

Introduction to the Endocrine System

- **Diabetes Mellitus**

INTRODUCTION

Pancreas

The pancreas functions:

- **Exocrine function:** produces and secretes digestive enzymes
- **Endocrine Function:** produces important hormones in Islets of Langerhans; insulin, glucagon, and Somatostatin.

Pancreatic Hormones

- **Insulin**

- Produced by the **beta cells (β -cells)** in the pancreas.
- stimulates the uptake of glucose by body cells
- decreasing blood levels of glucose

- **Somatostatin**

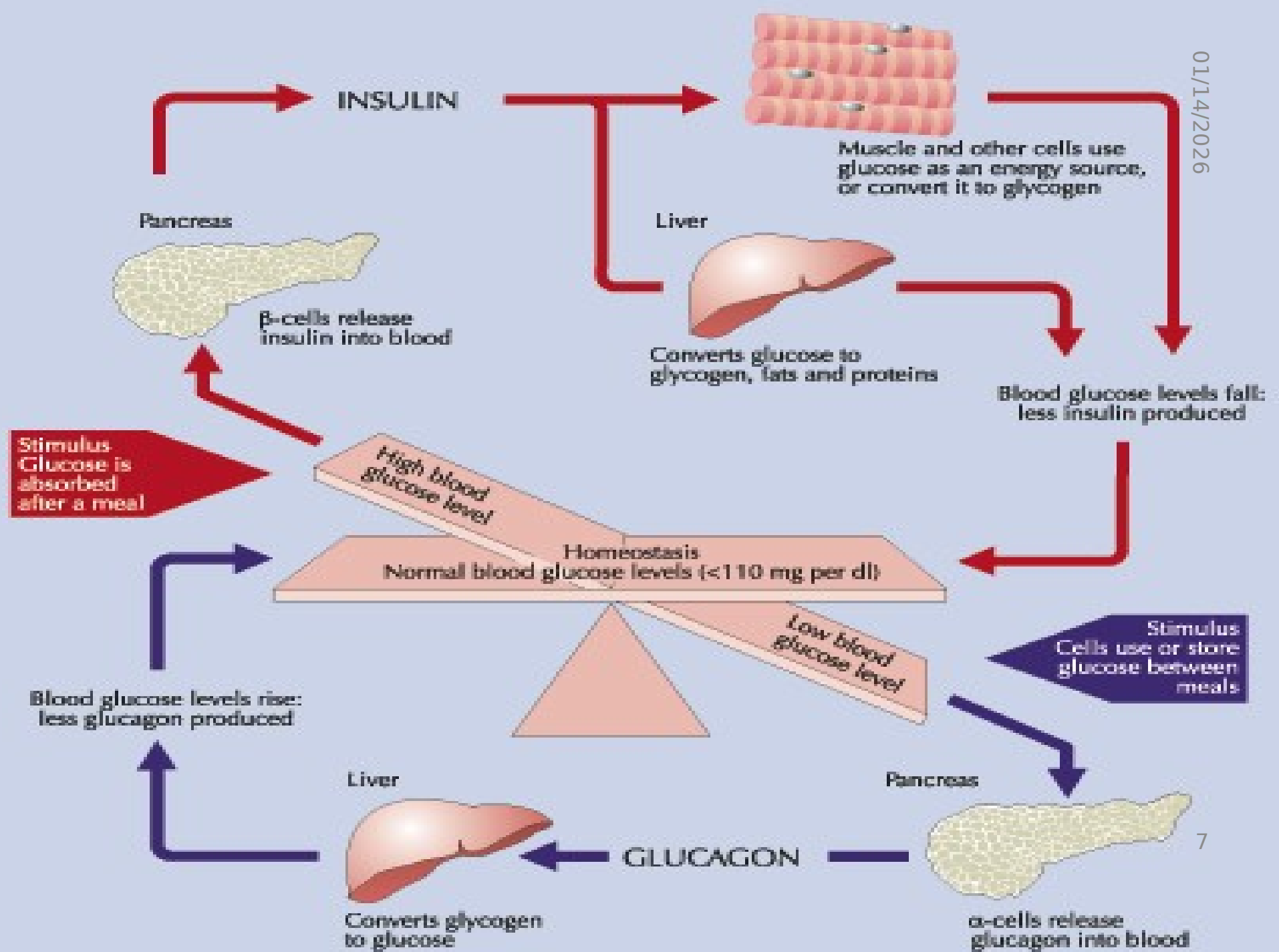
- Produced by the **delta Cells (δ -cells)** in the pancreas.
- Inhibits both glucagon and insulin.

Pancreatic Hormones

- **Glucagon**

- Produced by the **alpha cells (α -cells)**.
- Stimulates the breakdown of glycogen and the release of glucose from liver
- increasing blood levels of glucose.
- When liver glucose is not available,
 - ✓ Lipolysis (breakdown of fat) OR
 - ✓ Proteolysis (breakdown of aas) occurs

- Glucagon and insulin work together to regulate & maintain blood sugar levels



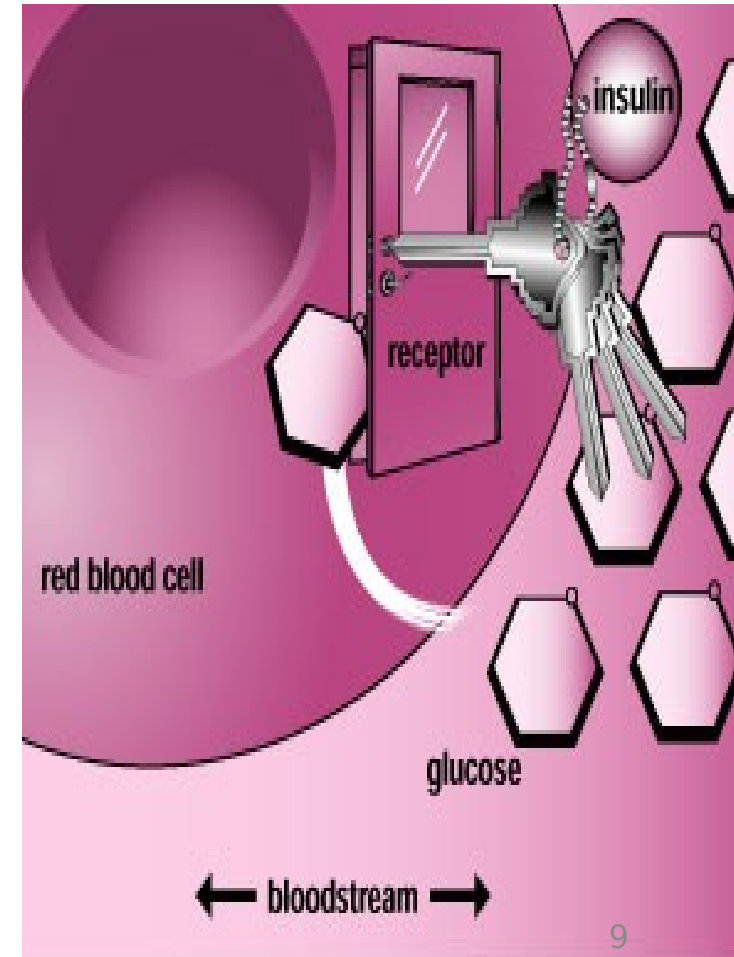
Insulin

- Pancreas secretes 40-50 units of insulin
(U-40 to 50) daily in two steps:
 - Secreted at low levels during **fasting (basal insulin secretion)**
 - Increased levels **after eating (prandial insulin secretion)**
 - An early burst of insulin occurs within 10 minutes of eating
 - Then proceeds with increasing release as long as hyperglycemia is present

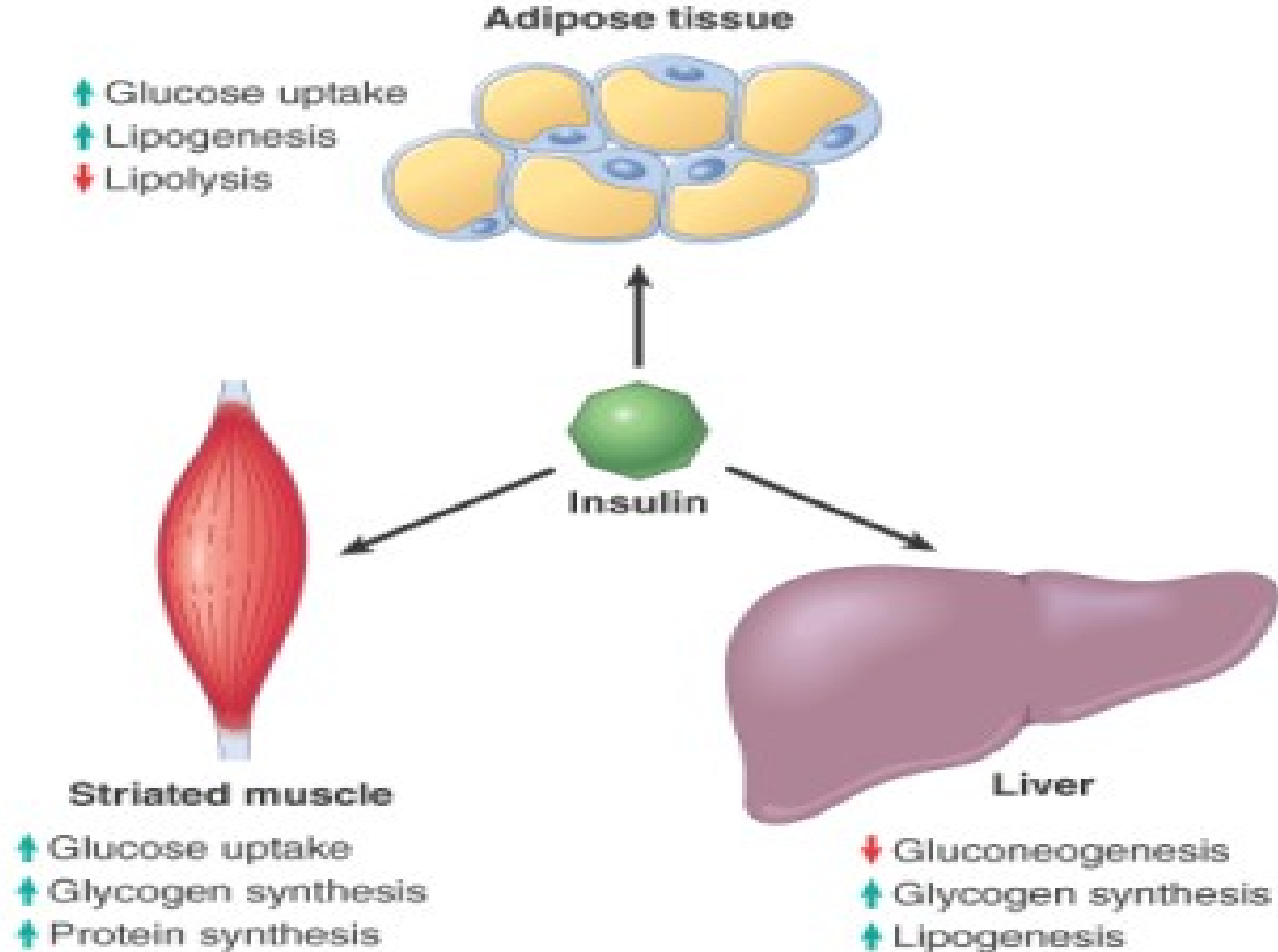
Functions of insulin

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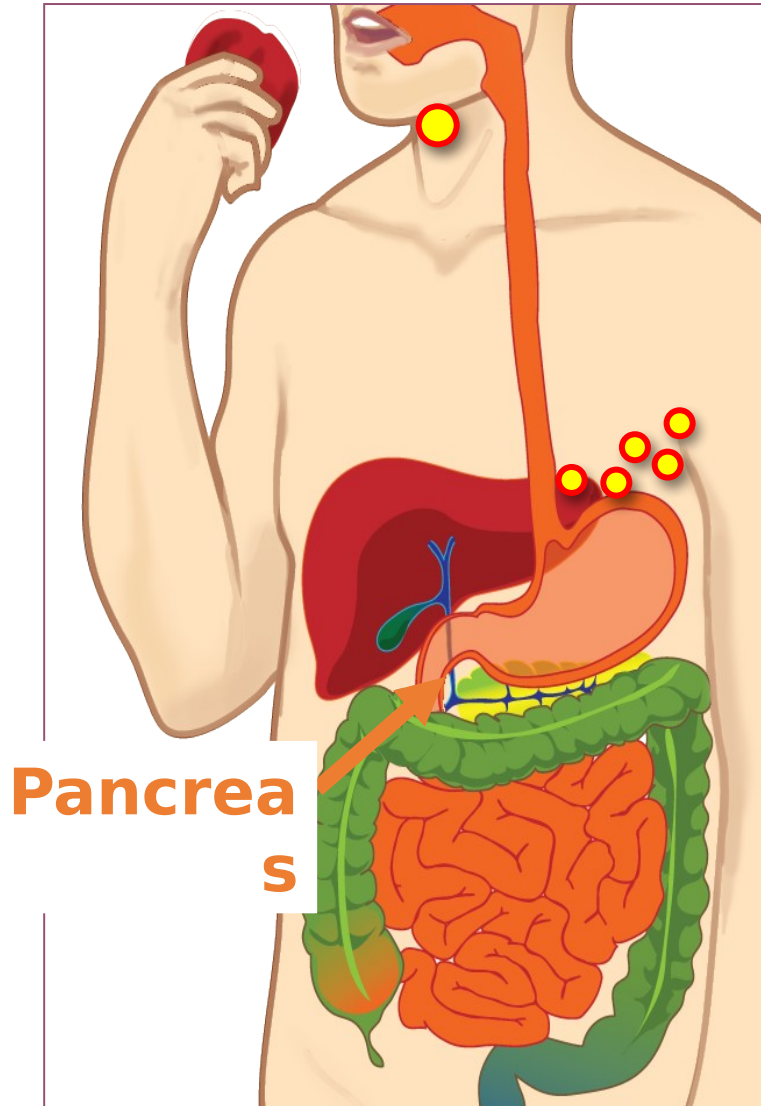
- Enables glucose to be transported into cells for energy for the body
 - Glucose is the preferred fuel of the body cells and the only fuel that the brain can use
- Facilitates conversion of:
 - ✓ **excess glucose** → **fat**
 - ✓ **glucose** → **glycogen** to be stored in muscles and the liver
- Prevents the breakdown of body protein for energy



Functions of insulin



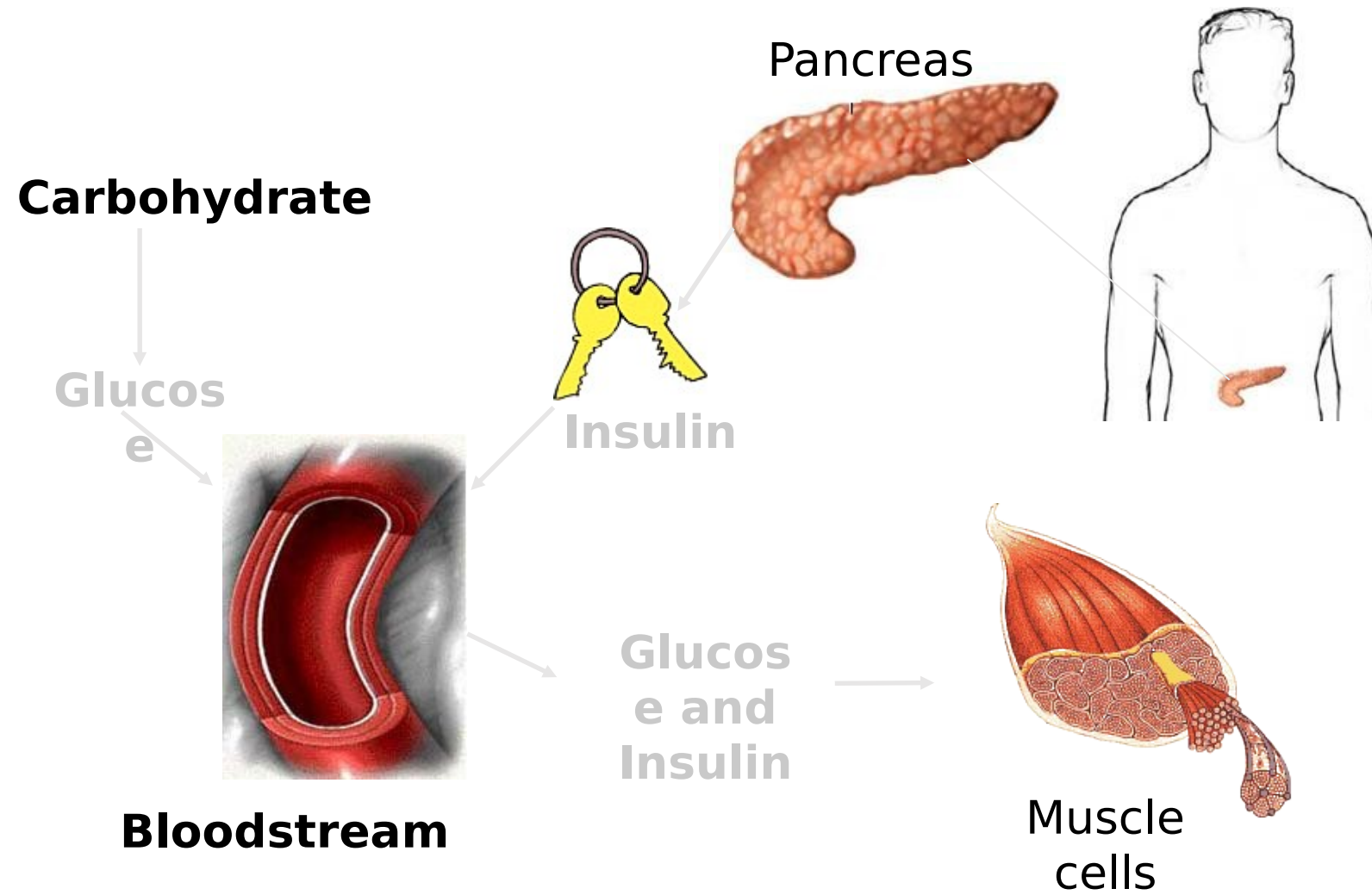
How Food Becomes Glucose



- During digestion, food is broken down to sugar (glucose)
- Insulin lowers blood sugar by helping sugar move from blood into cells
- The body's cells use sugar for energy

Glucose

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What Is Diabetes Mellitus?

In people with diabetes...

The pancreas does not make any insulin

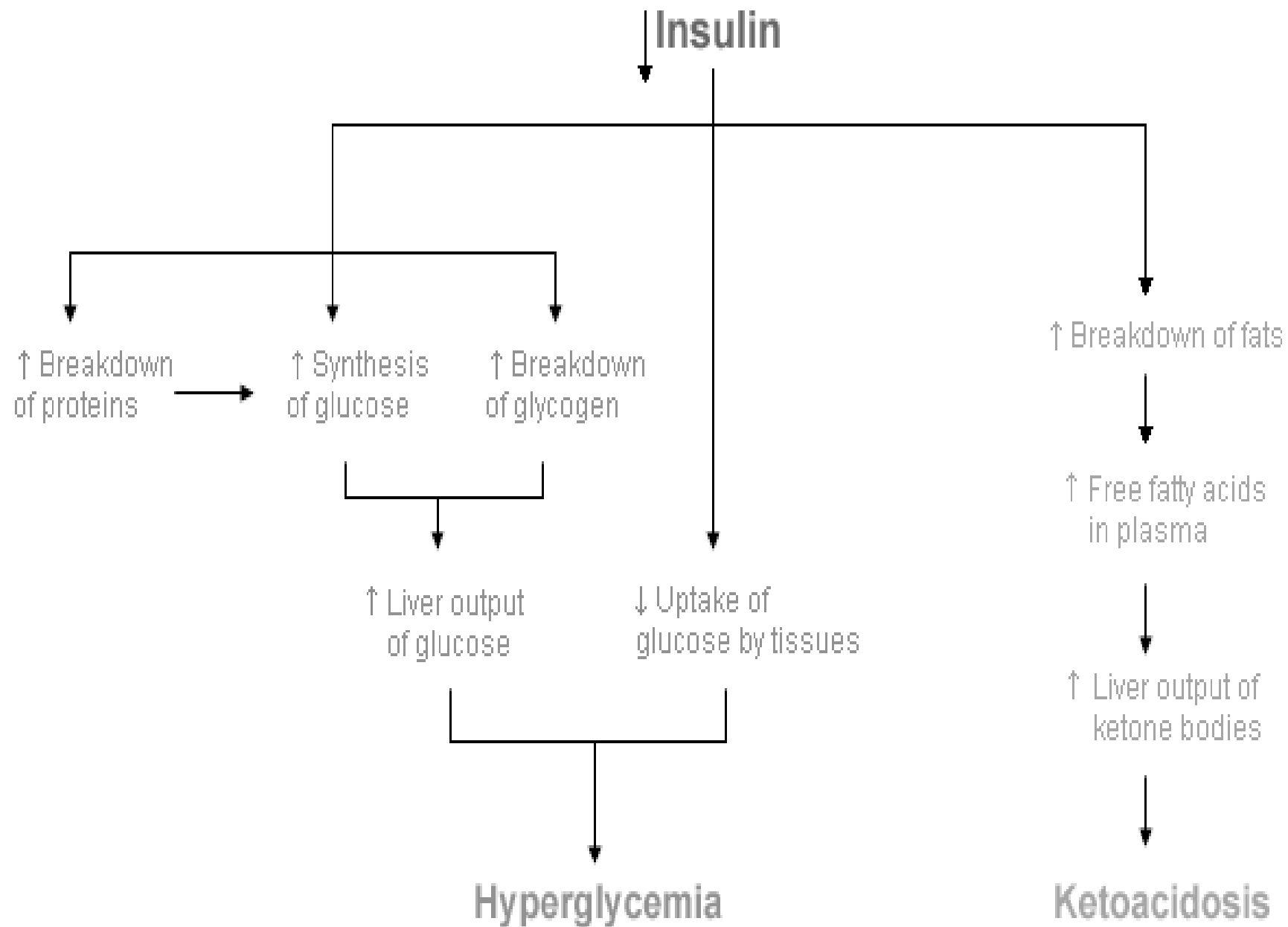
OR

The pancreas does not make enough insulin
(this gets worse with time)

OR

The body prevents the insulin that is being made from working correctly

Blood sugar gets too high and can lead to many serious problems (complications)



Types of Diabetes

1. Type 1 DM
2. Type 2 DM
3. Gestational DM
4. Other types:
 - A. LADA (Latent Autoimmune Diabetes in Adults)
 - B. MODY (maturity-onset diabetes of youth)
 - C. Secondary Diabetes Mellitus

Type 1 diabetes

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- ▶ Previously called IDDM or juvenile-onset DM.
- ▶ Characterized by an acute onset.
- ▶ Usually strikes children and young adults, although disease onset can occur at any age.
- ▶ May account for 5% to 10% of all diagnosed cases of diabetes.

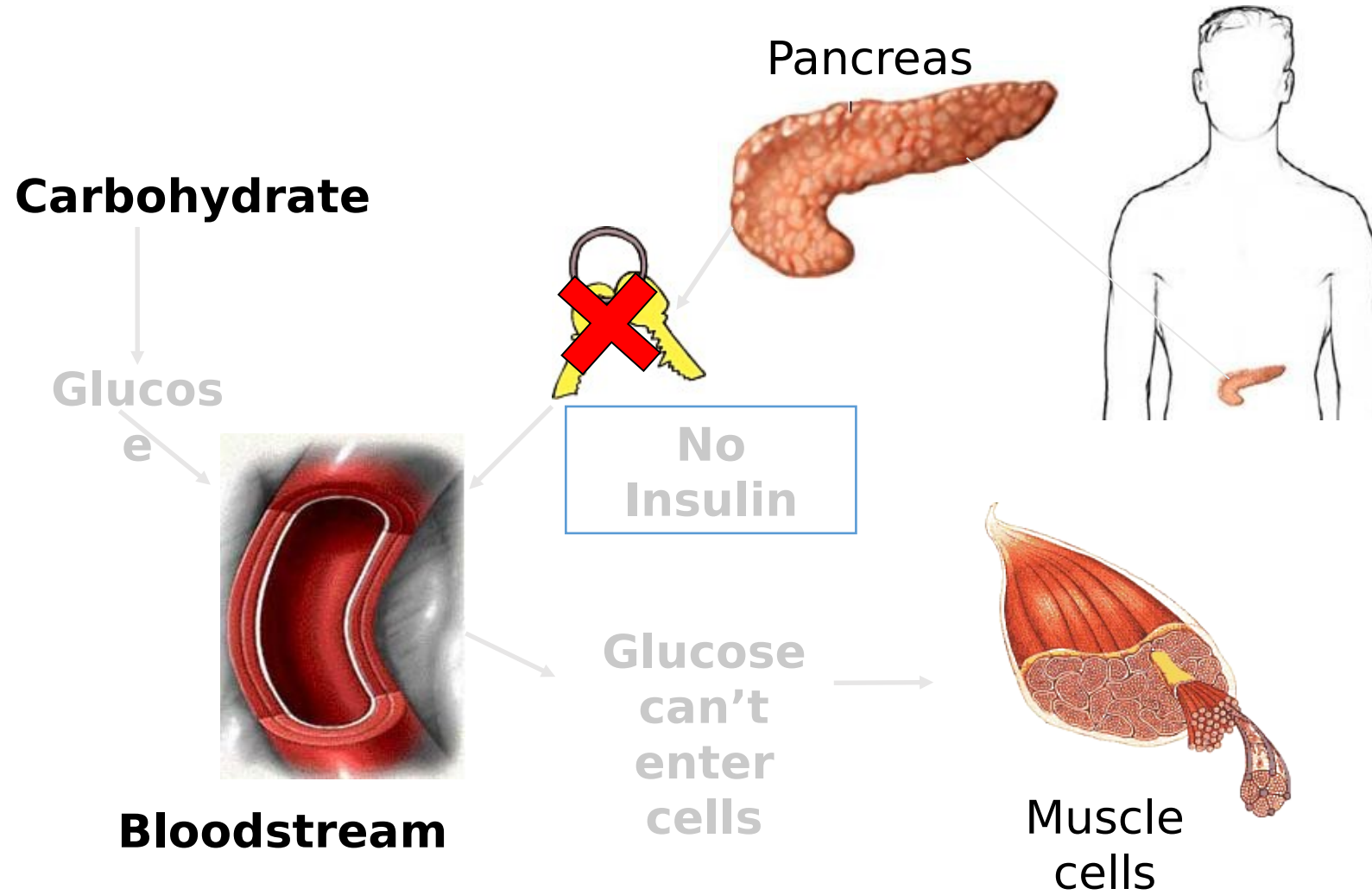
T1D

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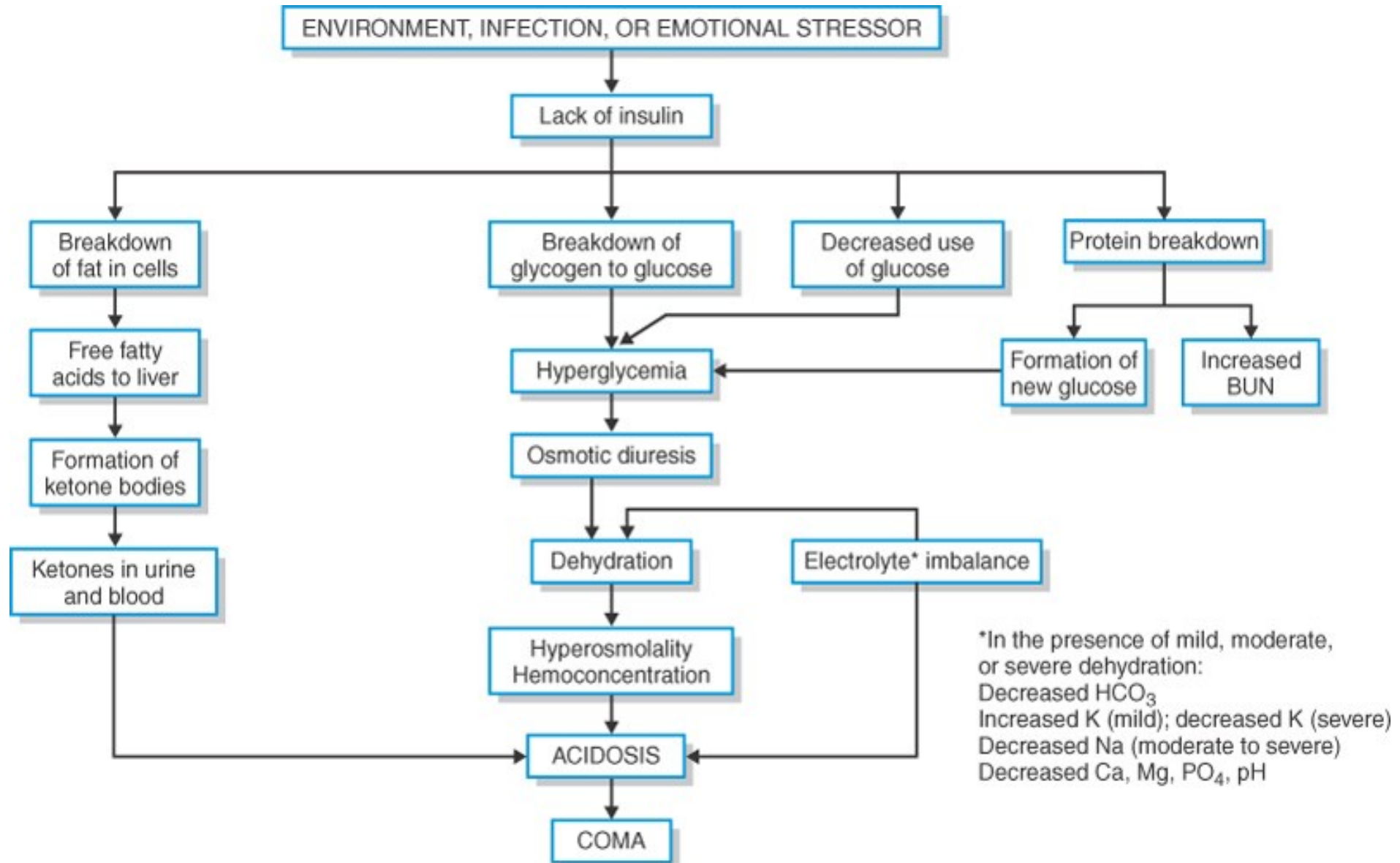
- ▶ **Etiology:** Most cases of T1D are due to **destruction of the pancreatic β -cells by T-cells** (WBCs concerned with the immune system).
- ▶ Clinical symptoms of T1D occur when **$\sim 90\%$ of β -cells** cells have been destroyed.

T1D

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PP of T1D



Type 2 diabetes

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- ▶ Previously called **NIDDM** or **adult-onset DM**.
- ▶ May account for about 90% to 95% of all diagnosed cases of diabetes.
- ▶ Usually seen in older people.
- ▶ With the onset many people do not have dramatic symptoms compared to those with T1D.

T2D

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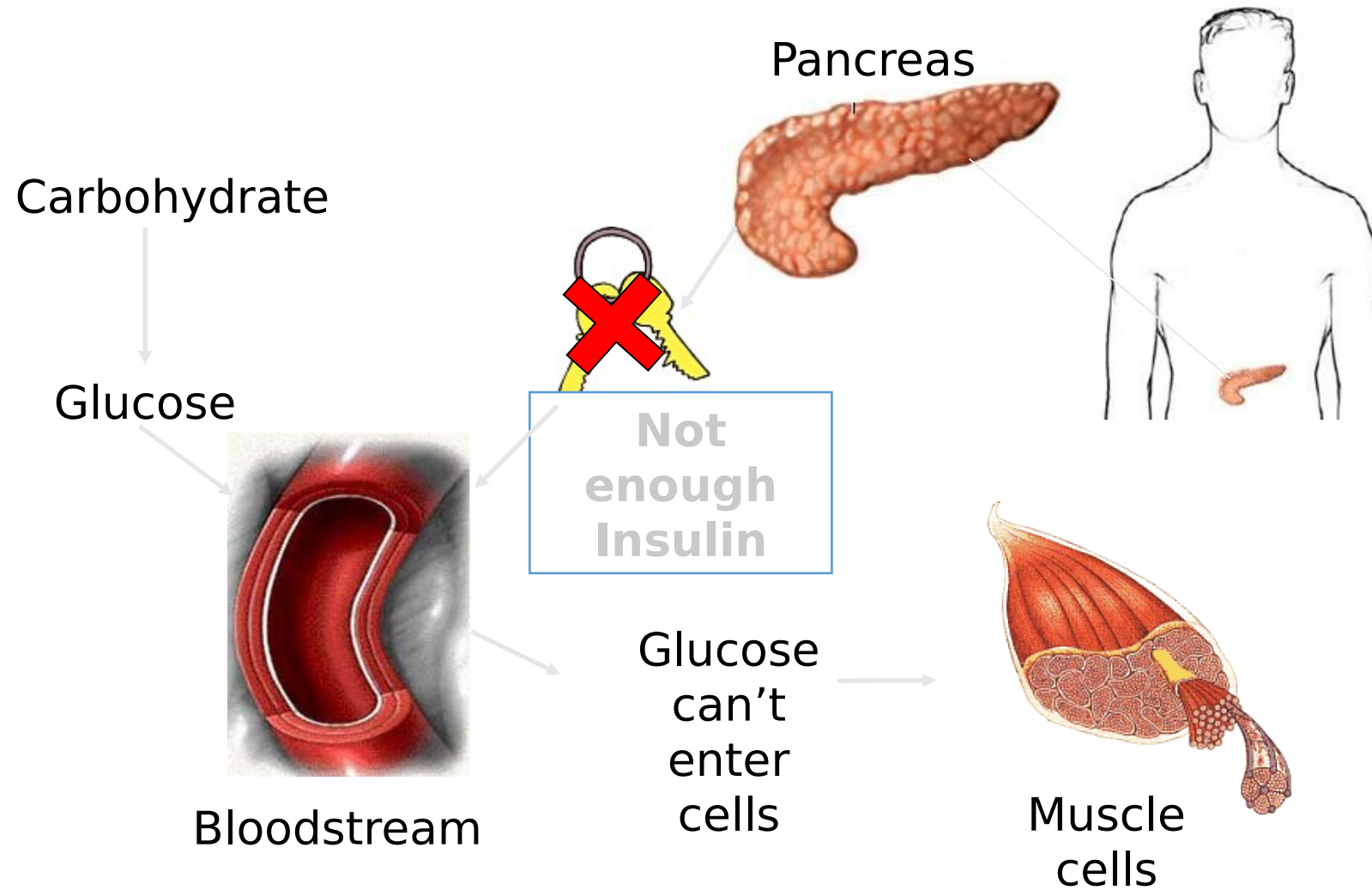
- ▶ Associated with older age, obesity, family history of DM, history of gestational diabetes, impaired glucose metabolism, physical inactivity, & race/ethnicity.
- ▶ In recent years, T2D has been increasingly found among **children and adolescents**;
 - ✗ in association with increasing early obesity and
 - ✗ in those who have a family history of T2D, or²¹ whose mothers had diabetes in pregnancy

T2D

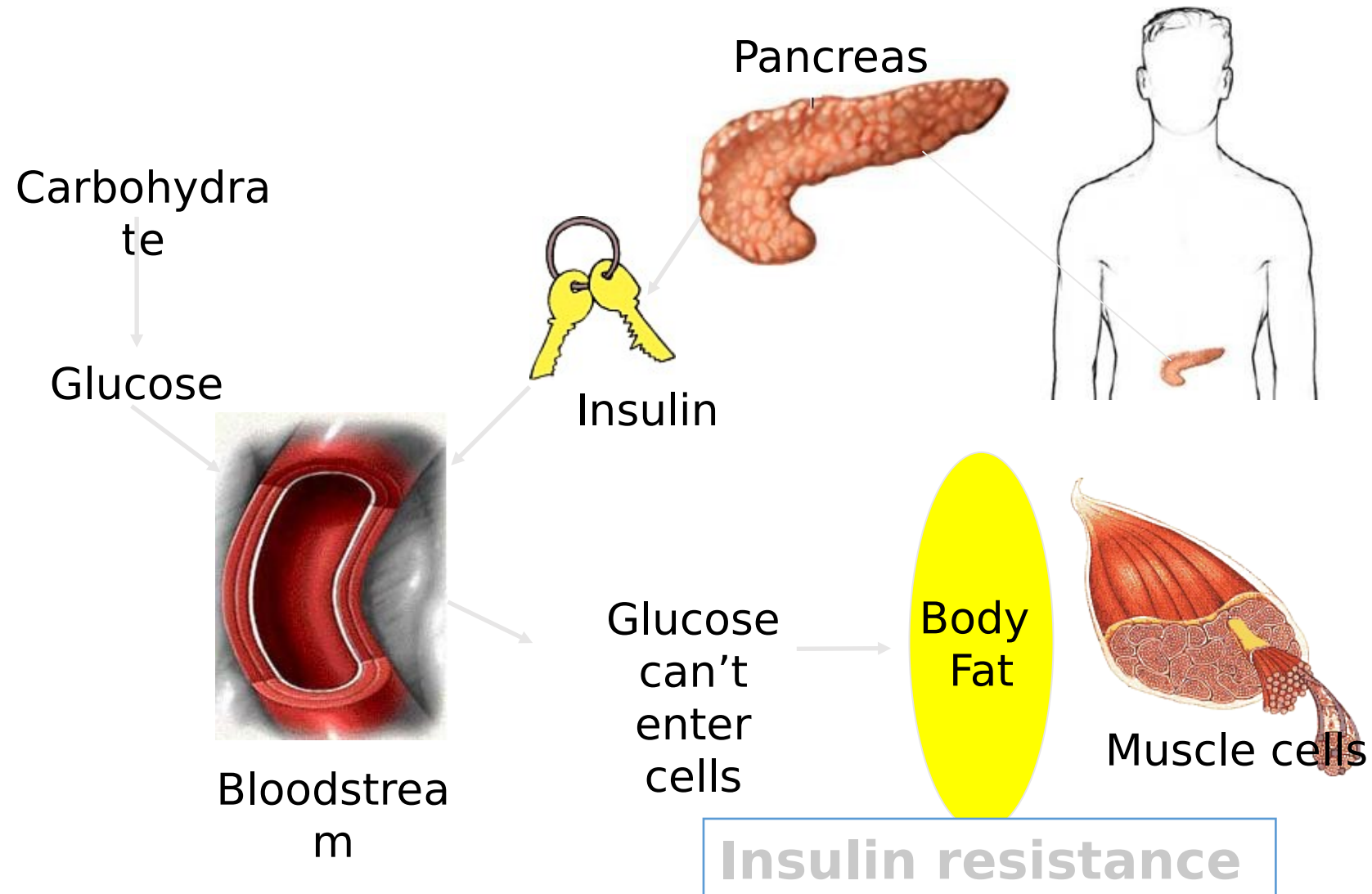
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- **Etiology:** it results from either
 - **Insulin resistance** (overweight people), is the decreased response of the liver and peripheral tissues (muscle, fat) to insulin,
 - **Inadequate insulin production** (lean people), or
 - **combination of both.**

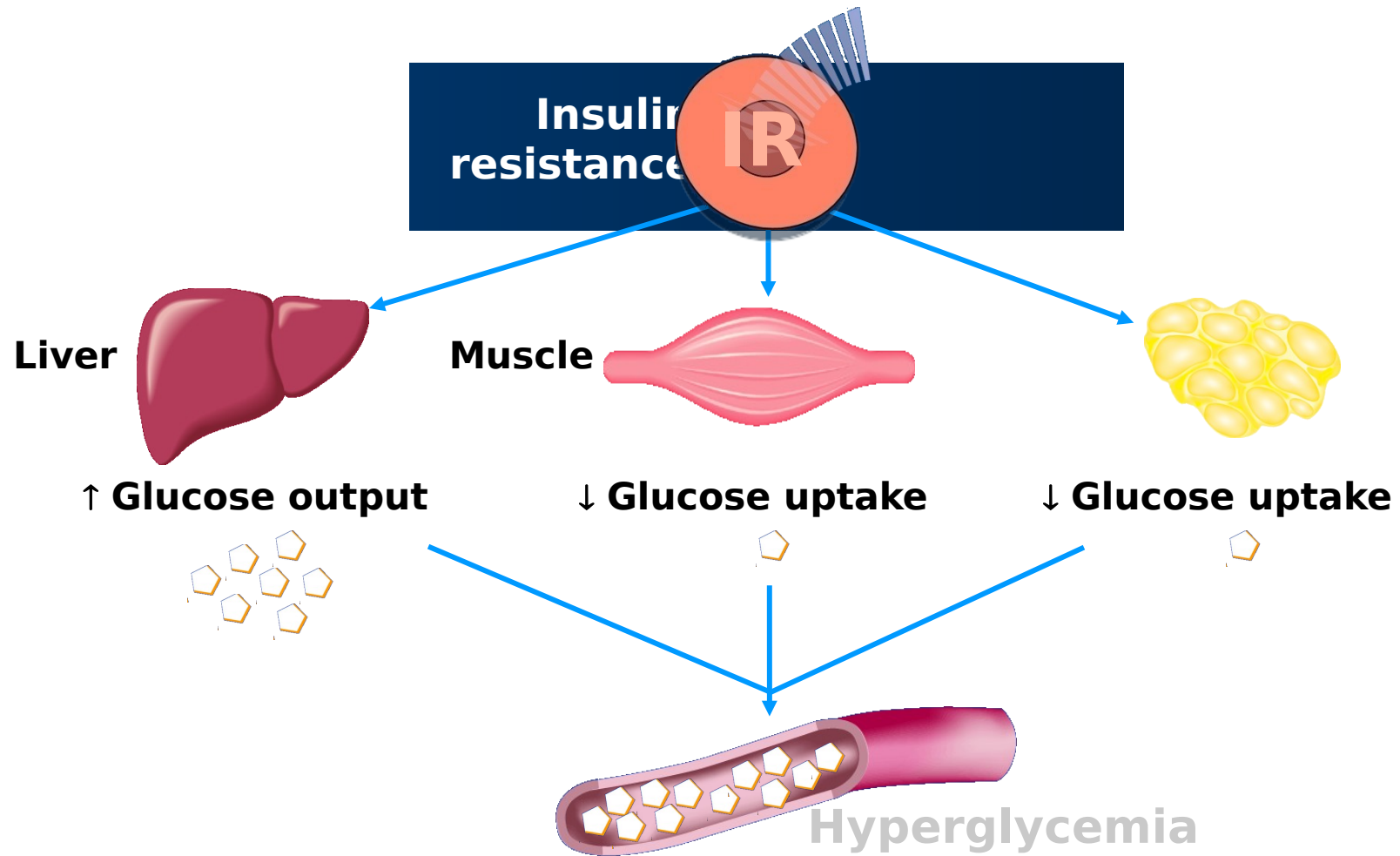
People with Type 2 diabetes



People with Type 2 diabetes



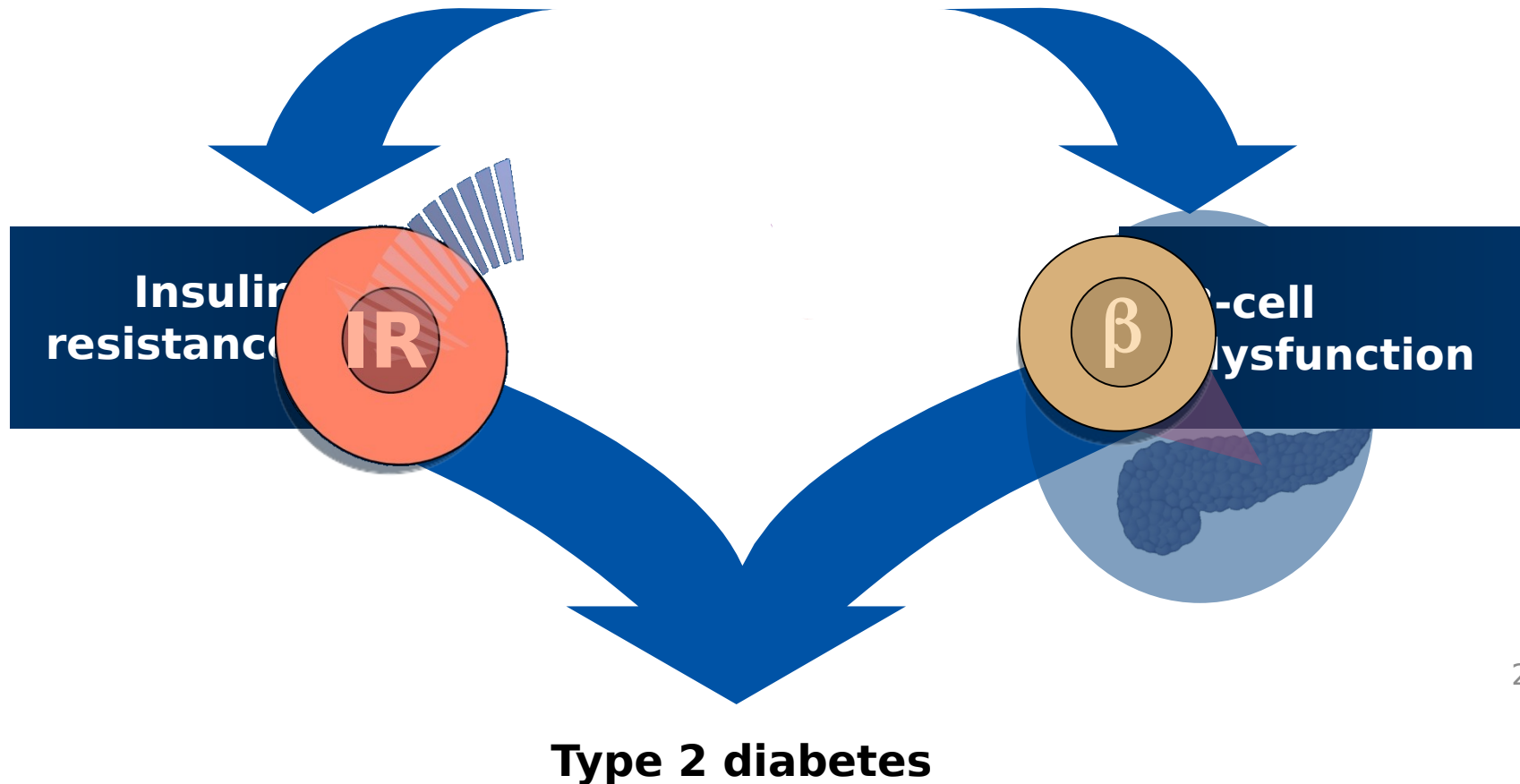
IR- reduced response to circulating insulin



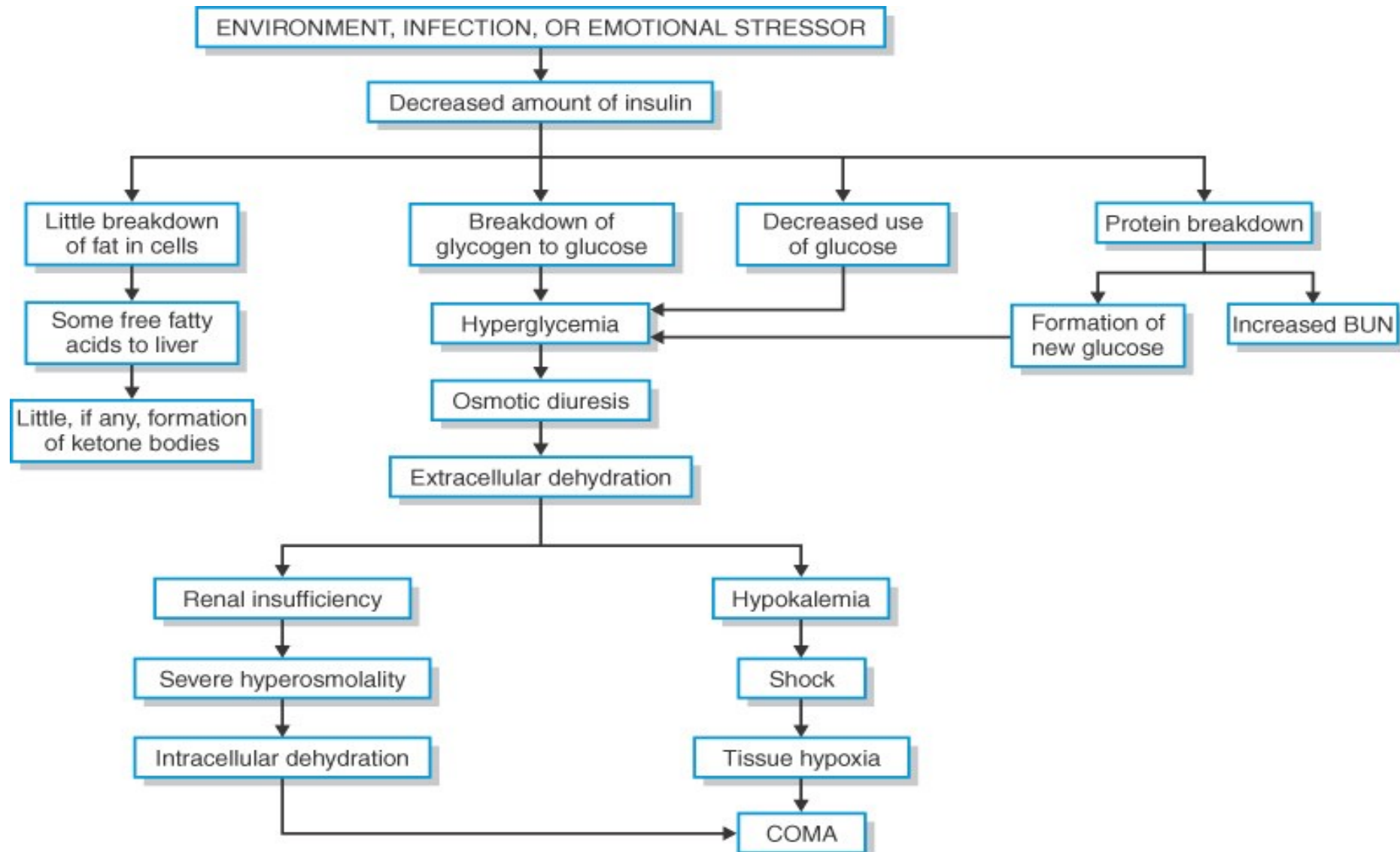
Insulin resistance and β -cell dysfunction are core defects of type 2 diabetes

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**Genetic susceptibility,
obesity, sedentary
lifestyle**



PP of T2D



Difference between T1D and T2D

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Characteristics	Type 1 Diabetes	Type 2 Diabetes
Formerly known as	IDDM or “Juvenile-onset” DM	NIDDM or “adult-onset” DM
Etiology	Autoimmune	Peripheral resistance
% of diabetic pop/n	5-10%	90-95%
Age of onset	Usually < 30 yr + some adults	Usually > 40 + some obese children
Onset	Rapid	Gradual
Pancreatic function	Little or no insulin	Insulin is: low, normal or high
Family history	Generally not strong	Strong
Obesity	Rare (Normal or underweight)	Common (80% are overweight)
Hx of ketoacidosis	Often present	Rare except in stress
Clinical presentation	moderate to severe symptoms: 3Ps, fatigue, wt loss and ketoacidosis	Mild symptoms: Polyuria and fatigue. Diagnosed on routine PE
Treatment	Insulin, Diet, Exercise	Diet, Exercise, Oral anti

Gestational diabetes

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- ▶ Hyperglycemia diagnosed in some women during pregnancy.
- ▶ **Ethiology:** placental hormones, which causes insulin resistance.
- ▶ During pregnancy, GDM requires treatment to normalize maternal blood glucose levels to avoid complications in the infant.

GD

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- ▶ After pregnancy, 5% to 10% of women with gestational diabetes are found to have T2D.
- ▶ Women who have had gestational diabetes have a 20% to 50% chance of developing T2D in the next 5-10 years.
- ▶ Screening for diabetes during pregnancy is now being recommended between the 24th & 28th weeks of gestation.

- GDM occurs more frequently among :
 - ❑ age 25 years or older;
 - ❑ age 25 years or younger and obese;
 - ❑ family Hx of diabetes in first-degree relatives; or
 - ❑ Member of an ethnic/racial group with a high prevalence of diabetes (eg, Hispanic American, Native American, Asian American,

RISK FACTORS OF DM

Risk factors that cannot be changed:

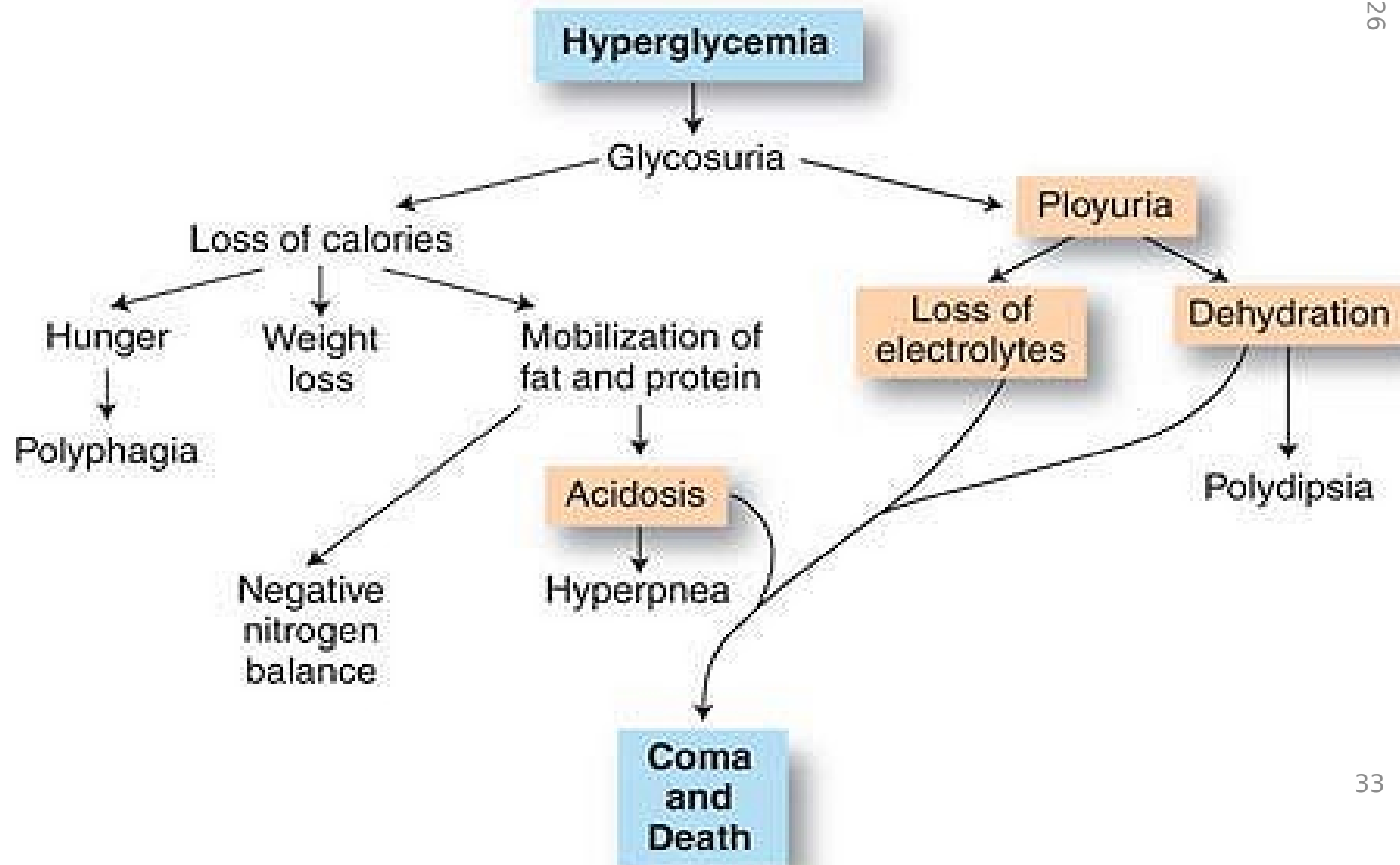
- Family history of diabetes
- High-risk ethnic population
- History of heart disease
- History of GDM or delivery of babies over 4kg (9 lbs)

Risk factors that can

be changed:

- Overweight (i.e., BMI ≥ 27 kg/m²)
- High blood pressure ($\geq 140/90$ mm Hg)
- Physical inactivity

CLINICAL MANIFESTATIONS



CMs

Other symptoms include:

- ▮ sudden vision changes,
- ▮ tingling or numbness in hands or feet,
- ▮ dry skin, skin lesions or wounds that are slow to heal, and
- ▮ recurrent infection,
- ▮ Impotence in men,
- ▮ The signs of ketoacidosis are:
 - ✗ Nausea, Vomiting,
 - ✗ Pain in the stomach,
 - ✗ Rapid / Acidotic breathing,
 - ✗ High pulse rate,

DIABETES

KNOW THE SYMPTOMS

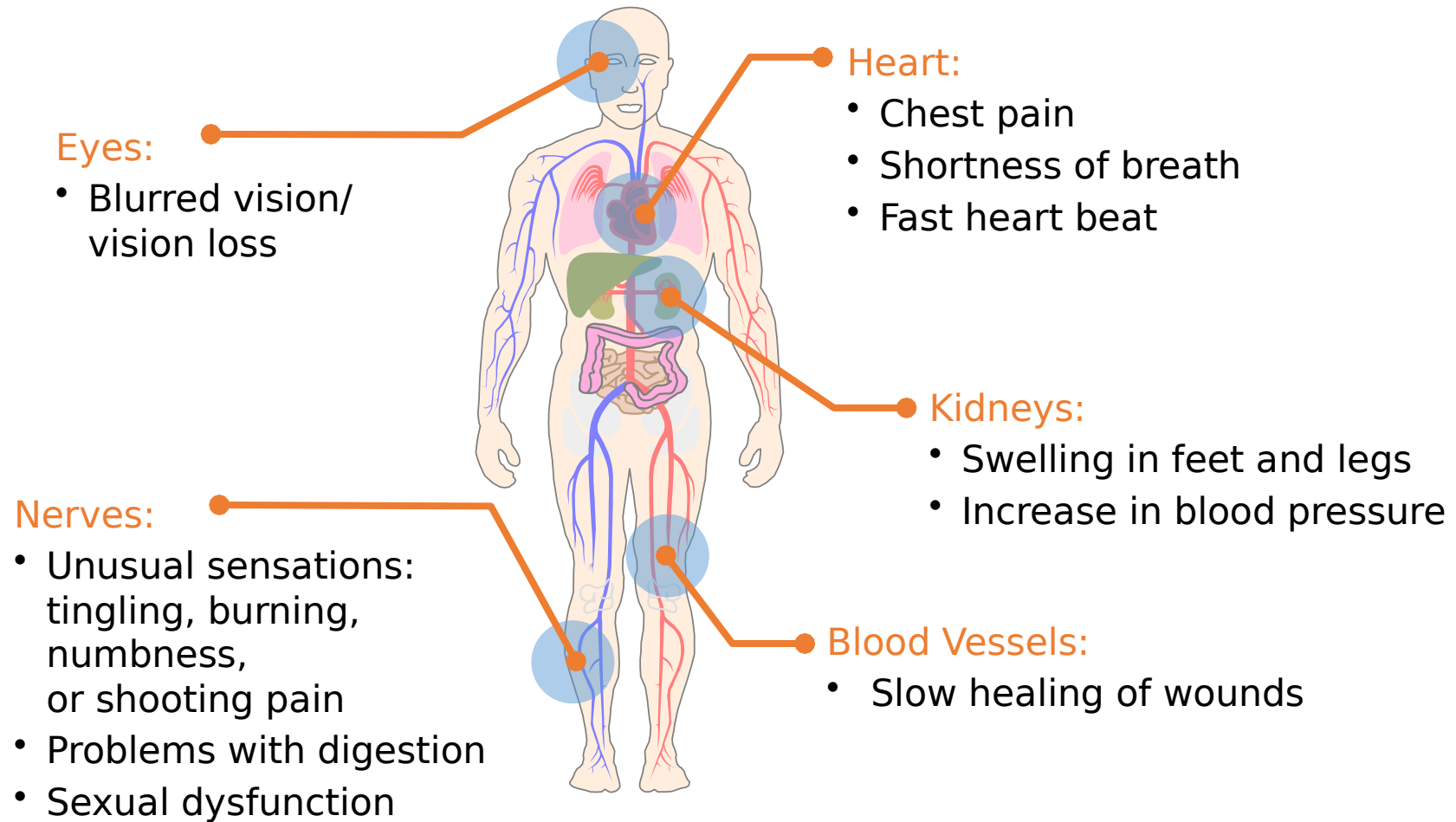


CMs

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- Some patients may be Asymptomatic mainly Type 2 and Gestational diabetes patients
- **In the long term,**
 - T1D can severely hurt the blood vessels in vital organs. This can further cause damage to the heart, eyes, kidneys or other body organs.
 - T2D can cause atherosclerosis with blood vessel narrowing, heart disease and stroke.

In the long term, Diabetes Can Cause Problems in Many Parts of the Body:



DIAGNOSIS OF DIABETES

Laboratory Tests

1. Blood Tests

- **FBG test:** two tests > 126 mg/dL
- **OGTT:** > 200 mg/dL at 2hrs.
- **Glycosylated hemoglobin (HbA1c) test**
- **FSBS** (finger stick blood sugar)

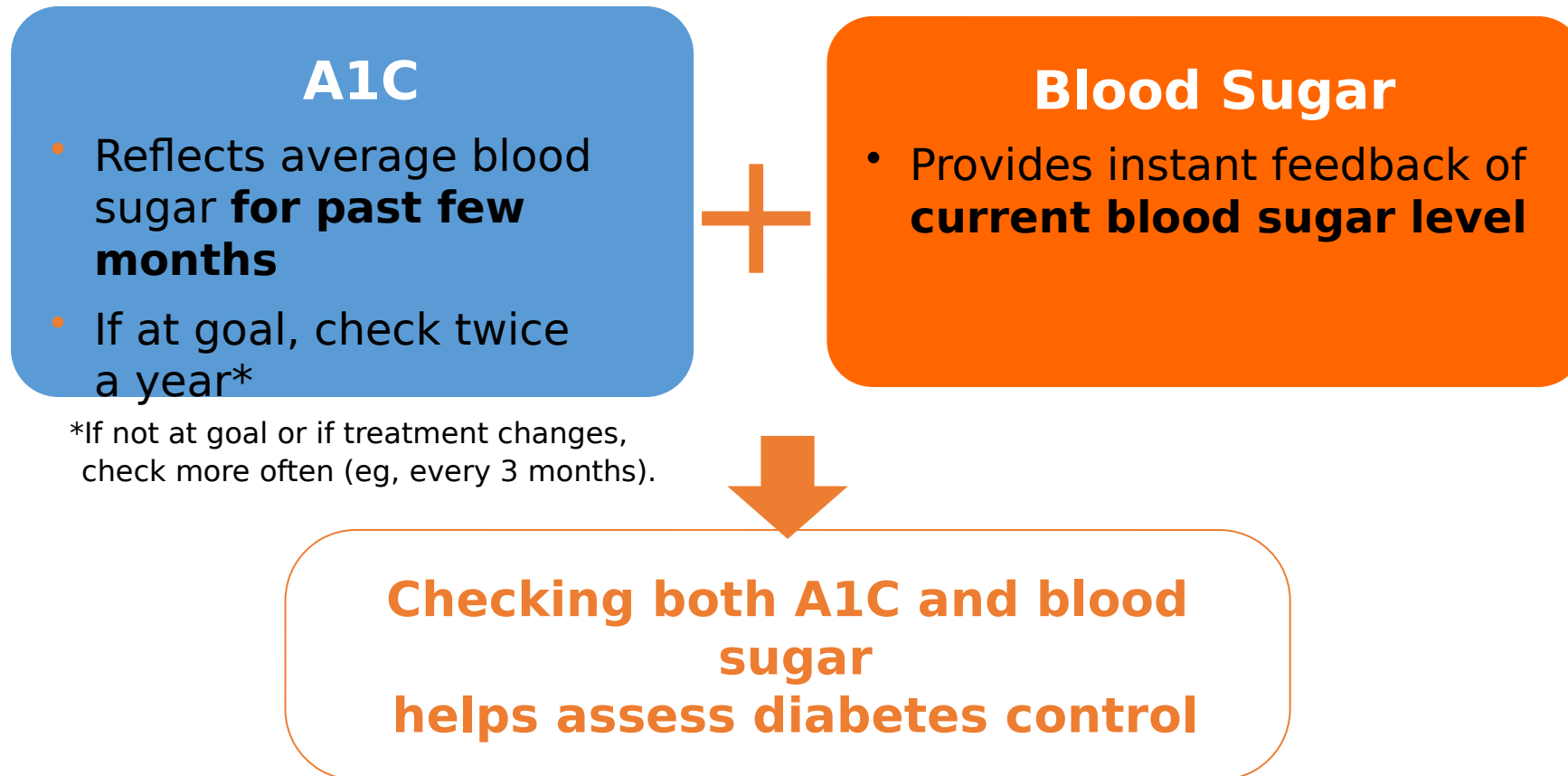


Laboratory Tests

Hemoglobin A1c is:

- glycosylated hemoglobin.
- a good indicator of blood glucose control.
- is the blood test with a memory.
- gives a % that indicates control over the preceding 2-3 months.
- Performed 2 times a year.
- A hemoglobin of 6% indicates good control and level >8% indicates action is needed.

Checking Both A1C and Blood Sugar Is Important



Laboratory Tests

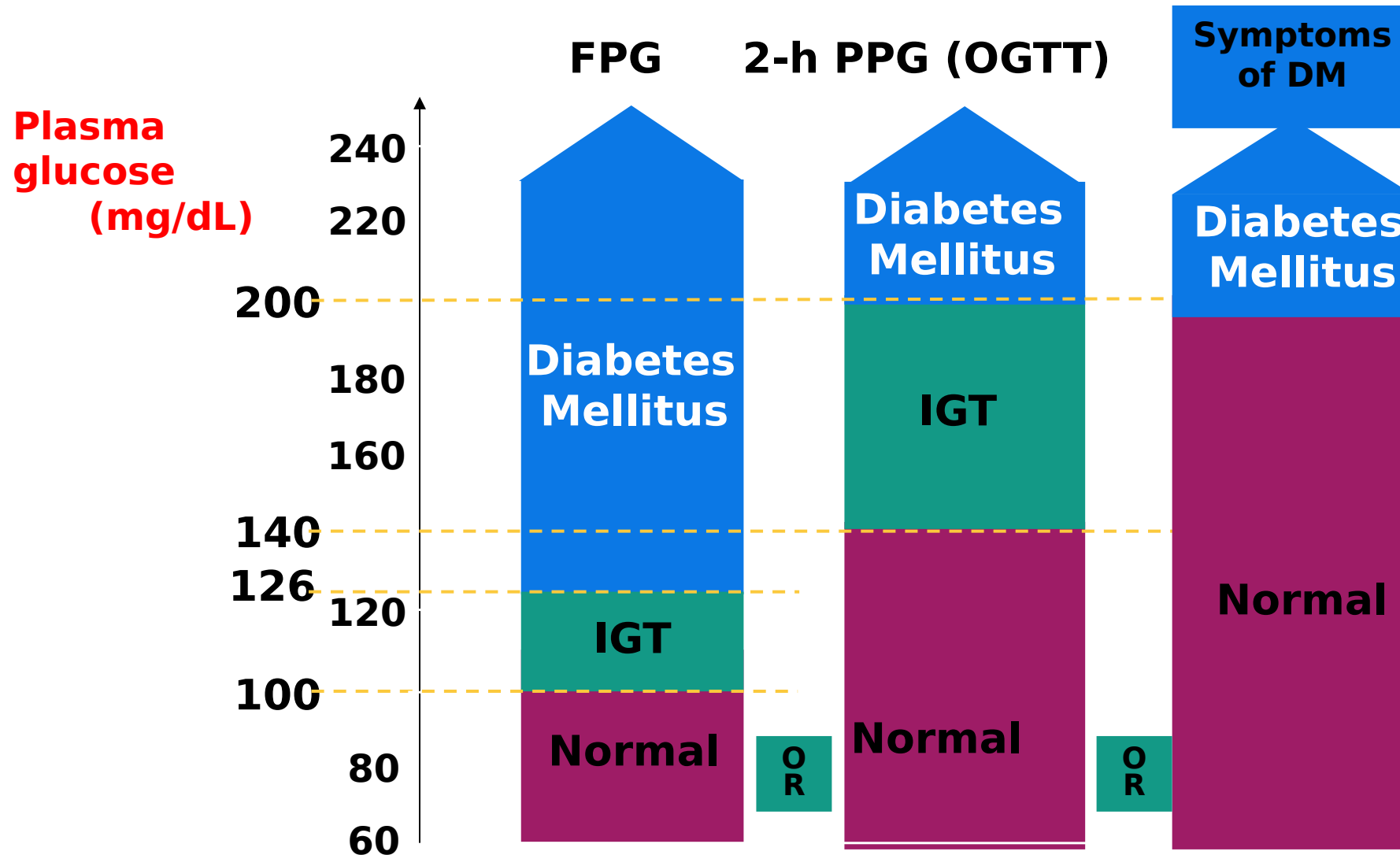
2. Urine Test:

Urine Test If blood glucose test strips are not available

- Ketone
- Renal function
- Glucose

Diagnostic Criteria of Diabetes

C/RPG



'Casual' -that measured at any time of day.

American Diabetes Association. *Diabetes Care*. 2004;27(suppl 1):S5-S10

Diagnosis of Pre-diabetes and Diabetes

Category	ADA & AACE Recommendations		ADA Recommendations
	FPG (blood sugar in the morning, before eating)	2-h PPG (OGTT) (blood sugar after meals)*	A1C[†]
No Diabetes	<100 mg/dL	<140 mg/dL	<5.7%
Prediabetes	100-125 mg/dL	140-199 mg/dL	5.7%-6.4%
Diabetes	≥126 mg/dL	≥200 mg/dL	≥6.5%

**** On 2 separate occasions**

A1C ~ average blood sugar for past few months

ADA=American Diabetes Association; AACE=American Association of Clinical Endocrinologists; FPG=fasting plasma glucose; PPG=postprandial glucose.

*2-h plasma glucose on the 75-g oral glucose tolerance test. †ADA only.

1. American Diabetes Association. *Diabetes Care*. 2010;33(suppl 1):S11-S61. 2. Rodbard HW, et al. *Endocr Pract*. 2007;13(suppl 1):3-68.

Pre-Diabetes

- Pre-diabetes refers to a state between “normal” and “diabetes”.
- **FBG100 -125mg/dL** (higher than normal but not high enough for diagnosis of diabetes)
- Affects about 41 million people in USA
- Previously referred to as either **IFG** or **IGT**

Pre-Diabetes

Impaired Fasting Glucose (IFG)

- Defined as a **FBG** $\geq$ to 100 but $<$ 126

Impaired Glucose Tolerance (IGT)

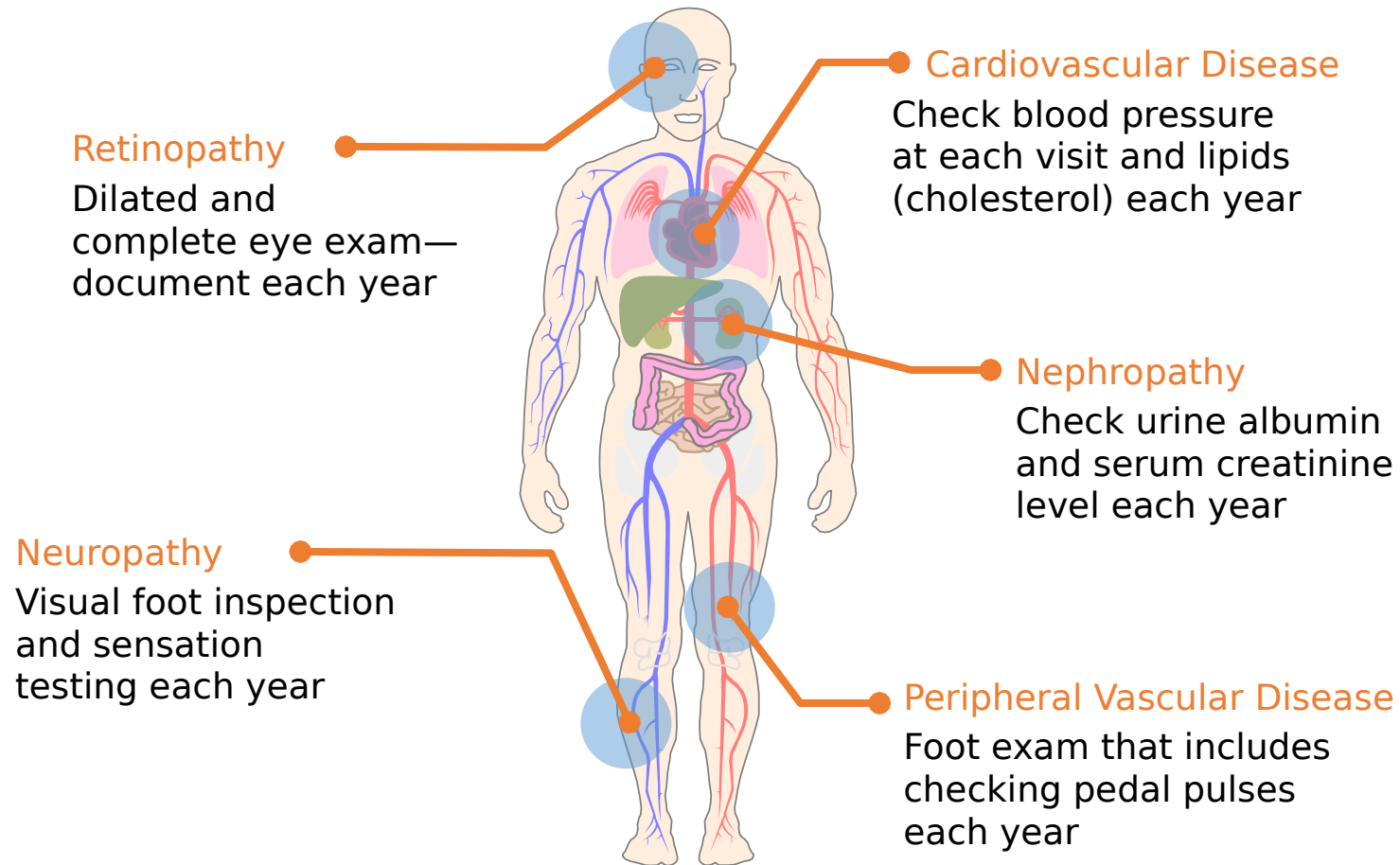
- Defined as a plasma blood glucose of $\geq$ to 140 but $<$ 200 after a 2 hr 75gm glucose tolerance test
- 8-10% of US population have this problem with a 25 % risk of developing T2DM

Values of Diagnosis of DM & Other Hyperglycemas

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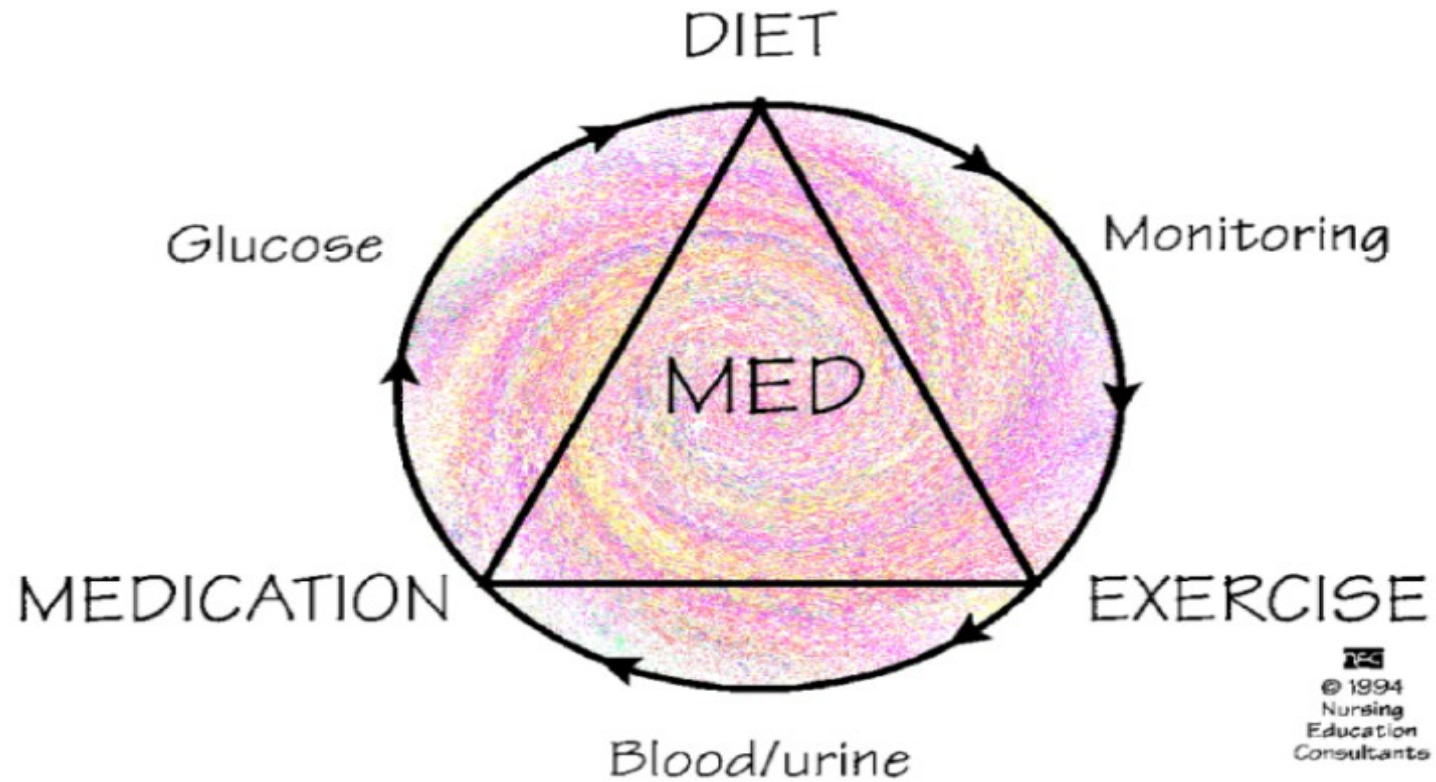
Category	Venous Plasma*Glucose concentration, Mmol l ⁻¹ (mg dl ⁻¹)
Diabetes mellites	
Fasting or	≥7.0 (≥126)
2-h post glucose load	≥11.1 (≥200)
Impaired Glucose Tolerance (IGT)	
2-h post glucose load	(≥140 - <200)
Impaired Fasting Glycaemia (IFG)	
Fasting	(≥100 - <126)

Recommendations for Screening of Diabetes Complications in Stable Patients



Management of DM

TRIANGLE OF DIABETES MANAGEMENT



Type One: Insulin + Diet + Exercise

Type Two:

Diet + exercise

then

Diet + exercise + OHG tablets

then

Diet + exercise + OHG tablets + insulin

Treatment Goals

INDEX	GOAL
<u>Glycemic control</u>	
▶ A1C	▶ <7%
▶ Preprandial plasma glucose	▶ 90-130 mg/dl
▶ Peak post prandial plasma glucose	▶ <180 mg/dl
▶ FBS or	▶ <130 or
▶ RBS	▶ <200
<u>Blood pressure</u>	<130/80
<u>Lipids</u>	
▪ LDL	▶ <100mg/dl
▪ HDL	▶ >40mg/dl
▪ Triglycerides	▶ <150mg/dl

Healthcare Team

Members of the team include

1. Primary care provider
2. Endocrinologist/ Diabetologist
3. Certified diabetes educator
4. Nutritionist
5. Sub specialists



A. Non pharmacologic Therapy

1. Patient or Diabetes Education
2. Healthy eating/Diet
3. Exercise
4. Weight reduction
5. Self-monitoring of blood glucose
(SMBG)