MEDICAL EDUCATION RESOURCE

Regulation of Blood Glucose, Insulin and Diabetes Mellitus

? REGULATION OF BLOOD GLUCOSE, GLUCOSE TESTING, GTT, IGT, IFG, INSULIN & DIABETES MELLITUS

Structured for fast reading + perfect for MBBS/PG students.

? REGULATION OF BLOOD GLUCOSE

? Normal Fasting Blood Glucose

- **70–110 mg/dL** (lab-to-lab variation exists).

? Major organs involved

- **Liver** (primary regulator)
- **Muscle**
- **Adipose tissue**
- **Pancreas (Islets of Langerhans)**
- **Brain** (uses glucose continuously)

? Hormonal Regulation

? 1. Insulin (?-cells)

Lowers blood glucose

How?

- ? Glucose uptake (muscle, adipose)
- ? Glycogenesis
- ? Lipogenesis
- ? Protein synthesis
- ? Gluconeogenesis
- ? Glycogenolysis
- ? Lipolysis

? 2. Glucagon (?-cells)

Raises blood glucose

- ? Glycogenolysis
- ? Gluconeogenesis
- ? Lipolysis

? 3. Adrenaline

- Rapid ? in glucose
- ? Glycogenolysis; ? insulin secretion

? 4. Cortisol

- ? Gluconeogenesis
- ? Protein breakdown
- Causes hyperglycemia

? 5. Growth Hormone

- Anti-insulin effect
- ? Lipolysis
- ? Insulin resistance

? 6. Thyroid Hormones

- Mild ? glucose absorption & utilization

? Sources of Blood Glucose

- Dietary carbohydrates
- Liver glycogen breakdown
- Gluconeogenesis (lactate, glycerol, amino acids)

? DETERMINATION OF BLOOD GLUCOSE

? Sample Handling

- Collected in **fluoride vial** ? inhibits glycolysis
- Plasma preferred over serum

? Laboratory Methods

1. **Glucose oxidase–peroxidase (GOD–POD)**
    - Most common; specific
2. **Hexokinase method**
    - Reference method
3. **Ortho-toluidine**
    - Older method; less specific
4. **Glucometer**
    - Uses **glucose oxidase** or **glucose dehydrogenase**

? GLUCOSE TOLERANCE TEST (GTT / OGTT)

? Indications

- Suspected diabetes
- Gestational diabetes
- Impaired glucose tolerance evaluation

? Preparation

- 3 days: normal carbohydrate diet
- Overnight fast: 10–16 hours
- No smoking/exercise during test

? Procedure

- Fasting blood glucose measured
- Administer **75 g anhydrous glucose** orally
- Measure plasma glucose at **2 hours**

? Interpretation (WHO Criteria)

? Fasting Glucose

- Normal: **<100 mg/dL**
- IFG: **100–125 mg/dL**
- Diabetes: **?126 mg/dL**

? 2-hour Post Glucose

- Normal: **<140 mg/dL**
- IGT: **140–199 mg/dL**
- Diabetes: **?200 mg/dL**

? IMPAIRED GLUCOSE TOLERANCE (IGT)

- Fasting: **<126 mg/dL**
- 2 hours post-glucose: **140–199 mg/dL**
- Indicates **pre-diabetes** ? high risk for progression.

? IMPAIRED FASTING GLYCEMIA (IFG)

- Fasting glucose: **100–125 mg/dL**
- 2-hour value: **<140 mg/dL**
- Represents early glucose dysregulation.

? INSULIN

? Secretion

- From **?-cells** as **proinsulin ? insulin + C-peptide**
- C-peptide helps measure endogenous insulin levels.

? Stimulated by

- Glucose (most potent)
- Amino acids
- Fatty acids

- Incretins (GLP-1, GIP)

? Mechanism of action

- Via **tyrosine kinase receptor**
- Activates:
  - **GLUT-4 translocation** in muscle + adipose
  - Glycogen synthesis
  - Lipogenesis
  - Protein synthesis

? DIABETES MELLITUS

? Diagnostic Criteria

Any one:

- Fasting glucose **?126 mg/dL**
- Random glucose **?200 mg/dL** + symptoms
- 2-hour glucose **?200 mg/dL**
- HbA1c **?6.5%**

? Types of Diabetes

? Type 1 DM

- Autoimmune ?-cell destruction
- Absolute insulin deficiency
- Seen in children
- Prone to ketoacidosis
- C-peptide low

? Type 2 DM

- Insulin resistance + ?-cell dysfunction
- Associated with obesity
- C-peptide normal/high early, low late
- More common in adults

? Gestational Diabetes Mellitus (GDM)

- Detected at **24–28 weeks**
- 75 g OGTT:
  - Fasting ?92
  - 1 hour ?180

- 2 hour ?153

? Complications of Diabetes

? Acute

- DKA
- HHS (Type 2)
- Hypoglycemia

? Chronic

- **Microvascular**: retinopathy, nephropathy, neuropathy
- **Macrovascular**: CAD, stroke, PVD
- Foot ulcers
- Infections

? Laboratory Markers in Diabetes

- **HbA1c** ? reflects 3-month glucose
- **Fasting glucose**
- **C-peptide** ? endogenous insulin

- **Urine ketones** ? DKA
- **Autoantibodies** (GAD, IA-2) in Type 1 DM

? Ultra-Short High-Yield Summary

- Insulin ? glucose; glucagon ? glucose.
- GOD–POD is the commonest glucose test.
- OGTT uses **75 g** glucose; 2-hour >200 = diabetes.
- IFG = fasting 100–125; IGT = 2-hour 140–199.
- Insulin acts via **tyrosine kinase / GLUT-4**.
- Type 1 = autoimmune; Type 2 = insulin resistance.
- HbA1c ?6.5% = diabetes.
- C-peptide = endogenous insulin marker.

? GESTATIONAL DIABETES MELLITUS (GDM)

? Definition

Any degree of glucose intolerance **first recognized during pregnancy** (usually 2nd or 3rd trimester).

? Why does GDM occur?

Pregnancy hormones cause **insulin resistance**:

- Human placental lactogen (hPL)
- Progesterone
- Cortisol
- TNF-?
- Growth hormone

Pancreas cannot compensate ? hyperglycemia.

? Risk Factors

- Obesity
- Family history of diabetes
- Previous GDM
- PCOS
- Macrosomic baby in past pregnancy
- Multiple pregnancy
- Age > 25 years

- Unexplained stillbirth

? Screening (24–28 weeks)

75 g OGTT single-step test (DIPSI / WHO):

Venous plasma glucose:

- **Fasting ? 92 mg/dL**
- **1 hour ? 180 mg/dL**
- **2 hour ? 153 mg/dL**

Any **one** abnormal value = **GDM**.

? Complications

? Maternal

- Type 2 DM later in life
- Pre-eclampsia
- Polyhydramnios
- Preterm labor

? Fetal

- Macrosomia

- Shoulder dystocia
- Neonatal hypoglycemia
- RDS
- Hyperbilirubinemia
- Stillbirth (uncontrolled GDM)

? Management

- Diet + exercise (first line)
- Medical nutrition therapy
- **Insulin** if needed
- Metformin (allowed in many guidelines)
- Continuous glucose monitoring in high-risk cases
- Frequent fetal monitoring

? Postpartum

- Re-test mother at **6–12 weeks postpartum** ? 75 g OGTT
- High risk of future Type 2 diabetes

? ALIMENTARY GLUCOSURIA

? Definition

Presence of glucose in urine after a **high-carbohydrate meal**, despite **normal blood glucose**.

? Cause

- Rapid intestinal absorption ? sudden transient rise in blood glucose
- Exceeds temporary **renal threshold** ? glucose spills into urine
- Often seen after heavy sweets/starch intake

? Key Points

- **Blood glucose is normal again** by the time test is done.
- No kidney disease.
- No diabetes.
- Common in:
  - Pregnancy
  - Large carbohydrate load
  - Individuals with **low renal threshold**

? Clinical Importance

- Benign condition
- Does **not** progress to diabetes
- Needs reassurance, not treatment

? RENAL GLUCOSURIA

? Definition

Glucosuria **despite normal blood glucose** because of **defective glucose reabsorption** in renal tubules.

? Types

? 1. Familial Renal Glucosuria

- Mutation in **SGLT2** transporter (proximal tubule)
- Glucose reabsorption impairment
- Autosomal recessive
- Completely benign

? 2. Secondary Causes

- Fanconi syndrome

- Pregnancy
- Heavy metal poisoning
- Certain drugs (e.g., SGLT2 inhibitors — intentionally cause glucosuria)

? Key Features

- Blood glucose = normal
- Persistent glucosuria
- No ketones
- No hyperglycemia
- Normal GTT
- No treatment usually required

? Differentiation from Alimentary Glucosuria

FEATURE	ALIMENTARY	RENAL GLUCOSURIA
Cause	High CHO load	Tubular defect
Duration	Temporary	Persistent
Blood glucose	Normal	Normal

FEATURE	ALIMENTARY	RENAL GLUCOSURIA
GTT	Normal	Normal
Pathology	None	Proximal tubule SGLT2 defect

? Ultra-Short Summary

- **GDM** ? insulin resistance of pregnancy; diagnosed by 75 g OGTT; risk of macrosomia & neonatal hypoglycemia.
- **Alimentary glucosuria** ? glucose in urine after heavy carb intake; benign; transient.
- **Renal glucosuria** ? due to tubular SGLT2 defect; persistent glucosuria with normal sugars; benign.

? REDUCING SUBSTANCES IN URINE

? What are reducing substances?

Compounds that reduce **cupric ($Cu^{2?}$) to cuprous ($Cu?$)** ions in Benedict's / Fehling's test.

? Common Reducing Substances

- **Glucose** (most common)
- **Fructose**
- **Galactose**
- **Lactose**

- **Pentoses**
- **Ascorbic acid**
- Certain **drugs** (salicylates, nalidixic acid)

? Why important?

- Positive Benedict's test ? Diabetes
- Must confirm **specific sugar** (glucose oxidase dipstick is specific for glucose)

? Clinical Contexts

- **Galactosemia** ? galactose in urine
- **Hereditary fructose intolerance** ? fructose in urine
- **Alimentary glucosuria** ? transient glucose
- **Renal glucosuria** ? glucose with normal blood sugar

? GLYCOSURIA

? Definition

Presence of **glucose in urine**.

? Mechanism

Occurs when:

1. **Blood glucose exceeds renal threshold**
   (~ 180 mg/dL in normal adults)

2. **Renal tubular reabsorption defect**
   (renal glucosuria)

? Types of Glycosuria

? 1. Diabetic Glycosuria

- Hyperglycemia exceeds renal threshold ? glucose appears in urine.

? 2. Renal Glycosuria

- Normal glucose but proximal tubule cannot reabsorb it
- Seen in:
  - Familial renal glucosuria (SGLT2 defect)
  - Fanconi syndrome
  - Pregnancy (lowered renal threshold)

? 3. Alimentary Glycosuria

- After heavy carbohydrate meal
- Temporary and benign

? 4. Endocrine Glycosuria

Hormones increasing glucose:

- Hyperthyroidism

- Cushing syndrome
- Acromegaly
- Pheochromocytoma

? DIABETES MELLITUS (DM)

? Definition

Metabolic disorder characterized by:

- **Hyperglycemia**
- Disturbed metabolism of **carbohydrates, fats, proteins**
- Due to **insulin deficiency/resistance**

? Diagnostic Criteria (any one)

- Fasting plasma glucose **?126 mg/dL**
- Random plasma glucose **?200 mg/dL** + symptoms
- 2-hour OGTT value **?200 mg/dL**
- HbA1c **?6.5%**

? Types

? Type 1 DM

- Autoimmune destruction of ?-cells
- Absolute insulin deficiency
- Younger age, thin body
- Prone to DKA

? Type 2 DM

- Insulin resistance + ?-cell dysfunction
- Associated with obesity
- Most common
- May develop HHS

? Gestational DM

- Onset during pregnancy
- Diagnosed using 75 g OGTT

? Secondary DM

- Pancreatitis, Cushing, acromegaly, steroid use, hemochromatosis

? CLINICAL PRESENTATION OF DIABETES

? 1. Classical Symptoms (“3 Ps”)

- **Polyuria**
- **Polydipsia**
- **Polyphagia**
- Often with **weight loss**

? 2. Acute Presentation

- Blurred vision
- Fatigue
- Recurrent infections (UTI, candidiasis)
- Slow wound healing
- Ketonuria (Type 1)
- DKA or HHS in severe cases

? 3. Chronic Complications

? Microvascular

- Retinopathy
- Nephropathy
- Neuropathy (peripheral, autonomic)

? Macrovascular

- Coronary artery disease
- Stroke
- Peripheral vascular disease

? 4. Other Features

- Acanthosis nigricans (insulin resistance)
- Skin infections (furuncles, candidiasis)
- Erectile dysfunction
- Neuropathic foot pain

? Ultra-High Yield Summary

- **Reducing substances ? glucose** ? Benedict's detects *all* reducing sugars.
- Dipstick detects **only glucose** (glucose oxidase).
- Glycosuria occurs when **blood glucose crosses renal threshold** or **tubular defect exists**.
- Diabetes diagnosed by FPG ?126, 2 h OGTT ?200, or HbA1c ?6.5%.
- Classical diabetes symptoms = **polyuria, polydipsia, polyphagia, weight loss**.
- Type 1 ? autoimmune ? absolute insulin deficiency ? DKA prone.
- Type 2 ? insulin resistance ? obesity ? HHS risk.

? DIABETIC KETOACIDOSIS (DKA)

(Acute emergency of Type 1 DM)

? Pathophysiology

- Absolute **insulin deficiency**
- ? Glucagon ? ? Lipolysis ? ? Free fatty acids
- FFAs enter liver ? **excess ketone bodies**:
  - Acetoacetate
  - ?-Hydroxybutyrate
  - Acetone
- Results in **metabolic acidosis** (high anion gap)

? Triggers

- Infection (most common)
- Missed insulin doses
- Myocardial infarction
- Stroke
- Trauma

- Surgery

? Clinical Features

- Polyuria, polydipsia, dehydration
- Kussmaul breathing (deep, rapid)
- Fruity (acetone) breath
- Abdominal pain, vomiting
- Altered consciousness

? Laboratory Findings

- Blood glucose: **250–600 mg/dL**
- pH **<7.3**
- HCO?? **<18 mEq/L**
- Positive ketones
- High anion gap metabolic acidosis
- Potassium: initially high, body stores depleted

? Management

- IV fluids (NS)
- IV insulin infusion

- Potassium replacement
- Treat trigger (infection, etc.)

? HYPEROSMOLAR NONKETOTIC COMA (HHS / HONC)

(Acute emergency of Type 2 DM)

? Pathophysiology

- Severe hyperglycemia ? profound dehydration
- **Enough insulin present** to prevent ketosis
- Very high osmolality ? CNS depression

? Clinical Picture

- Elderly, Type 2 DM
- Profound dehydration
- Confusion ? coma
- No Kussmaul breathing
- No significant acidosis

? Laboratory Findings

- Blood glucose: **>600 mg/dL** (often >1000 mg/dL)
- pH: **>7.3**

- HCO?? **>18**
- Ketones: absent or mild
- Serum osmolality: **>320 mOsm/kg**

? Management

- Aggressive IV fluids
- Insulin (lower dose than DKA)
- Electrolyte replacement

? DKA vs HHS (Super High Yield)

FEATURE	DKA	HHS
Type	Type 1	Type 2
Glucose	250–600	>600
Ketones	Present	Absent/mild
pH	<7.3	>7.3
Osmolality	Mild ?	Very high ?
Onset	Rapid	Slow (days)
Mortality	Lower	Higher

? LACTIC ACIDOSIS

? Definition

Accumulation of **lactic acid** ? **high anion gap metabolic acidosis**.

? Causes (Important)

Type A (hypoxic)

- Shock
- Sepsis
- Severe anemia
- Cardiac failure
- Hypoxia
- Carbon monoxide poisoning

Type B (non-hypoxic)

- Metformin
- Alcohol
- Liver disease
- Malignancies
- Drugs/toxins

? Clinical Features

- Deep breathing
- Hypotension
- Severe acidosis
- Altered sensorium

? Lab Findings

- Lactate **> 5 mmol/L**
- pH **< 7.35**
- High anion gap metabolic acidosis

? CHRONIC COMPLICATIONS OF DIABETES

? 1. Microvascular Complications

? Retinopathy

- Non-proliferative ? microaneurysms, hemorrhages
- Proliferative ? neovascularization
- Risk increased by poor glycemic control

? Nephropathy

- Microalbuminuria ? macroalbuminuria ? CKD

- Kimmelstiel-Wilson nodules (nodular glomerulosclerosis)

? Neuropathy

- Peripheral (glove-and-stocking)
- Autonomic ? gastroparesis, impotence, orthostatic hypotension

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? 2. Macrovascular Complications

- Coronary artery disease
- Cerebrovascular disease (stroke)
- Peripheral arterial disease

? 3. Other Complications

- Foot ulcers
- Infections (skin, UTI, candidiasis)
- Gastroparesis
- Diabetic dermopathy
- Erectile dysfunction

? GLYCATED HEMOGLOBIN (HbA1c)

? What is HbA1c?

- Glycosylation of hemoglobin at **N-terminal valine of ?-chain**
- Reflects **average glucose over 8–12 weeks**

? Normal & Diagnostic Values

- Normal: **<5.7%**
- Pre-diabetes: **5.7–6.4%**
- Diabetes: **?6.5%**

? Therapeutic Target

- Most patients: **<7%**
- Stringent control (<6.5%) in young adults
- Lenient control (<8%) in elderly/comorbid

? Advantages

- No fasting required
- Reflects long-term control
- Useful for treatment monitoring

? Limitations

False values in:

- Hemolytic anemia
- Hemoglobinopathies
- Recent blood transfusion
- Chronic kidney disease (carbamylated Hb)

? Ultra-Short Summary

- **DKA** = Type 1, ketones + acidosis + Kussmaul breathing.
- **HHS** = Type 2, severe hyperglycemia + hyperosmolality, no ketones.
- **Lactic acidosis** = high lactate, high anion gap acidosis.
- **Chronic complications** = microvascular (retina, kidney, nerves), macrovascular (heart, brain, vessels).
- **HbA1c ?6.5%** = diabetes; reflects last 3 months.

? FAQS — Regulation of Blood Glucose, Diabetes, GTT, Complications

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1. Why does blood glucose stay within a narrow range?

Because of coordinated actions of **insulin**, **glucagon**, and other counter-regulatory hormones (cortisol, GH, adrenaline).

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2. Which hormone is the most powerful regulator of blood glucose?

Insulin — only hormone that lowers glucose.

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3. Why is plasma preferred over serum for glucose estimation?

Serum takes time to clot ? glucose falls due to glycolysis.
Plasma (with fluoride) prevents glycolysis.

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4. What is the renal threshold for glucose?

Around **180 mg/dL**.
Above this ? glucose appears in urine.

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5. What is the significance of OGTT?

Detects early abnormalities in glucose handling: **IGT** and **GDM**.

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6. Why do pregnant women often have glucosuria?

Pregnancy lowers renal threshold ? **benign glucosuria**.

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7. What is the difference between IGT and IFG?

- **IFG** = high fasting glucose
- **IGT** = high 2-hour post-glucose value

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8. Why does Type 1 DM cause ketosis, but Type 2 usually does not?

Type 1 has **absolute insulin deficiency**, so lipolysis is uncontrolled ? ketone production.
Type 2 has **some insulin** which suppresses ketosis.

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9. Why does DKA cause Kussmaul breathing?

Because metabolic acidosis stimulates respiratory compensation ? deep rapid breathing.

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10. Why doesn’t HHS have significant ketosis?

Presence of **enough insulin** to inhibit ketogenesis.

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11. Why is lactic acidosis common in shock?

Poor tissue perfusion ? anaerobic glycolysis ? excess lactate.

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12. What is the earliest marker of diabetic nephropathy?

Microalbuminuria (30–300 mg/day).

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13. Why is HbA1c a good long-term marker?

RBC lifespan = **120 days**, so glycation reflects ~3-month glucose.

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14. Can HbA1c be used in anemia?

No — hemolysis, transfusions, and CKD can give **false results**.

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15. Why does diabetes cause infections?

High glucose impairs neutrophil function, circulation, and immunity.

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16. Why do diabetics get foot ulcers?

Combination of:

- Peripheral neuropathy
- Poor blood supply
- Infection
- Loss of sensation

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17. Why is postprandial glucose more important for heart disease risk?

Post-meal hyperglycemia produces oxidative stress ? endothelial damage.

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18. What is the biochemical basis of weight loss in Type 1 DM?

No insulin ? lipolysis and proteolysis ? muscle and fat loss.

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19. Why do diabetics have polyuria?

Osmotic diuresis due to **glucose in urine**.

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20. Why do patients with DKA have normal or high potassium initially?

Acidosis shifts K? **out of cells**, but total body K? is low.

? IMPORTANT POINTS TO REMEMBER — ENTIRE CHAPTER

These are the most exam-relevant statements for rapid recall.

? REGULATION OF BLOOD GLUCOSE

- **Insulin is the only hypoglycemic hormone**; all others raise glucose.
- GLUT-4 is insulin-dependent (muscle + adipose).
- Liver controls fasting glucose via **glycogenolysis** and **gluconeogenesis**.

? GLUCOSE TESTING

- Fluoride inhibits glycolysis.

- **GOD–POD** is the most common method; **hexokinase** is the reference method.
- Glucometers use **glucose oxidase** or **glucose dehydrogenase**.

? OGTT / IGT / IFG

- OGTT uses **75 g glucose**.
- IFG = fasting **100–125 mg/dL**.
- IGT = 2-hour **140–199 mg/dL**.
- Diabetes = 2-hour **?200 mg/dL**.

? DIABETES MELLITUS

- Type 1: autoimmune, ketosis-prone, low C-peptide.
- Type 2: insulin resistance, associated with obesity, acanthosis nigricans.
- Diagnostic criteria:
    - Fasting ?126
    - Random ?200
    - 2 hr OGTT ?200
    - HbA1c ?6.5%

? ACUTE COMPLICATIONS

- **DKA**: Type 1, ketones + metabolic acidosis + Kussmaul breathing.
- **HHS**: Type 2, very high sugars, hyperosmolarity, no ketones.
- **Lactic acidosis**: lactate >5 mmol/L, high anion gap.

? CHRONIC COMPLICATIONS

? Microvascular:

- Retinopathy
- Nephropathy (first sign = microalbuminuria)
- Neuropathy (stocking–glove)

? Macrovascular:

- CAD, Stroke, PAD

? Others:

- Foot ulcers
- Infections
- Gastroparesis

- Erectile dysfunction

? GLYCATED HEMOGLOBIN (HbA1c)

- Reflects 3-month glucose.
- Target in most diabetics: **<7%**.
- False low: hemolysis, blood loss, CKD.
- False high: iron deficiency anemia.

? GLUCOSURIA

- Renal glucosuria: tubular defect (SGLT2).
- Alimentary glucosuria: transient after heavy carbs.
- Diabetic glucosuria: blood glucose > renal threshold.

? GDM

- Occurs due to **pregnancy-induced insulin resistance**.
- Diagnosed by 75 g OGTT at **24–28 weeks**.

? ULTRA-SHORT EXAM PEARLS

- **HbA1c ?6.5% = diabetes.**
- **IGT = 2-hour 140–199 mg/dL; IFG = 100–125 mg/dL.**
- **DKA ? ketones + acidosis + dehydration.**
- **HHS ? glucose >600 mg/dL, osmolality >320, no ketosis.**
- **Microalbuminuria = earliest sign of nephropathy.**
- **Post-prandial glucose predicts CV risk better than fasting.**
- **Type 1 = autoimmunity (GAD antibodies).**

? MCQs — Regulation of Blood Glucose & Diabetes

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1. The only hypoglycemic hormone in the body is:

A. Glucagon
B. Cortisol
C. Growth hormone
D. Insulin

Answer: D. Insulin

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2. GLUT-4 is stimulated by:

A. Glucagon
B. Insulin
C. Cortisol
D. Thyroxine

Answer: B. Insulin

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3. The reference method for glucose estimation is:

A. GOD–POD
B. Hexokinase
C. Benedict’s test
D. Glucose oxidase strip

Answer: B. Hexokinase

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4. In OGTT, the glucose load used for adults is:

A. 50 g
B. 60 g
C. 75 g
D. 100 g

Answer: C. 75 g

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5. Fasting glucose 110 mg/dL and 2-hour glucose 118 mg/dL indicates:

A. Diabetes mellitus
B. Impaired fasting glycemia
C. Impaired glucose tolerance
D. Normal

Answer: B. Impaired fasting glycemia

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6. Fasting glucose 98 mg/dL and 2-hour glucose 165 mg/dL indicates:

A. Normal
B. Diabetes
C. IGT
D. Renal glucosuria

Answer: C. IGT

---

7. Diagnostic HbA1c value for diabetes is:

A. >5.7%

B. >6.0%

C. ?6.5%

D. ?7.0%

Answer: C. ?6.5%

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8. Which hormone shows anti-insulin action?

A. Calcitonin

B. Cortisol

C. Oxytocin

D. ADH

Answer: B. Cortisol

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9. Renal threshold for glucose is approximately:

A. 90 mg/dL

B. 140 mg/dL

C. 180 mg/dL

D. 220 mg/dL

Answer: C. 180 mg/dL

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10. Glycosuria with normal blood glucose suggests:

A. Type 2 DM

B. Type 1 DM

C. Renal glucosuria

D. Uncontrolled DKA

Answer: C. Renal glucosuria

? MCQs — DKA, HHS, Lactic Acidosis

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11. Most common trigger for DKA:

A. Exercise
B. High-fat meal
C. Infection
D. Dehydration

Answer: C. Infection

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12. Which laboratory finding is characteristic of DKA?

A. pH > 7.4
B. HCO?? > 20
C. High anion gap metabolic acidosis
D. Low ketones

Answer: C. High anion gap metabolic acidosis

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13. A diabetic patient with glucose 950 mg/dL, no ketones, and osmolality 335 mOsm/kg most likely has:

A. DKA
B. HHS (Hyperosmolar state)
C. Lactic acidosis
D. Hypoglycemia

Answer: B. HHS

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14. Kussmaul breathing is characteristic of:

A. Hypoglycemia
B. HHS
C. DKA
D. Renal glycosuria

Answer: C. DKA

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15. Lactic acidosis occurs when lactate exceeds:

A. 1 mmol/L
B. 2 mmol/L
C. 3 mmol/L
D. 5 mmol/L

Answer: D. 5 mmol/L

? MCQs — GDM, Glucosuria, Complications

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16. Screening test for GDM at 24–28 weeks is:

A. Fasting glucose
B. HbA1c
C. 75 g OGTT
D. Random glucose

Answer: C. 75 g OGTT

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17. Alimentary glucosuria occurs due to:

A. Diabetes mellitus
B. Kidney disease
C. High carbohydrate meal
D. Fanconi syndrome

Answer: C. High carbohydrate meal

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18. Earliest manifestation of diabetic nephropathy is:

A. Proteinuria
B. Edema
C. Microalbuminuria
D. Reduced GFR

Answer: C. Microalbuminuria

19. Which is NOT a microvascular complication of DM?

A. Retinopathy
B. Neuropathy
C. Nephropathy
D. Coronary artery disease

Answer: D. Coronary artery disease
(Macrovascular.)

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20. HbA1c indicates glycemia over the past:

A. 1 week
B. 2 weeks
C. 1 month
D. 2–3 months

Answer: D. 2–3 months

? More Clinical MCQs

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21. Which type of DM has low C-peptide levels?

A. Type 2
B. LADA
C. Type 1
D. MODY

Answer: C. Type 1

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22. Presence of ketones in urine is most typical of:

A. Type 2 DM
B. Renal failure
C. Type 1 DM
D. Alimentary glucosuria

Answer: C. Type 1 DM

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23. Hyperosmolar nonketotic coma is characterized by:

A. Severe ketosis
B. Glucose < 200 mg/dL
C. Severe dehydration
D. Low serum osmolality

Answer: C. Severe dehydration

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24. Which hormone increases gluconeogenesis?

A. Insulin
B. Aldosterone
C. Glucagon
D. Thyroxine

Answer: C. Glucagon

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25. Best indicator of long-term glycemic control is:

A. Fasting glucose
B. Postprandial glucose
C. HbA1c
D. Random glucose

Answer: C. HbA1c

? CLINICAL CASE–BASED QUESTIONS (Expanded Set)

? 1. Polyuria, Polydipsia, Weight Loss

A 17-year-old boy presents with 3 weeks of polyuria, excessive thirst, fatigue, and weight loss. Random glucose is 320 mg/dL. Urine ketones are positive.

Diagnosis:
?? **Type 1 Diabetes Mellitus**

Reason:
Hyperglycemia + weight loss + ketosis strongly suggest Type 1 DM.

? 2. Borderline Fasting Sugar

A 45-year-old sedentary man has:

- Fasting glucose: 112 mg/dL
- 2-hour OGTT: 125 mg/dL
- HbA1c: 5.8%

Diagnosis:
?? **Impaired Fasting Glycemia (IFG)**

? 3. Abnormal OGTT

A 50-year-old woman undergoes OGTT:

- Fasting: 95 mg/dL
- 2-hour: 172 mg/dL

Diagnosis:
?? **Impaired Glucose Tolerance (IGT)**

? 4. Late Presentation with Very High Sugar

A 70-year-old diabetic woman presents with lethargy, dehydration, and confusion.
Investigations:

- Glucose: 880 mg/dL
- Serum osmolality: 340 mOsm/kg
- pH: 7.38
- No ketones

Diagnosis:
?? **Hyperosmolar Hyperglycemic State (HHS)**

? 5. Kussmaul Breathing + Acidosis

A 21-year-old Type 1 diabetic skipped insulin. Now breathing deeply and rapidly (Kussmaul).
Lab:

- Glucose: 420 mg/dL
- pH: 7.12
- HCO??: 10
- Ketones: Positive

Diagnosis:
?? **Diabetic Ketoacidosis (DKA)**

? 6. High Lactate in Shock

A 60-year-old man in septic shock shows:

- Lactate: 8 mmol/L
- pH: 7.21
- High anion gap acidosis

Diagnosis:
?? **Lactic Acidosis (Type A)** due to hypoperfusion.

? 7. Recurrent Infections + High HbA1c

A 52-year-old obese man has recurrent fungal infections.
HbA1c = 9.8%

Interpretation:
?? Poor glycemic control over the last 3 months.

? 8. Pregnancy With Failed OGTT

28-year-old pregnant woman at 26 weeks:

- Fasting = 95 mg/dL
- 1 hr = 182 mg/dL

- 2 hr = 168 mg/dL

Diagnosis:
?? **Gestational Diabetes Mellitus (GDM)**

? 9. Clear Glycosuria With Normal Glucose

A 20-year-old woman:

- Fasting glucose: 88 mg/dL
- Urine glucose: positive
- OGTT: normal

Diagnosis:
?? **Renal Glucosuria** (tubular SGLT2 defect)

? 10. Glucosuria After Eating Sweets

A boy eats a lot of sweets at a party. Urine next morning shows glucose.
Fasting sugar = 90 mg/dL.

Diagnosis:
?? **Alimentary Glucosuria** (benign)

? 11. Diabetic With Acute Belly Pain

A 34-year-old diabetic on SGLT2 inhibitors presents with abdominal pain, nausea, and ketonuria but glucose of only 180 mg/dL.

Diagnosis:

?? **Euglycemic DKA** (SGLT2 inhibitor–related)

? 12. Long-Standing Diabetes With Numb Feet

A 60-year-old diabetic complains of burning sensation and loss of vibration sense in feet.

Diagnosis:

?? **Diabetic Peripheral Neuropathy**

? 13. Vision Problems in a Diabetic

A 48-year-old diabetic has blurred vision. Fundus: microaneurysms & cotton-wool spots.

Diagnosis:

?? **Non-proliferative Diabetic Retinopathy**

? 14. Frothy Urine With Microalbuminuria

A 55-year-old diabetic has urine albumin: 75 mg/day.

Diagnosis:

?? **Early Diabetic Nephropathy (Microalbuminuria)**

? 15. Chronic Smoker With High HbA1c but Normal Glucose

A smoker has:

- HbA1c: 7.0%
- Fasting glucose: 95 mg/dL

- Fructosamine: normal

Reason:
?? **Falsely high HbA1c** (carbonylation / hemoglobin abnormalities)

? 16. Hypoglycemia in a Non-Diabetic

A 45-year-old man has recurrent hypoglycemia.
Insulin: High
C-peptide: High

Diagnosis:
?? **Insulinoma**

? 17. Ketoacidosis Without Hyperglycemia

A chronic alcoholic presents with:

- Ketones high
- Glucose normal
- pH: 7.19

Diagnosis:
?? **Alcoholic Ketoacidosis**

? 18. Diabetic With Non-Healing Foot Ulcer

A 64-year-old diabetic has a chronic foot ulcer with reduced pulses in the limb.

Diagnosis:
?? **Peripheral Arterial Disease (macrovascular complication)**

? 19. Abdominal Obesity + High BP + High TG + Fasting Glucose 115 mg/dL

Diagnosis:
?? **Metabolic Syndrome (Syndrome X)**

? 20. Diabetes Suspected but HbA1c Normal

A 25-year-old has:

- HbA1c = 4.8%
- Recurrent osmotic symptoms
- Fasting glucose = 142 mg/dL

Diagnosis:
?? **Diabetes** (HbA1c misleading due to hemolysis/high RBC turnover)

? 21. Extremely High HbA1c in Iron Deficiency

A woman with anemia has:

- HbA1c = 12.4%
- Fasting glucose = 115 mg/dL

Interpretation:
?? **False high HbA1c** due to prolonged RBC survival in iron deficiency.

? 22. Vomiting + Deep Breathing + Acetone Smell

A child with newly diagnosed DM has severe dehydration, deep breathing, and fruity breath.

Diagnosis:
?? **DKA** (classic presentation)

? 23. Hyperglycemia + Dehydration + Normal pH

A 70-year-old bedridden diabetic:

- Glucose: 780 mg/dL
- Osmolality: 345 mOsm/kg
- pH: 7.39
- Ketones: none

Diagnosis:
?? **HHS (Hyperosmolar state)**

? 24. High Lactate in Metformin User

A 62-year-old diabetic on metformin has:

- Lactate: 7.2 mmol/L
- pH: 7.19

Diagnosis:

?? **Metformin-induced lactic acidosis**

? 25. Sudden Visual Loss in Diabetic

Fundus: vitreous hemorrhage, neovascularization.

Diagnosis:

?? **Proliferative Diabetic Retinopathy**

? VIVA VOCE — Regulation of Blood Glucose & Diabetes (Whole Chapter)

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1. What is the normal fasting blood glucose level?

70–110 mg/dL.

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2. Which hormone lowers blood glucose?

Insulin (the only hypoglycemic hormone).

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3. What is the primary organ regulating blood glucose?

The liver.

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4. Which glucose transporter is insulin-dependent?

GLUT-4 (muscle and adipose tissue).

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5. What is the renal threshold for glucose?

Around 180 mg/dL.

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6. Which is the reference method for glucose estimation?

Hexokinase method.

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7. Why is fluoride used in blood glucose sampling?

It inhibits glycolysis (preserves glucose).

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8. What is OGTT used for?

Diagnosing diabetes, IGT, and GDM.

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9. How much glucose is used in OGTT?

75 g anhydrous glucose.

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10. Define Impaired Fasting Glycemia.

Fasting glucose 100–125 mg/dL.

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11. Define Impaired Glucose Tolerance.

2-hour OGTT value 140–199 mg/dL.

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12. Diagnostic criteria for diabetes (OGTT).

2-hour plasma glucose ?200 mg/dL.

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13. What is HbA1c?

Glycation of hemoglobin that reflects 2–3 months' average blood glucose.

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14. HbA1c diagnostic cut-off for diabetes?

?6.5%.

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15. What conditions make HbA1c unreliable?

Hemolysis, recent transfusion, anemia, CKD.

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16. What are the “3 Ps” of diabetes?

Polyuria, polydipsia, polyphagia.

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17. Why does polyuria occur in diabetes?

Osmotic diuresis due to glucose in urine.

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18. Which type of diabetes is ketosis-prone?

Type 1 diabetes.

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19. What is C-peptide used for?

Assess endogenous insulin production.

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20. What is the biochemical cause of weight loss in Type 1 DM?

Fat and muscle breakdown due to absence of insulin.

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21. What is the earliest sign of diabetic nephropathy?

Microalbuminuria.

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22. What are the microvascular complications of diabetes?

Retinopathy, nephropathy, neuropathy.

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23. What are the macrovascular complications?

CAD, stroke, peripheral arterial disease.

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24. What is the cause of diabetic retinopathy?

Chronic hyperglycemia damaging retinal vessels.

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25. What is the cause of diabetic neuropathy?

Sorbitol accumulation + microvascular ischemia.

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26. Why does diabetes cause infections?

Impaired immunity and high glucose environment.

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27. Describe the mechanism of DKA.

Insulin deficiency ? lipolysis ? ketone production ? metabolic acidosis.

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28. Clinical sign of DKA respiration?

Kussmaul breathing (deep, rapid).

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29. What is the typical pH in DKA?

<7.3.

---

30. Characteristic lab finding in DKA?

High anion gap metabolic acidosis.

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31. Why does potassium fall during treatment of DKA?

Insulin drives K? into cells.

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32. Why doesn’t HHS have ketones?

Enough insulin present to block ketogenesis.

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33. Typical glucose level in HHS?

600 mg/dL (often >1000 mg/dL).

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34. Major complication of HHS?

Severe dehydration and hyperosmolarity leading to coma.

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35. What is serum osmolality in HHS?

320 mOsm/kg.

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36. What is lactic acidosis?

Accumulation of lactate causing metabolic acidosis.

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37. Common cause of lactic acidosis in diabetics?

Metformin (especially in renal failure).

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38. Why does shock cause lactic acidosis?

Tissue hypoxia ? anaerobic glycolysis ? lactate accumulation.

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39. What is gestational diabetes?

Glucose intolerance first diagnosed in pregnancy.

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40. Screening test for GDM?

75 g OGTT at 24–28 weeks.

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41. Why do pregnant women have glucosuria?

Lowered renal threshold for glucose.

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42. What is renal glucosuria?

Glucose in urine despite normal blood glucose due to tubular SGLT2 defect.

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43. What is alimentary glucosuria?

Glucosuria after heavy carbohydrate intake (benign; transient).

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44. Why does diabetes cause retinopathy?

Protein kinase C activation and microvascular damage.

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45. Why does hyperglycemia increase cardiovascular risk?

Endothelial dysfunction + accelerated atherosclerosis.

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46. Why is post-prandial glucose important?

Strong predictor of atherosclerosis and cardiovascular events.

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47. What is metabolic syndrome?

Obesity + high BP + high TG + low HDL + high fasting glucose.

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48. What is euglycemic DKA?

DKA with near-normal glucose (seen with SGLT2 inhibitors).

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49. What biochemical test confirms ongoing hemolysis in diabetics?

Elevated LDH + low haptoglobin.

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50. Why is fructosamine used?

Short-term glycemic control marker (2–3 weeks).