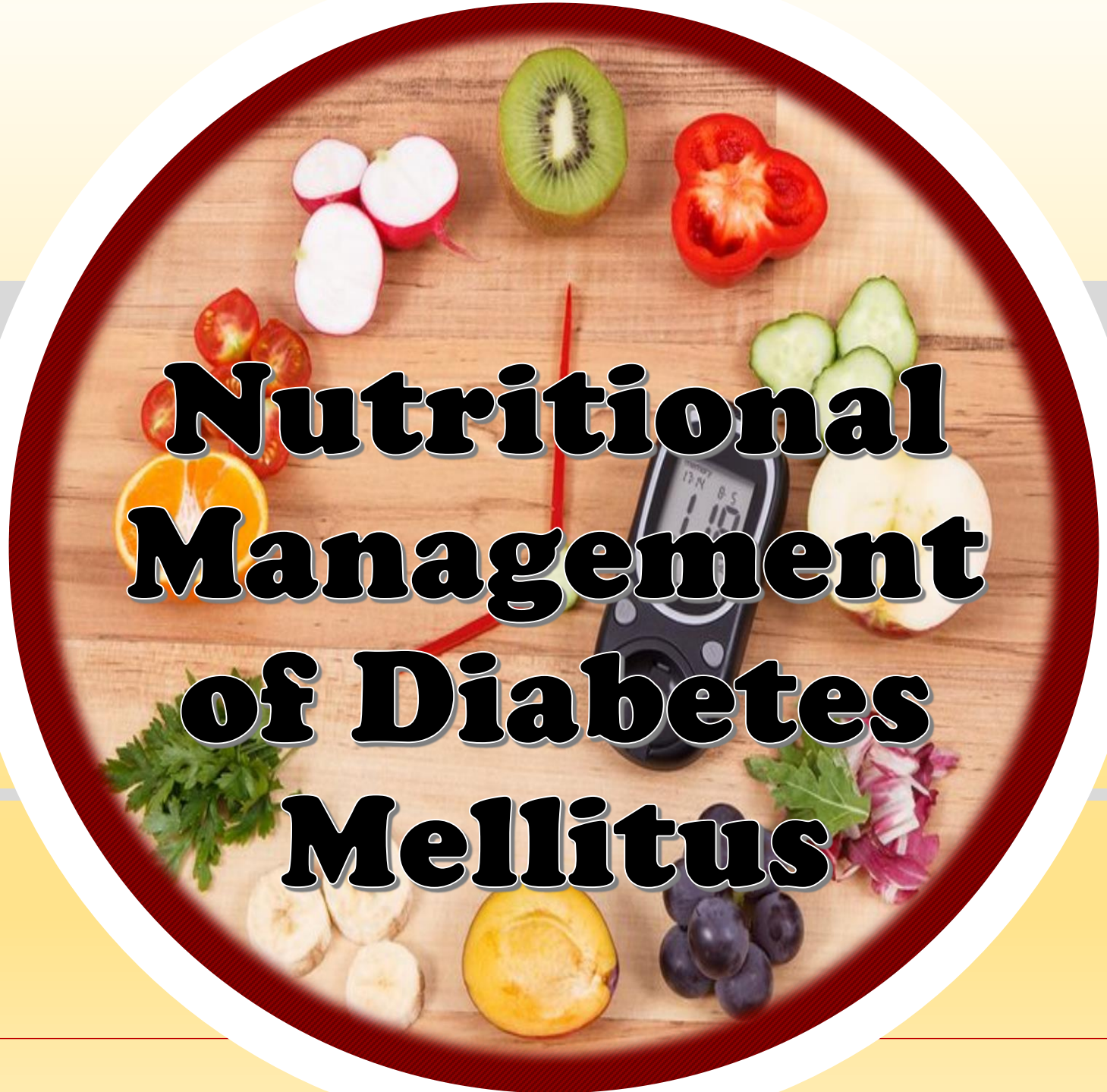
❑ Ways to Take Insulin:

Insulin cannot be taken by mouth because stomach acid destroys insulin. It is most often injected under the skin into fatty tissue. There are different insulin delivery methods available:

1. ***Insulin syringe*** *- insulin is drawn from a vial into a syringe. Using the needle, you inject the insulin under the skin.*
2. ***Insulin pump*** *- a small machine worn on the body pumps insulin under the skin throughout the day. A small tube connects the pump to a small needle inserted into the skin.*
3. ***Insulin pen*** *- disposable insulin pens have prefilled insulin delivered under the skin using a replaceable needle.*
4. ***Inhaler*** *- a small device you use to inhale insulin powder through your mouth. It is used at the start of meals.*
5. ***Injection port*** *- a short tube is inserted into the tissue under the skin. The port containing tube is adhered to skin using adhesive tape. Fast-acting insulin is injected into the tube using a syringe or pen. This allows you to use the same injection site for 3 days before rotating to a new site.*

Insulin is injected into these sites on the body:

Abdomen *Upper arm* *Thighs* *Hips*



Nutritional Management of Diabetes Mellitus

Nutritional Management of Diabetes Mellitus

- *The goal for Nutrition Therapy is*
  - *Attain and maintain optional metabolic outcomes including glucose level, lipid and lipoprotein profile, blood pressure etc.*
  - *Prevent and treat chronic complications.*
  - *Enhance health through food choices.*
  - *Address individual nutritional needs.*
  - *Modify dietary habit*

Principles of the diet:-

A Low calorie, Low simple carbohydrate, High complex carbohydrate, Low fat (low Saturated & High Unsaturated), High Protein, Vitamin and mineral Supplements, High dietary fiber and liberal fluid & High Antioxidants diet are recommended

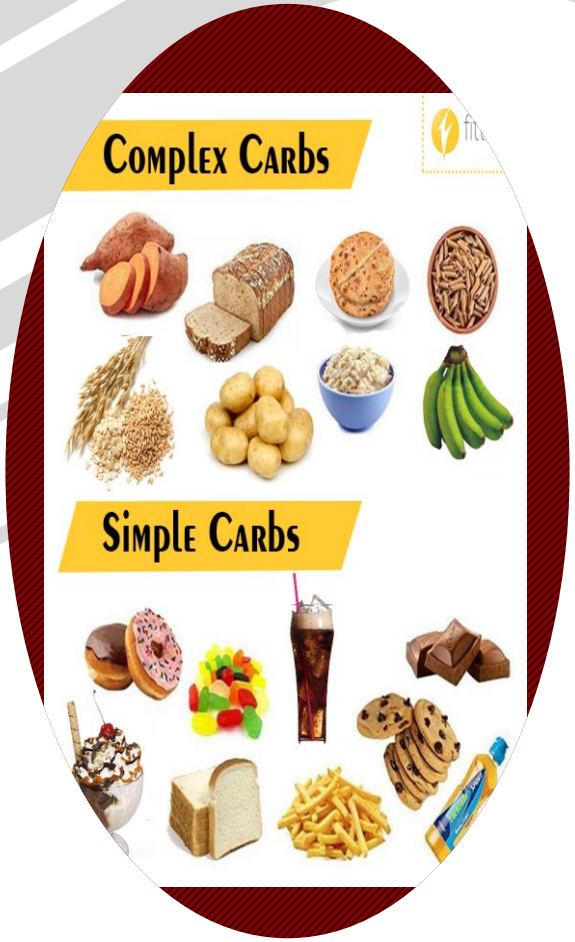
Calories:

- *The total intake of calories is more important for a diabetic than the exact proportion of proteins, fats and carbohydrates in the diet.*
- *Additional calories required extra insulin. A diabetic should be kept on a well-balanced diet providing just enough calories to maintain the ideal body weight.*
- *The latter depends on age, sex, height and body frame.*

The recommended energy need for diabetic patient based on body weight

What do you wet status	*Energy need (Kcal/Kg. Body Weight)*
Underweight	*40*
Ideal weight	*30*
Overweight	*20*

Carbohydrate



- *Consumed carbohydrates are deposited as glycogen in the muscles and liver by the action of insulin. In diabetes due to deficiency of insulin, this metabolism disturbed.*
- *In a diabetic person carbohydrates should be given about 50-60 % of total calories.*
- *To maintain the blood sugar level within range the total amount of carbohydrate can conventionally be divided into 4-5 equal portions.*
- *The launch should be served comprised of 1/3 (33%) of the total carbohydrate and 1/3 (33%) should be served during dinner. Of the remaining 1/3 (25%) is served during breakfast and the rest 9% during evening tea or at bedtime.*

Proteins:

- A diet high in protein is good for the health of diabetic, because it—
  - Supply the essential amino acids, needs for tissues repair.
  - Does not raise blood sugar during absorption as much as carbohydrates.
  - Does not supply as many calories as fat.
- 0.8-1.2 gm of protein per kilogram of ideal body weight is adequate, more may be given if necessary, and the amounts of fats and carbohydrates reduce proportionally.
- Sources of vegetable protein may be a desirable alternate to animal protein as they contain more soluble fiber and less saturated fat and cholesterol than animal proteins and may help in decreasing serum cholesterol.

Fats:

- As diabetics are at risk of developing cardiovascular disease Fats should be provided about 20%-25% of the calories requirements.
- Reasons for the amount of visible fat in the diet is restricted are-
  - They cannot be oxidized as readily as carbohydrates.
  - The normal end-products of fat oxidation are carbon-di-oxide and water.
  - If extra amounts of fats are ingested Ketone bodies are produce in extra amount and occurs diabetic coma.
- Good sources are fatty fish – especially salmon, halibut, mackerel, tuna, sardines, sea bass, herring, pompano, and lake trout. 2 to 3 servings of fish per week are recommended.
- Vegetarian sources of omega-3 fatty acids are flax seeds, walnuts, canola oil, soybean and soy products; however, vegetarian sources may not be as effective.

Vitamins:

- *Carbohydrates are not completely metabolized when there is a diffidence if vitamin—B complex. It is postulated that products of partial carbohydrates metabolism, like pyruvic acid, accumulate in situation and damage themselves resulting in peripheral neuropathy. So the diabetic requires supplements of vitamins—B complex.*
- *It is also advisable to supply vitamin— A, as the liver, which is the store house of this vitamins may damaged.*
- *Vitamin D is thought to help boost insulin sensitivity, which is vital for blood glucose regulation.*
- *Vitamin E- Increasing vitamin E in the bloodstream may decrease the likelihood of developing type 2 diabetes, and in type 2 diabetics may improve glucose tolerance. Furthermore, the antioxidant nature of vitamin E may reduce the risk of diabetic complications.*
- *vitamin C also lowered blood pressure in people with type 2 diabetes, which is beneficial for heart health as well.*

Minerals:

- *1 multimineral tablet with vitamin tablet should be given to the patients.*
- *Manganese- A deficiency of manganese is common amongst diabetics. Manganese could be a key co-factor in the way enzymes within the body handle glucose metabolism.*
- *Magnesium- deficiency has been shown to directly influence the blood sugar control of type 2 diabetics.*
- *Zinc- itself may be a crucial element in insulin metabolism. Zinc is well-known as a powerful guardian against viral infections, and may also act to protect beta cells from destruction.*
- *Selenium- Because of its antioxidant properties, selenium might thus prevent the development of diabetes.*

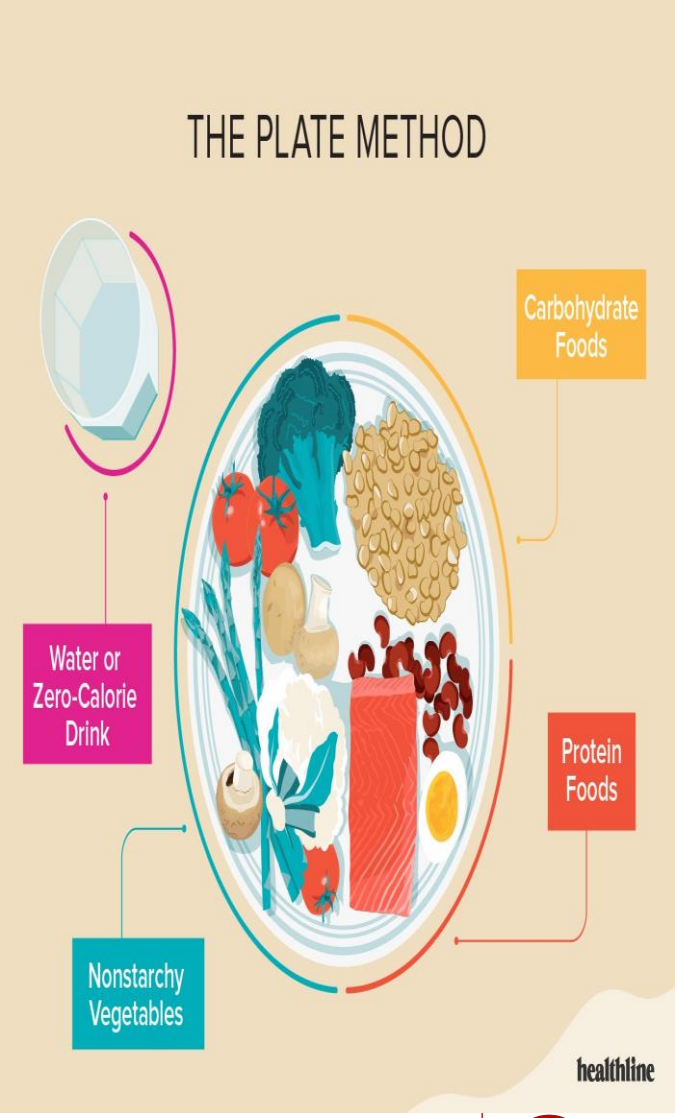
Fluids & Dietary fibers:

- *In diabetic patients, there is no restriction of fluid. So a liberal fluid intake is prescribed.*

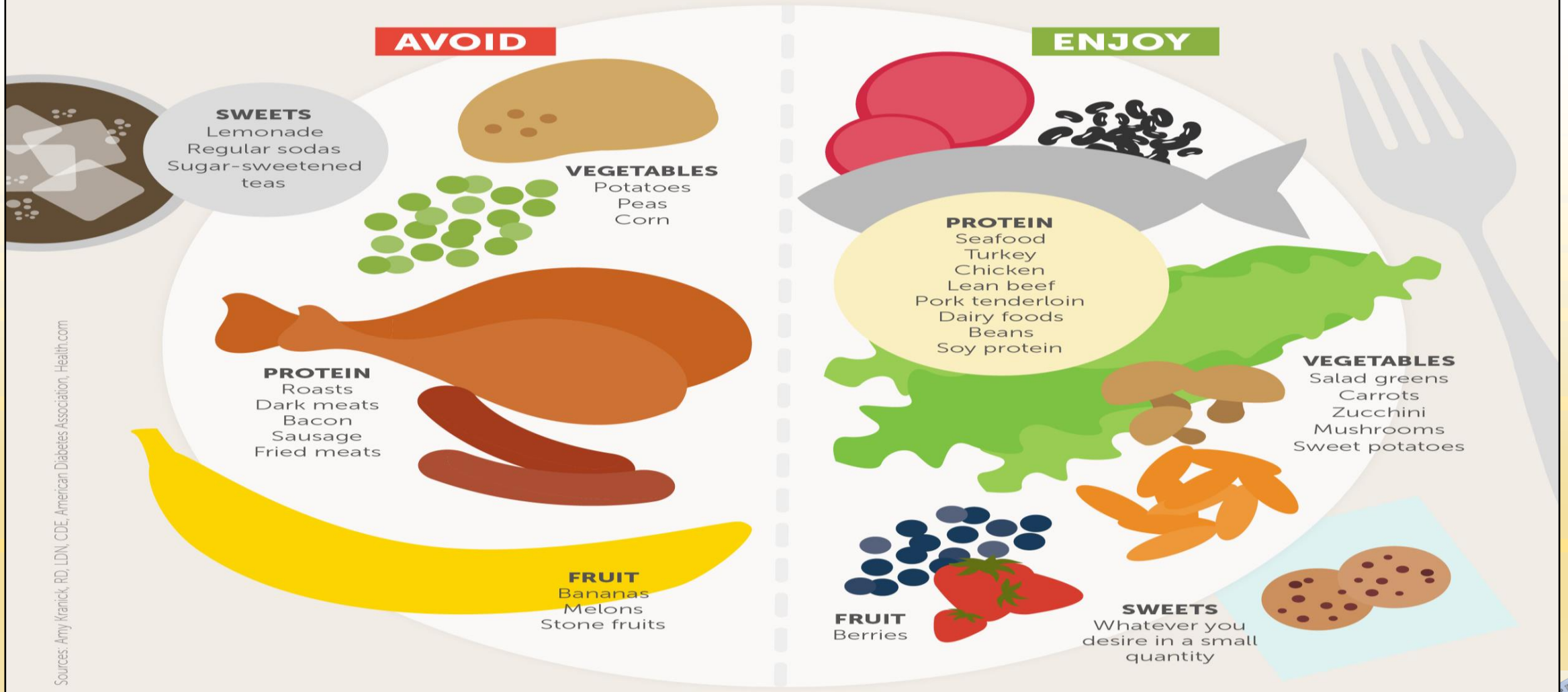
- *Dietary fibers benefits type 1 and type 2 diabetics. Such diet –*
  - *Lower insulin requirements.*
  - *Increased peripheral tissue insulin sensitivity.*
  - *Decreased serum cholesterol and triglyceride values.*
  - *Aids in weight control.*
- *Soluble fibers such as pectin, gums, and hemicelluloses increased intestinal transit time, delay gastric emptying, slow glucose absorption and lower serum cholesterol.*
- *Insoluble fibers such as cellulose and lignin decrease the intestinal transit time, increased fecal bulk, delay glucose absorption and slow starch hydrolysis.*

Dietary guidelines for diabetics

- *The distribution of nutrient, energy contribution should be made considering the age, gender, bodyweight, physical activity, and occupation of the patient.*
- *Simple sugar should be restricted in diet raise blood sugar level rapidly.*
- *The net of insulin dose should be adjusted on the basis of carbohydrate to insulin ratio.*
- *The intake of different types of oil in mixture is preferred than single type of oil. Mixture of PUFA, MUFA and SFA in recommended doses should be included in diet.*
- *Diabetic diet should be supplemented with vitamins and minerals to prevent oxidative damage and related complications.*
- *The diabetic patient should take meal and snacks timely to avoid hypoglycemia. 3 main meals and 3 snacks between meals can be taken.*
- *Instead of large heavy meals small frequent meal help to maintain good glycemic control. Small amount of food can be taken at 2:00 hours intervals.*
- *The diet should be incorporated with fruits and vegetables rich in antioxidants, micronutrient and phytochemicals.*



Healthy Picks for Diabetics



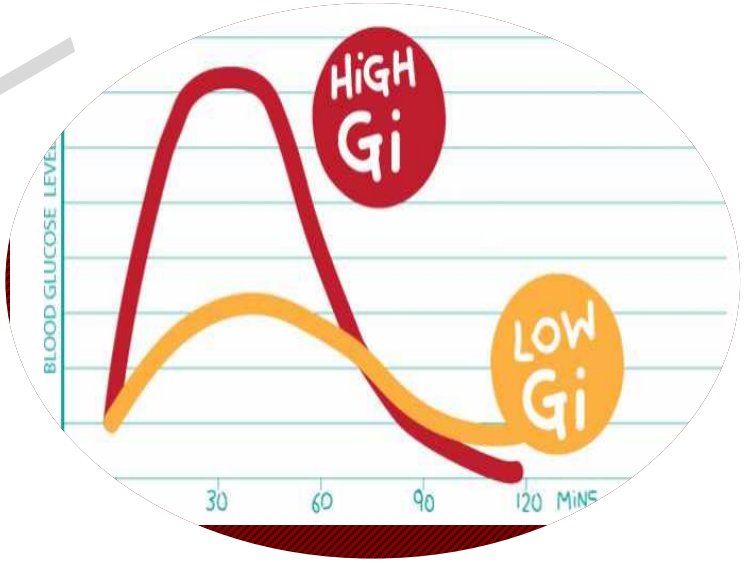
Food Exchange System of Diabetic Diet

- *The amount of food intake and the total calorie intake of a diabetic should not vary widely from day to day for this reason a food exchange system is widely used keep uniformity in meal planning and it allows a wide variety of foods to be included in the diet.*

- *According to National Institute of Nutrition, ICMR 7 types of food exchange group are in use-*
  - *Vegetable exchange*
  - *fruit exchange*
  - *cereals exchange*
  - *Legume and pulses exchange*
  - *Flesh food exchange*
  - *milk exchange*
  - *fat exchange.*
- *The usual food intake should be categorised into exchange amount based on portion size and food consumed at each meal and snacks.*

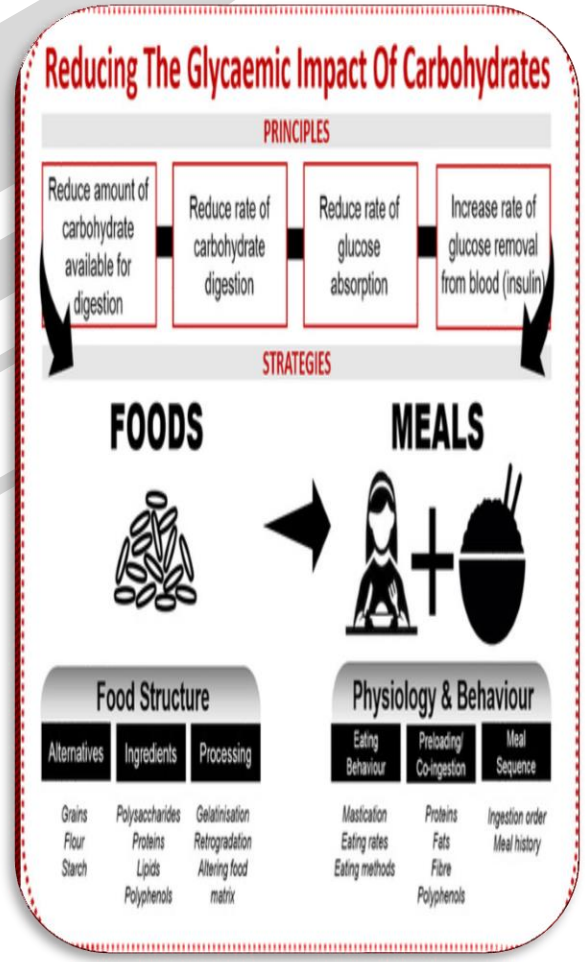
Glycaemic Index:

- *The glycemic index, or GI, measures how a carbohydrate-containing food raises blood glucose.*
- *Foods are ranked based on how they compare to a reference food– either glucose or white bread.*
- *A food with a high GI raises blood glucose more than a food with a medium or low GI.*



$$\text{Glycemic Index} = \frac{\text{blood glucose level after ingestion of product containing 50g carbohydrates}}{\text{blood glucose level after ingestion of 50 g glucose}} * 100$$

Affects the GI of a food:



- *Fat and fiber tend to lower the GI of a food.*
- *As a general rule, the more cooked or processed a food, the higher the GI; however, this is not always true.*
- *Below are a few specific examples of other factors that can affect the GI of a food:*
  - *Ripeness and storage time – the more ripe a fruit or vegetable is, the higher the GI.*
  - *Processing – juice has a higher GI than whole fruit; mashed potato has a higher GI than a whole baked potato, stone ground whole wheat bread has a lower GI than whole wheat bread.*
  - *Cooking method- how long a food is cooked (al dente pasta has a lower GI than soft-cooked pasta)*

Glycemic Index

Low GI (<55), Medium GI (56-69) and High GI (70>)

Grains / Starchs		Vegetables		Fruits		Dairy		Proteins	
Rice Bran	27	Asparagus	15	Grapefruit	25	Low-Fat Yogurt	14	Peanuts	21
Bran Cereal	42	Broccoli	15	Apple	38	Plain Yogurt	14	Beans, Dried	40
Spaghetti	42	Celery	15	Peach	42	Whole Milk	27	Lentils	41
Corn, sweet	54	Cucumber	15	Orange	44	Soy Milk	30	Kidney Beans	41
Wild Rice	57	Lettuce	15	Grape	46	Fat-Free Milk	32	Split Peas	45
Sweet Potatoes	61	Peppers	15	Banana	54	Skim Milk	32	Lima Beans	46
White Rice	64	Spinach	15	Mango	56	Chocolate Milk	35	Chickpeas	47
Cous Cous	65	Tomatoes	15	Pineapple	66	Fruit Yogurt	36	Pinto Beans	55
Whole Wheat Bread	71	Chickpeas	33	Watermelon	72	Ice Cream	61	Black-Eyed Beans	59
Muesli	80	Cooked Carrots	39						
Baked Potatoes	85								
Oatmeal	87								
Taco Shells	97								
White Bread	100								
Bagel, White	103								

Artificial Sweeteners for Diabetic Diet

- *Sweeteners or sugar alternatives are sugar substitutes that duplicate the effect of sugar in taste with less food energy. Some sugar substitutes are natural and some are synthetic. Those, not natural are called artificial sweeteners. They are also called non nutritive sweeteners (NNS) and noncaloric sweeteners.*

- *Health benefits of Artificial Sweeteners: People with diabetes mellitus can enjoy different varieties of food items by using artificial sweeteners in place of sugars. As they face difficulty in controlling blood glucose levels, an alternative to sucrose can help them to regulate the sugar level of their body in a better way.*

- *Artificial fitness are classified into 2 types low calorie sweeteners and non caloric sweeteners.*

  - *Low calorie sweeteners:*

    - *low calorie sweeteners are generally polyols or sugar alcohols. They occurred in nature and they can be synthesised on industrial scale from easily accessible carbohydrates such as sucrose, starch, glucose, invert sugar, xylose and lactose. Then polyols are lactitol, maltitol, mannitol, sorbitol, erythritol, xylitol, isomalt.*
    - *They are white crystalline, water soluble powder. They are less sweet and 50% of calorie value is available to human body.*

Non calorie sweeteners:

- The most known and commonly used low/no calorie sweeteners worldwide are acesulfame potassium (or acesulfame-K), aspartame, cyclamate, saccharin, sucralose and steviol glycosides.

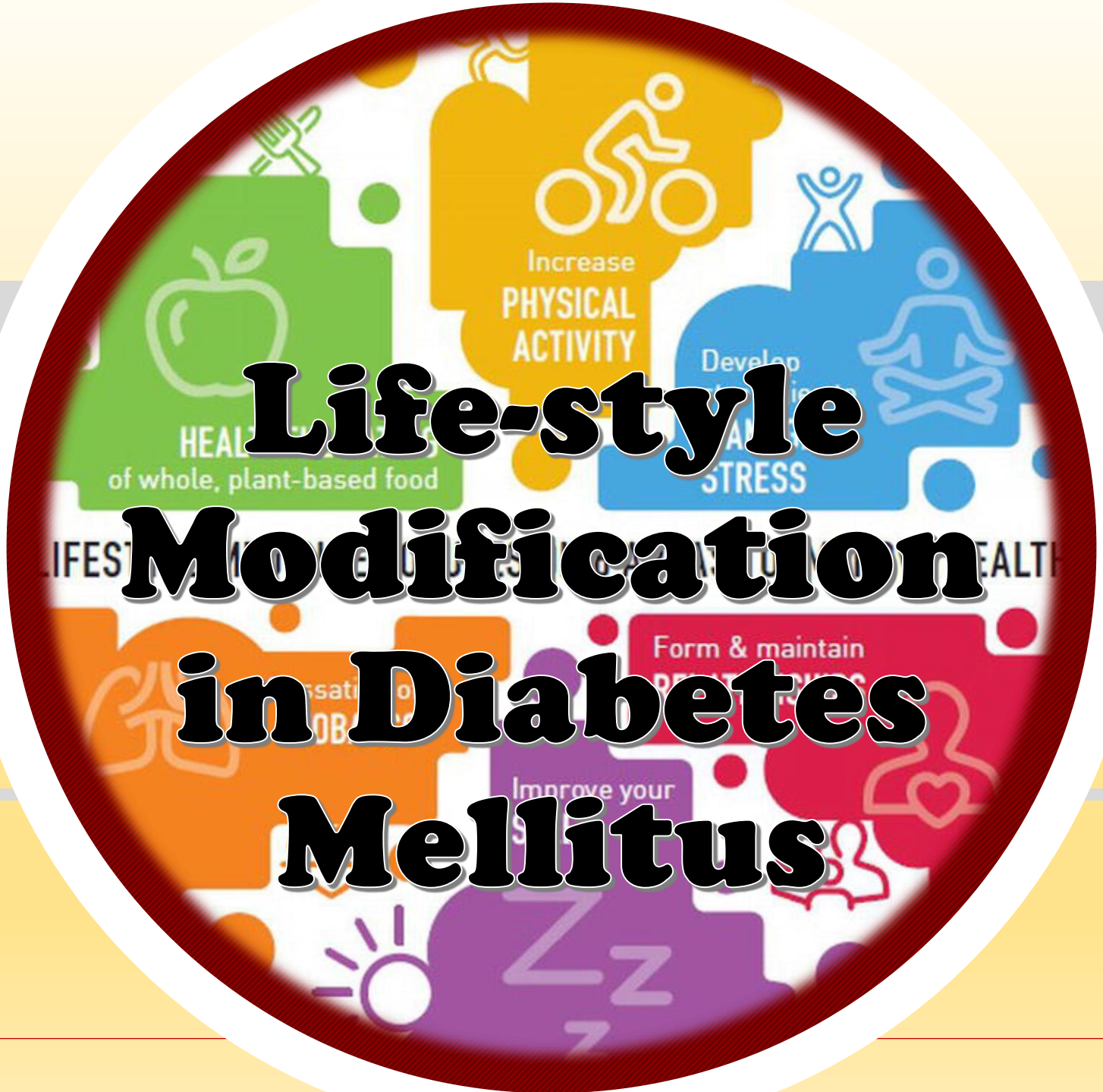
- Acesulfame K-
  - It belongs to the class of dihydro-oxathiazinone dioxides. It is approximately 200 times sweeter than sucrose when used at moderate sweetness levels.
  - It is used in a wide variety of foods and beverages like dairy products, bakery products, sweets and chewing gum, jams, marmalades, preserve and canned fruit etc.

- Aspartame-
  - It is also an intense nutritive sweetener, which is produced by combining the two amino acids L- phenylalanine and L- aspartic acid by a methyl- ester link. It has a clean sweet taste and 180-200 times sweeter than sucrose.
  - Major market for it is soft drinks and table top sweetener. It is also used in confectionary, pharmaceutical tablets and dry syrups, yogurt, dairy products, dry mix products.

- Neotame-
  - It is a derivative of aspartame. It is produced by aspartame and 3,3-dimethylbutyraldehyde via reduction alkylation followed by purification, drying and milling. It is approximately 8000 times as sweet as sucrose and has clean sweet taste.
  - Many products like soft drinks, chewing gums, dairy drinks, confectionary bar etc. use combinations of neotame and other sugars and its substitutes.

Non calorie sweeteners:

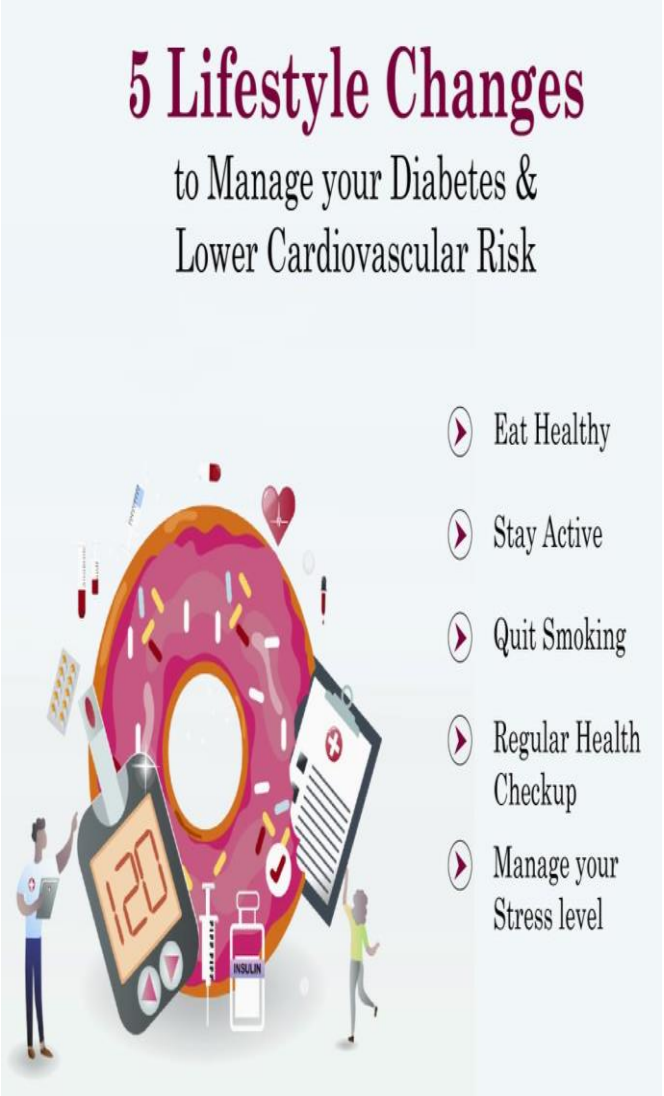
- **Saccharine-**
  - Saccharin is the oldest chemical sugar substitute. Its sweetness depends on how it is used and ranges from 200 to 700 times sweeter than sugar.
  - Application of saccharine are in beverage like carbonated soft drinks, toothpaste, medicine
- **Cyclamate-**
  - It is not as sweet as Saccharin, but it has less of a bitter aftertaste and for some reason mixes well with it.
  - It is used in beverages and table top sweetener.
- **Sucralose-**
  - It is high potency sweetener, made up from sucrose by a process of chemical modification that results in the enhancement of the sweetness intensity.
  - It is considered as versatile sweetener used for wide variety of foods and beverages.



Life-style Modification in Diabetes Mellitus

Life-style Modification in Diabetes Mellitus

- *Lifestyle modification is an integral part of diabetes management changes in the lifestyle and adoption of few behavioural skills are essential along with pharmacological and nutritional treatment. The following modification in lifestyle are required to lead a life with glycemic control and to retard diabetes complications.-*
  1. *Physical activity and weight control*
  2. *Avoidance of alcohol*
  3. *Users of dietary fiber and nutraceuticals.*

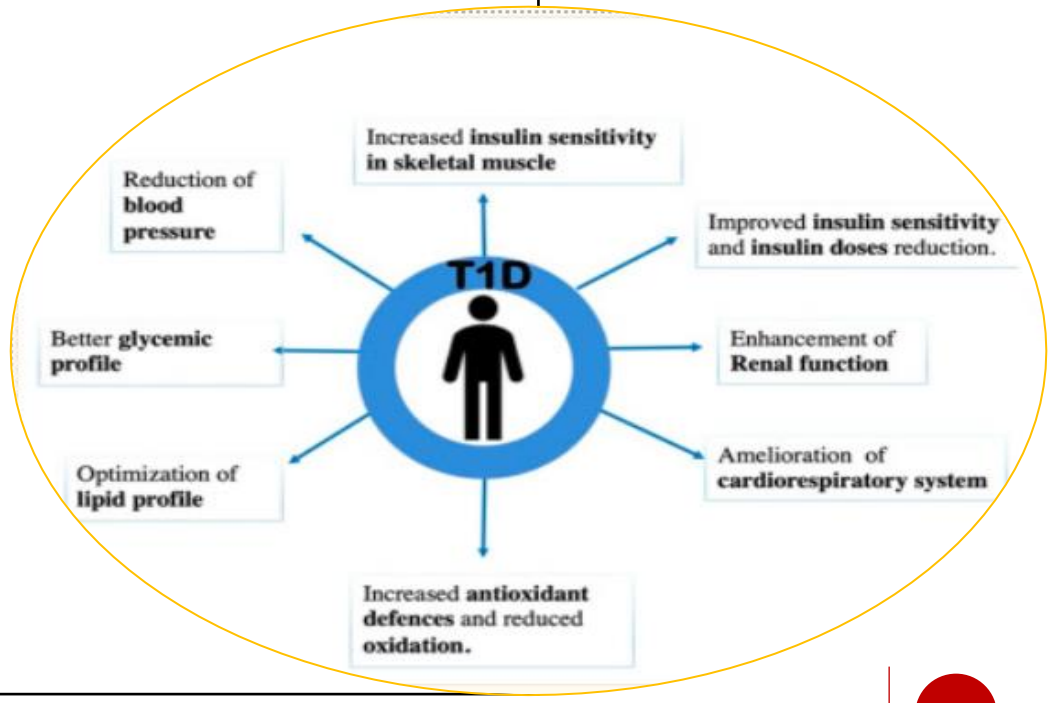


Physical activity & Diabetes Mellitus

- *Physical activity is defined as a subgroup of activities referred to all repetitive, planned and structured movements specifically designed to improve health and physical fitness.*

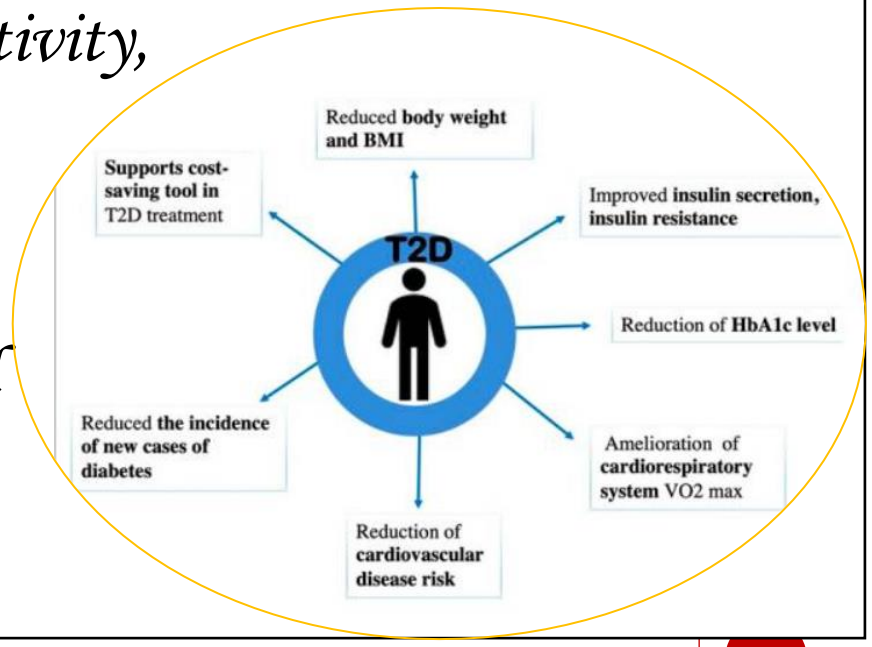
Physical activity & Type 1 Diabetes Mellitus

- *Regular PA in people with T1D produces the same positive effects. The benefits of PA in subjects with T1D are mainly related to the*
  - *(1) increased insulin sensitivity in skeletal muscle,*
  - *(2) possible positive effects on glycaemic control,*
  - *(3) increased antioxidant defences and reduced oxidation,*
  - *(4) decreased blood pressure,*
  - *(5) reduction of cardiovascular diseases,*
  - *(6) optimization of lipid profile and*
  - *(7) enhancement of renal function*



❑ *Physical activity & Type 2 Diabetes Mellitus*

- *Regular PA is a key component of the therapeutically approach for T2D subjects. Indeed, it has positive effects on*
  - *(1) reduction of body weight and body mass index (BMI),*
  - *(2) improvement in glucose tolerance and insulin sensitivity,*
  - *(3) reduction of HbA1c level,*
  - *(4) improvement of cardiorespiratory system,*
  - *(5) reduction of cardiovascular disease risk (CVD) and*
  - *(6) reduction of incidence of new cases of diabetes*

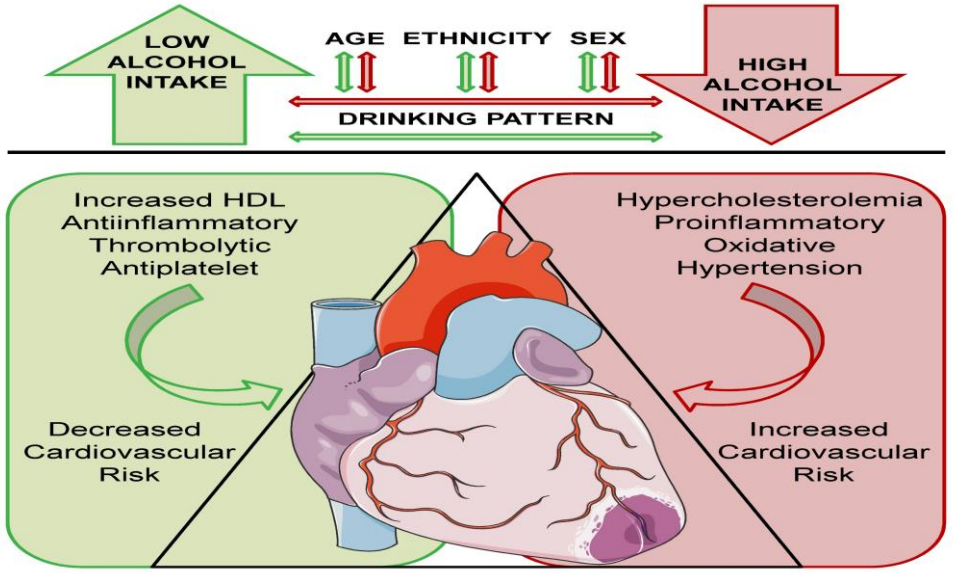


Consumption of alcohol & Diabetes Mellitus

- *Chronic heavy consumption of alcohol has deleterious effect on metabolic control and may even be associated with impaired insulin resistance.*

- *Liver processes alcohol. When one consumes alcohol in excess, its ability to release glucose is hampered, as the liver wants to get rid of the alcohol. Hence, it lowers sugar levels, putting one at risk of hypoglycemia and complications. Alcohol also stimulates appetite, causing to over-eat and lower sugar control.*

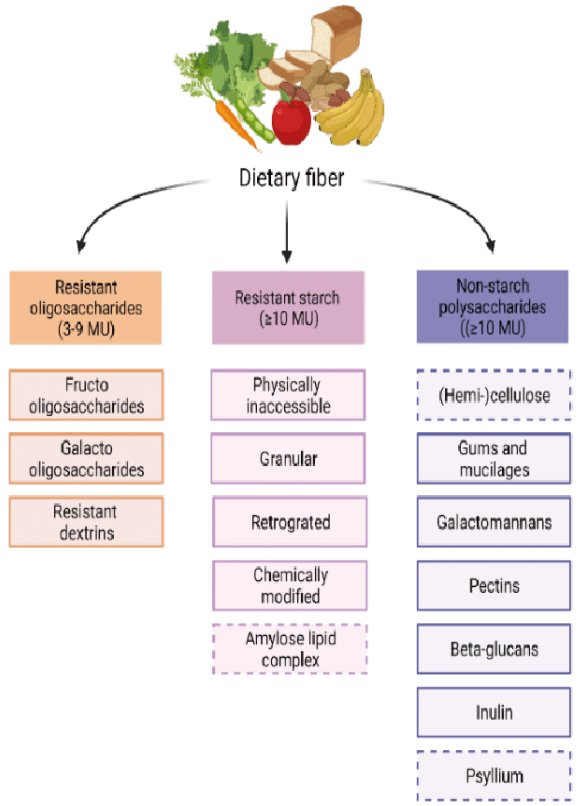
- *Other effects of alcohol:*
  - *Beer and sweet wine contain carbohydrates that raise sugars.*
  - *Alcohol also increases triglyceride levels.*
  - *Affects liver.*
  - *Can cause nausea, flushing, slurring of speech, and increased heart rate.*
  - *Increases rate of heart attack and stroke with diabetes*



Uses of dietary fiber in Diabetes Mellitus

- *American Association of Cereal Chemists (AACC) in 2000 defined **dietary fibre** as the edible parts of plant or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. Dietary fibre includes polysaccharides, oligosaccharides, lignin and associated plant substances.*

- *Classification Of Dietary Fibre*
- *The most widely accepted classification for dietary fibre has been to differentiate dietary components on their solubility in a buffer at a defined pH, and/or their fermentability in an invitro system using an aqueous enzyme solution representative of human alimentary enzymes.*
- *Thus most appropriately dietary fibre is classified into two categories such as water- insoluble/less fermented fibres: cellulose, hemicellulose, lignin and the water- soluble/well fermented fibres: pectin, gums and mucilages.*



Classification of dietary fibre components based on water solubility/fermentability

Characteristic	Fibre component	Description	Main food sources
Water insoluble/Less fermented	Cellulose	Main structural component of plant cell wall. Insoluble in concentrated alkali, soluble in concentrated acid.	Plants (vegetables, sugar beet, various brans)
	Hemicellulose	Cell wall polysaccharides, which contain backbone of β-1,4 glucosidic linkages. Soluble in dilute alkali.	Cereal grains
	Lignin	Non-carbohydrate cell wall component. Complex cross-linked phenyl propane polymer. Resists bacterial degradation.	Woody plants
Water soluble/Well fermented	Pectin	Components of primary cell wall with D-galacturonic acid as principal components. Generally water soluble and gel forming	Fruits, vegetables, legumes, sugar beet, potato
	Gums	Secreted at site of plant injury by specialized secretary cells. Food and pharmaceutical use.	Leguminous seed plants (guar, locust bean), seaweed extracts (carrageenan, alginates), microbial gums (xanthan, gellan)
	Mucilages	Synthesized by plant, prevent desiccation of seed endosperm. Food industry use, hydrophilic, stabilizer.	Plant extracts (gum acacia, gum karaya, gum tragacanth)

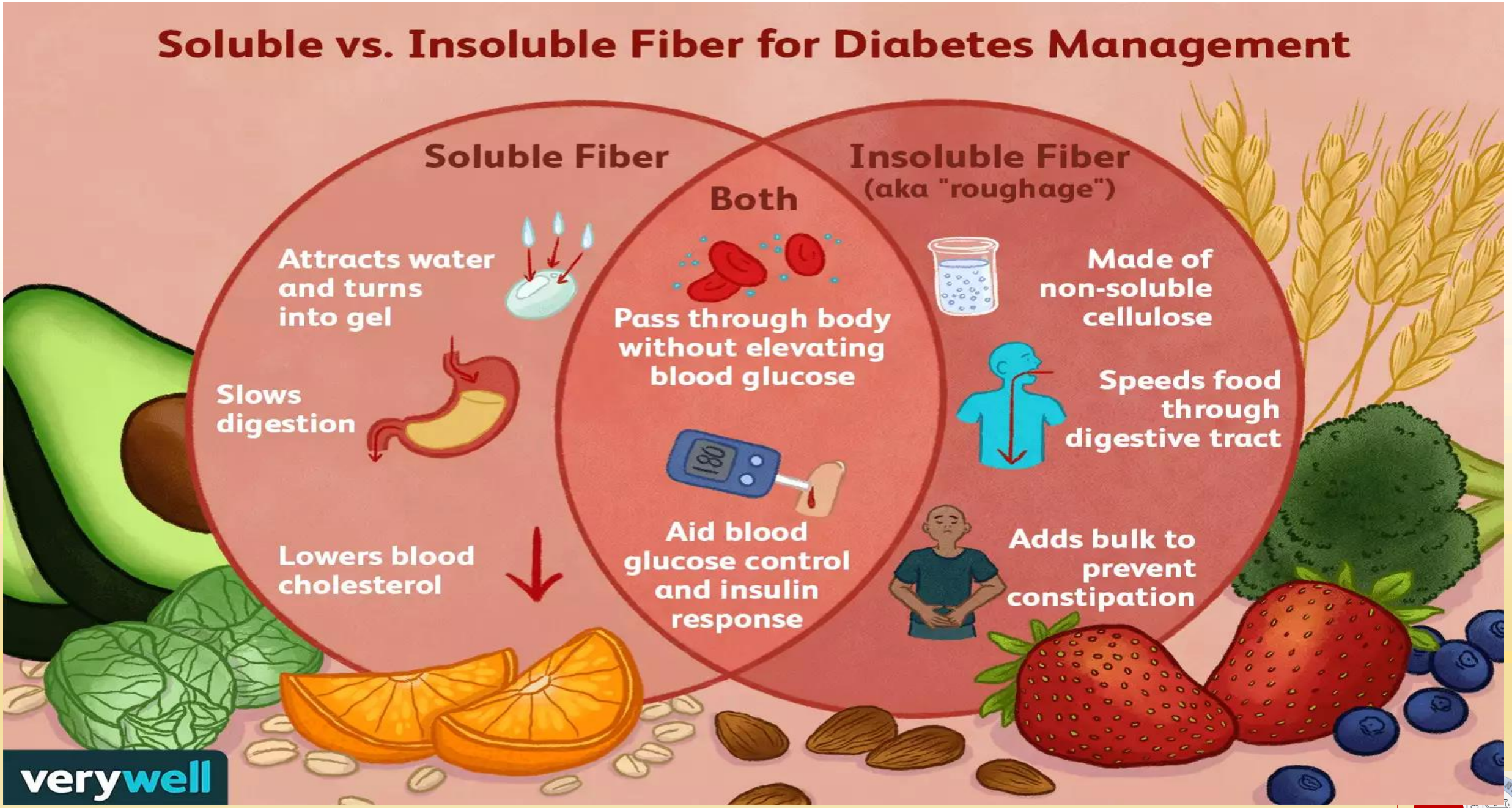
Table 2. Classification of fiber components based on fermentability

Characteristic	Fiber component	Main food source
Partial or low fermentation	Cellulose	Plants (vegetables, sugar beet, various brans)
	Hemicellulose	Cereal grains
	Lignin	Woody plants
	Cutin/suberin/other plant waxes	Plant fibers
	Chitin and chitosan, collagen	Fungi, yeasts, invertebrates
	Resistant starches	Plants (corn, potatoes, grains, legumes, bananas)
Well fermented	Curdlan	Bacterial fermentation
	β-Glucans	Grains (oat, barley, rye)
	Pectins	Fruits, vegetables, legumes, sugar beet, potato
	Gums	Leguminous seed plants (guar, locust bean), seaweed extracts (carrageenan, alginates), plant extracts (gum acacia, gum karaya, gum tragacanth), microbial gums (xanthan, gellan)
	Inulin	Chicory, Jerusalem artichoke, onions, wheat
	Oligosaccharides/analogues	Various plants and synthetically produced (polydextrose, resistant maltodextrin, fructooligosaccharides, galactooligosaccharides, lactulose)
Animal origin		Chondroitin

❑ Benefits of Fiber for Managing Diabetes

❑ Incorporating fiber-rich foods into a diet can help manage diabetes and decrease symptoms. For those with diabetes, an adequate amount of fiber may:

1. **Steady Blood Sugar-** for people with type 2 diabetes, eating more fiber can help improve blood glucose control. The human body is unable to absorb and break down fiber. Because of this, fiber does not cause a spike in blood glucose the way other carbohydrates can.
2. **Boost Weight Loss-** Since fiber cannot be digested and moves slowly through the stomach, fiber-rich foods stay in the stomach longer and cause longer periods of fullness. Many foods high in fiber tend to also be low in calories. Since eating low-calorie fiber sources may cause less eat, it can help create a caloric deficit that leads to weight loss.
3. **Prevent Heart Disease-** adequate soluble fiber intake can reduce the risk of heart disease by decreasing LDL cholesterol. Soluble fiber does this by binding to cholesterol particles in the small intestine, preventing these particles from entering the bloodstream.


Soluble vs. Insoluble Fiber for Diabetes Management
Soluble Fiber
Attracts water and turns into gel
Slows digestion
Lowers blood cholesterol
Both
Pass through body without elevating blood glucose
Aid blood glucose control and insulin response
Insoluble Fiber
(aka "roughage")
Made of non-soluble cellulose
Speeds food through digestive tract
Adds bulk to prevent constipation
verywell

❑ How Much Fiber Do We Need?

❑ The amount of fibre is recommended based on energy intake. Fibre intake of 30 g/2000 kcal is considered to be safe.

❑ Ways to Get More Fiber

❑ Increasing the amount of fiber in diet can allow to reap great benefits, but know that a sudden increase in fiber consumption can lead to uncomfortable digestive symptoms such as bloating, gas, constipation, diarrhoea, or cramps.

❑ Take it slow—increase the fiber in diet gradually, adding a bit more every few days.

- Aim to eat three to five servings of non-starchy vegetables each day (a serving is 1/2 cup cooked or 1 cup raw).
- Consume two servings of high-fiber fruits such as berries, apples, or pears daily.
- Include plenty of whole grains, such as whole-grain bread, oatmeal, and ancient grains (quinoa, bulgar, barley, farro, millet, freekeh).
- Snack on unsalted nuts (one serving is 1/4 cup, or about one handful).
- Sprinkle ground flax, hemp, or chia seeds into yogurt.
- Toss legumes, such as chickpeas, into salad for a protein and fiber boost.
- Make dessert recipes with an added emphasis on fiber.
- Try low-fat and unbuttered popcorn as a snack.

Uses of Nutraceuticals in Diabetes Mellitus

❑ *According to DeFelice, nutraceutical can be defined as, "a food (or part of a food) that provides medical or health benefits, including the prevention and /or treatment of a disease."*

❑ *A nutraceutical may be a naturally nutrient- rich food such as spirulina, garlic, soy or a specific component of a food like omega-3 oil from salmon.*

❑ *Classification of Nutraceuticals*

- Nutraceuticals are categorized on the basis of foods available in the market:

1. Traditional 2. *Non-traditional* 3. Commercial

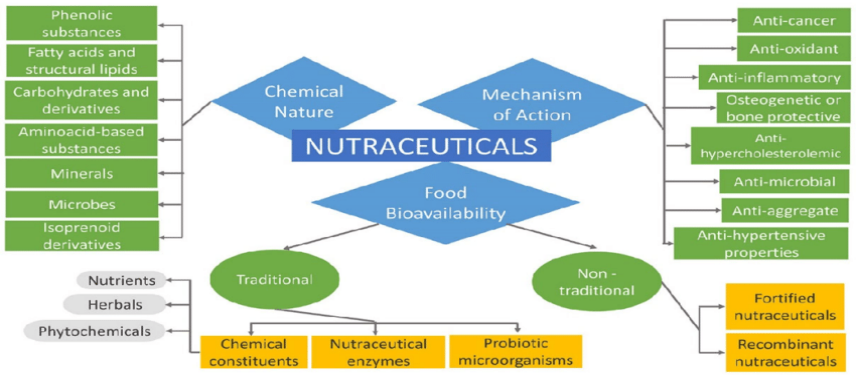
1. Traditional nutraceuticals are simply natural with no changes to the food. Food contains several natural components that deliver benefits beyond basic nutrition, such as lycopene in tomatoes, omega-3 fatty acids in salmon or saponins in soy. They are grouped on the basis of-

I. Chemical Constituents

a) Nutrients b) Herbals c) Phytochemicals

II. Probiotic Microorganisms

III. Nutraceutical Enzymes



I. Chemical Constituents

a) Nutrients

Substances such as vitamins, minerals, amino acids and fatty acids with established nutritional functions. Most vegetables, wholegrain cereals, dairy products, fruits and animal products such as meat, poultry, contain vitamins and are helpful in curing heart diseases, stroke, cataracts, osteoporosis, diabetes and cancer.

b) Herbals

Nutraceuticals holds a great promise to improve health and prevent chronic diseases with the help of herbals. Some examples are willow bark (*Salix nigra*), having active component as salicin, which is anti-inflammatory, analgesic, antipyretic, astringent and antiarthritic.

c) Phytochemicals

Phytochemicals are one class of nutraceuticals. For example, Carotenoids (Isoprenoids) found in various fruits, vegetables and egg yolk, are anticarcinogenic, boost natural killer immune cells. Legumes (chickpeas and soybeans), grains, palm oil contain non-carotenoids, which remove cholesterol and are anti-carcinogenic.

II. Probiotic Microorganisms

'Probiotics' mean 'for life' and are defined as live microorganisms, which when consumed in adequate amounts, confer a health effect on the host. They are friendly bacteria that promote healthy digestion and absorption of some nutrients. They act to crowd out pathogens, such as yeasts, other bacteria and viruses that may otherwise cause disease and develop a mutually advantageous symbiosis with the human gastrointestinal tract.

III. Nutraceutical Enzymes

Enzymes are an essential part of life, without which our bodies would cease to function. Those people who are suffering from medical conditions such as hypoglycaemia, blood sugar disorders, digestive problems and obesity, eliminate the symptoms by enzyme supplements to their diet. e.g., Hemicellulase, Amyloglucosidase, β-Amylase, Glucoamylase etc.

2. Non-traditional nutraceuticals are artificial foods prepared with the help of biotechnology. Food samples contain bioactive components which are engineered to produce products for human- wellness. They are arranged into-

I. Fortified nutraceuticals II. Recombinant nutraceuticals

I. Fortified nutraceuticals

It constitutes fortified food from agricultural breeding or added nutrients and/or ingredients. e.g., orange juice fortified with calcium, cereals with added vitamins or minerals and flour with added folic acid. Some examples are milk fortified with cholecalciferol used in vitamin D deficiency.

II. Recombinant nutraceuticals

Energy-providing foods, such as bread, alcohol, fermented starch, yogurt, cheese, vinegar, and others are produced with the help of biotechnology.

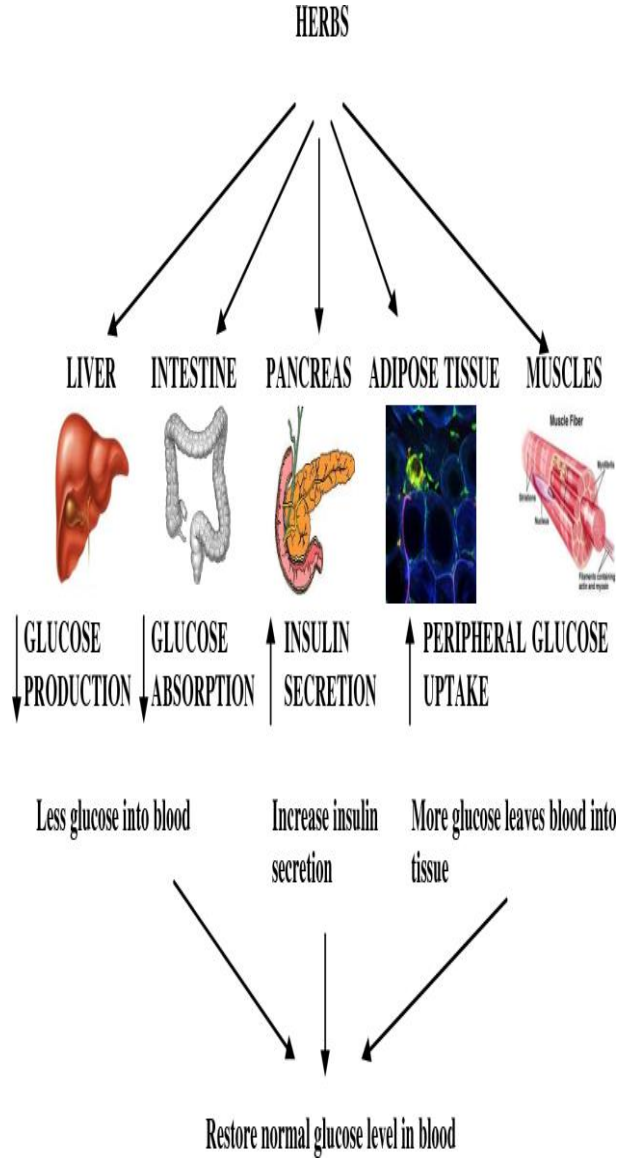
3. Commercial nutraceuticals

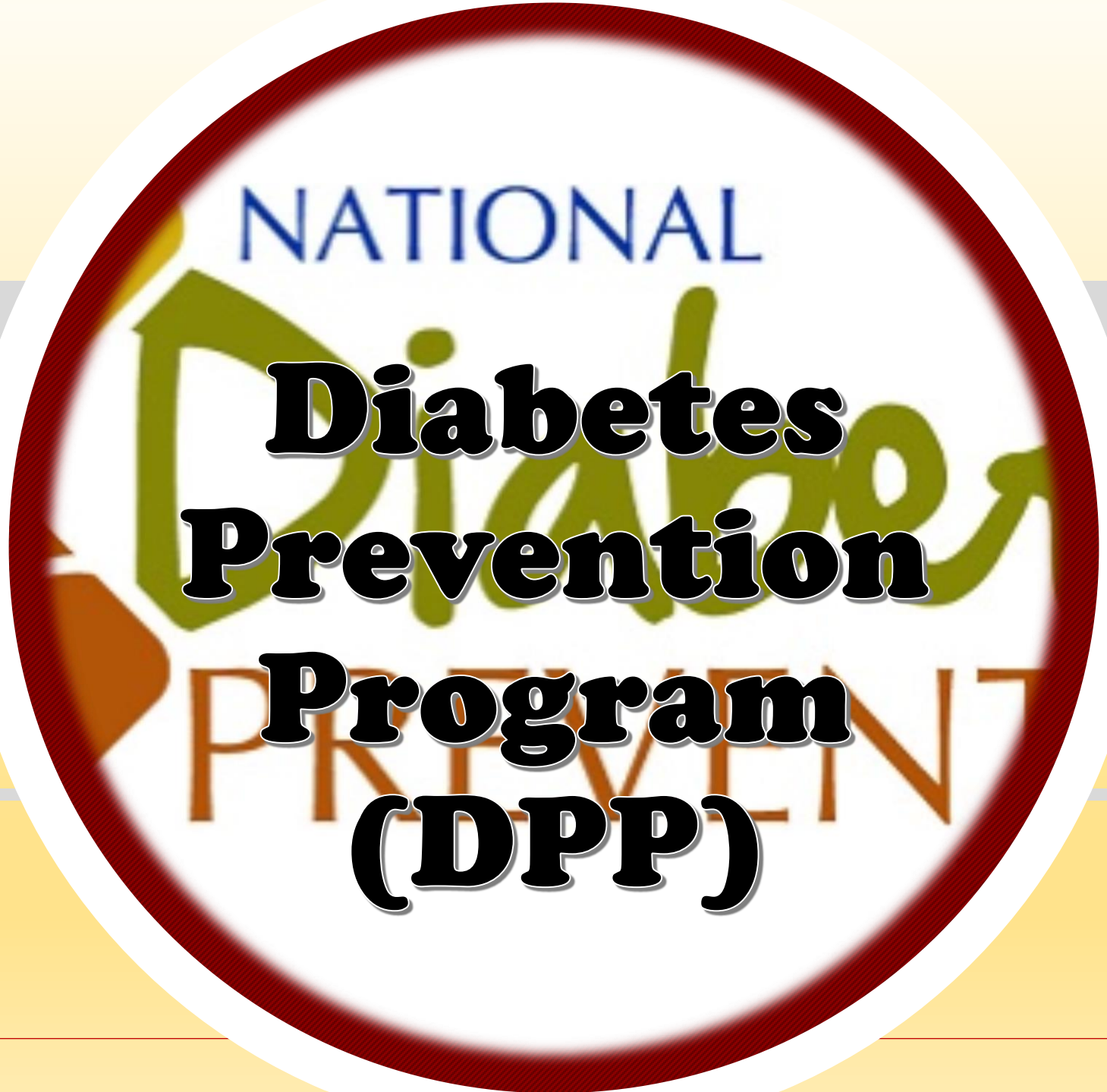
Many pharmaceutical companies are now trying to manufacture nutraceutical because there is undoubtedly a very huge and growing market. Nutraceuticals cover most of the therapeutic areas, such as anti-arthritic, cold and cough, sleeping disorders, digestion etc. Examples include- Splenda Essentials- Zero calorie sweetener products, Calcium Plus Milk- Lower risk of osteoporosis, Rescue Water- Support liver function and have necessary nutrients. Fish Oil Plus- Perfect brain food etc.

Effect of Nutraceutical on Diabetes mellitus

Diabetes mellitus is characterized by abnormally high levels of blood glucose, either due to insufficient insulin production, or due to its ineffectiveness.

- i. Docosahexaenoic acid modulates insulin resistance and is also vital for neurovisual development. This is especially important in women with gestational diabetes mellitus which foster the recommendation for essential fatty acids during pregnancy.
- ii. Lipoic acid is a universal antioxidant, now used for the treatment of diabetic neuropathy. Lipoic acid may be more effective as a long-term dietary supplement aimed at the prophylactic protection of diabetics from complications.
- iii. Dietary fibers from psyllium have been used extensively both as pharmacological supplements, food ingredients, in processed food to aid weight reduction, for glucose control in diabetic patients and to reduce lipid levels in hyperlipidaemia
- iv. Good magnesium status reduces diabetes risk and improves insulin sensitivity.
- v. Chromium picolinate, calcium and vitamin D appear to promote insulin sensitivity and improve glycemic control in some diabetics.





Diabetes Prevention Program (DPP)

National Diabetes Prevention Program (National DPP)

The National Diabetes Prevention Program—or National DPP—was created in 2010 to address the increasing burden of prediabetes and type 2 diabetes in the United States. This national effort created partnerships between public and private organizations to offer evidence-based, cost-effective interventions that help prevent type 2 diabetes in communities across the United States.

Goals of the National DPP

Through the National DPP, partner organizations:

- *Deliver CDC-recognized lifestyle change programs nationwide*
- *Ensure quality and adherence to proven standards*
- *Train community organizations that can run the lifestyle change program effectively*
- *Increase referrals to and participation in CDC-recognized lifestyle change programs*
- *Increase coverage by employers and public and private insurers*

Key Component: The Lifestyle Change Program

A key part of the National DPP is the lifestyle change program to prevent or delay type 2 diabetes. Hundreds of lifestyle change programs nationwide teach participants to make lasting lifestyle changes, like eating healthier, adding physical activity into their daily routine, and improving coping skills.

DPP Study Design

- *The DPP was a randomized, controlled clinical trial conducted at 27 clinical centers around the United States from 1996 to 2001. The trial enrolled 3,234 participants; 55 percent were Caucasian, and 45 percent were from minority groups at high risk for the disease, including African American, Alaska Native, American Indian, Asian American, Hispanic/Latino, or Pacific Islander. The trial also recruited other groups at high risk for type 2 diabetes, including people ages 60 and older, women with a history of gestational diabetes, and people with a parent, brother, sister, or child who had type 2 diabetes.*
- *DPP participants were randomly assigned to one of the following groups:*
  - *Lifestyle Change Group – Group participants joined a DPP Lifestyle Change Program that provided intensive training. Participants tried to lose 7 percent of their body weight and maintain that weight loss by eating less fat and fewer calories and exercising 150 minutes per week. Researchers met with participants individually at least 16 times in the first 24 weeks, and then every 2 months with at least 1 phone call between visits.*
  - *Metformin Group – Group participants took 850 mg of metformin twice a day and were provided standard advice about diet and physical activity.*
  - *Placebo Group – Group participants took a placebo twice a day instead of metformin and were provided standard advice about diet and physical activity.*

DPP Results

- *After about 3 years, the DPP showed that participants in the DPP Lifestyle Change Program lowered their chances of developing type 2 diabetes by 58 percent compared with participants who took a placebo (a pill without medicine).*
- *The DPP Lifestyle Change Program was effective for all participating racial and ethnic groups and both men and women.*
- *The Program worked particularly well for participants ages 60 and older, lowering their chances of developing type 2 diabetes by 71 percent. About 5 percent of participants in the DPP Lifestyle Change Program developed diabetes each year during the study compared with 11 percent of participants who took a placebo.*
- *Participants who took metformin lowered their chances of developing type 2 diabetes by 31 percent compared with participants who took a placebo.*
- *Metformin was effective for all participating racial and ethnic groups and both men and women.*
- *Metformin was most effective in women with a history of gestational diabetes, in people between the ages of 25 and 44, and in people with obesity who had a body mass index of 35 or higher.*

WORLD DIABETES DAY
NOVEMBER 14