

# CARBOHYDRATE METABOLISM DISORDERS

## DIABETES MELLITUS

### Fasting blood glucose:

Normal value after 12-14 hours of fasting is 70-110 mg/dL (2.8-6.2 mmol/L).  
(mmol/L × 18 = mg/dL)

Hyperglycemia

Hypoglycemia

### Fasting glucose levels according to age:

- < 2 days: 40 - 60 mg/dL
- < 1 year: 50 - 80 mg/dL
- 1-15 years: 60 - 106 mg/dL
- > 15 years: 74 - 106 mg/dL

## During glucose measurement

Patient has to be fasting for 12-14 hours. However, water consumption can continue, because dehydration can result with high glucose levels.

Serum or plasma has to be prepared in 30 minutes because blood cells continue using glucose.

Glucose levels continue to decrease if blood is kept without centrifugation.

It is better not to keep tourniquet for a long time to abstain from decreased glucose levels.

## **Type 1 DM:**

**Autoimmune or idiopathic. Tendency to Type 1 diabetes is hereditary.**

**Usually insulin is insufficient.**

**Ketosis is common.**

**Usually insulin is used as medication.**

## **Type 2 DM:**

**Insulin levels can be normal, low or high.**

**Hereditary.**

**Ketosis is rare.**

**Diet is important, oral hypoglycemic agents or insulin**

# Hyperglycemia:

## Causes of hyperglycemia:

1- Primary :

Diabetes mellitus

2- Secondary

Other pancreas diseases

Some other endocrine diseases

Cushing,

Thyrotoxicosis,

Pheochromositoma

Drugs

Steroids, Thiazide diuretics, beta  
blockers, oral contraceptives,

Some chronic diseases

Chronic kidney disease

Chronic liver disease

Infections

Other

Pregnancy

## Tests:

Blood sugar  
OGTT  
Ketones in urine

## Monitoring:

### Acute:

Glucose (Urine and blood)  
Ketones (Urine and blood)  
Acid-base  
Lactate  
Other parameters of cellular dehydration  
(K, Na, etc.)

### Chronic:

Blood glucose (fasting and normal)  
Urine glucose  
Glycosilated proteins (HbA1c, Fructosamine)  
Kidney functions; Urine proteins, Urea,  
Kreatinine,  
Lipids; Cholesterol, triglycerides etc

## Blood sugar levels:

### In healthy people:

Fasting 70-110 mg/dL (2.8-6.2 mmol/L)

2 hours after meals < 140 mg/dL

Random < 130 mg/dL (in older people <180 mg/dL)

Capillary blood (fingertip) glucose is 2-7 mg/dL higher than venous blood.

Capillary blood (fingertip) glucose is % 10-15 lower than plasma.

## As a result of the test:

OGTT > 200

≥ 140 mg/dL

If venous plasma ≥ 126 mg/dL or capillary and venous blood ~ 110 mg/dL DM is diagnosed.

However, in 2003 American Diabetes Association declared the highest limit for fasting blood glucose as, **5.6 mmol/L (100 mg/dL)**.

## Glycosylated proteins

Hemoglobin  $A_{1c}$  (glycosylated hemoglobin)

Fructosamine and glucosamine

Hemoglobin  $A_{1c}$  : % 4.5-5.5

HbA<sub>1c</sub> is the ratio of glycosylated beta-chain levels to all beta-chain levels.

- In type 1 diabetes, high HbA<sub>1c</sub> level is an indicator of developing retinopathy after 4 years
- Every % 10 drop in HbA<sub>1c</sub> levels decreases this risk by %

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## Hemoglobin A1c interpretation

Hb A1c: 5.5% equivalent glucose level 100 mg/dL

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Hb A1c: 7.0%	"	150
Hb A1c: 8.0%	"	180
Hb A1c: 9.0%	"	220
Hb A1c: 10.0%	"	250
Hb A1c: 11.5%	"	300
Hb A1c: 13.0%	"	350

Every %1 increase in HbA1c levels is equivalent to 30 mg increase in glucose.

**Low HbA1c levels are measured in diseases related to short life span of erythrocytes.(Etc. anemia)**

## **Glucosylated albumin and fructosamine**

**8 % of albumin in circulation is glycosylated.  
In hyperglycemia this level rises to 25 % .**

## Diabetic complications

- **Microvascular complications**  
Nephropathy, retinopathy, neuropathy are related to hyperglycemia due to increased exposure of microvascular system to high glucose levels.
- **Macrovascular complications**  
Atherosclerosis; lipotoxicity and glycosylation of lipoproteins

## Late complications of diabetes:

**\*Nephropathy Kidney functions;**

Urine proteins,

Urea,

Kreatinine,

**\*Cardiovascular diseases, Atherosclerosis;**

Cholesterol,

Triglyceride

**\*Retinopathy (eye examination)**

**\*Neuropathy**

**\* In 30 % Type 2 DM patients, late complications of diabetes are observed.**

**It is assumed that Type 2 Diabetes began at least 10 years before diagnosis.**