BIOCHEMISTRY
SURVIVAL BUNDLE

50 High-Yield Flashcards for 1st Year MBBS

Pathways Simplified | Exam Revision | Memory Tricks | Viva Favorites

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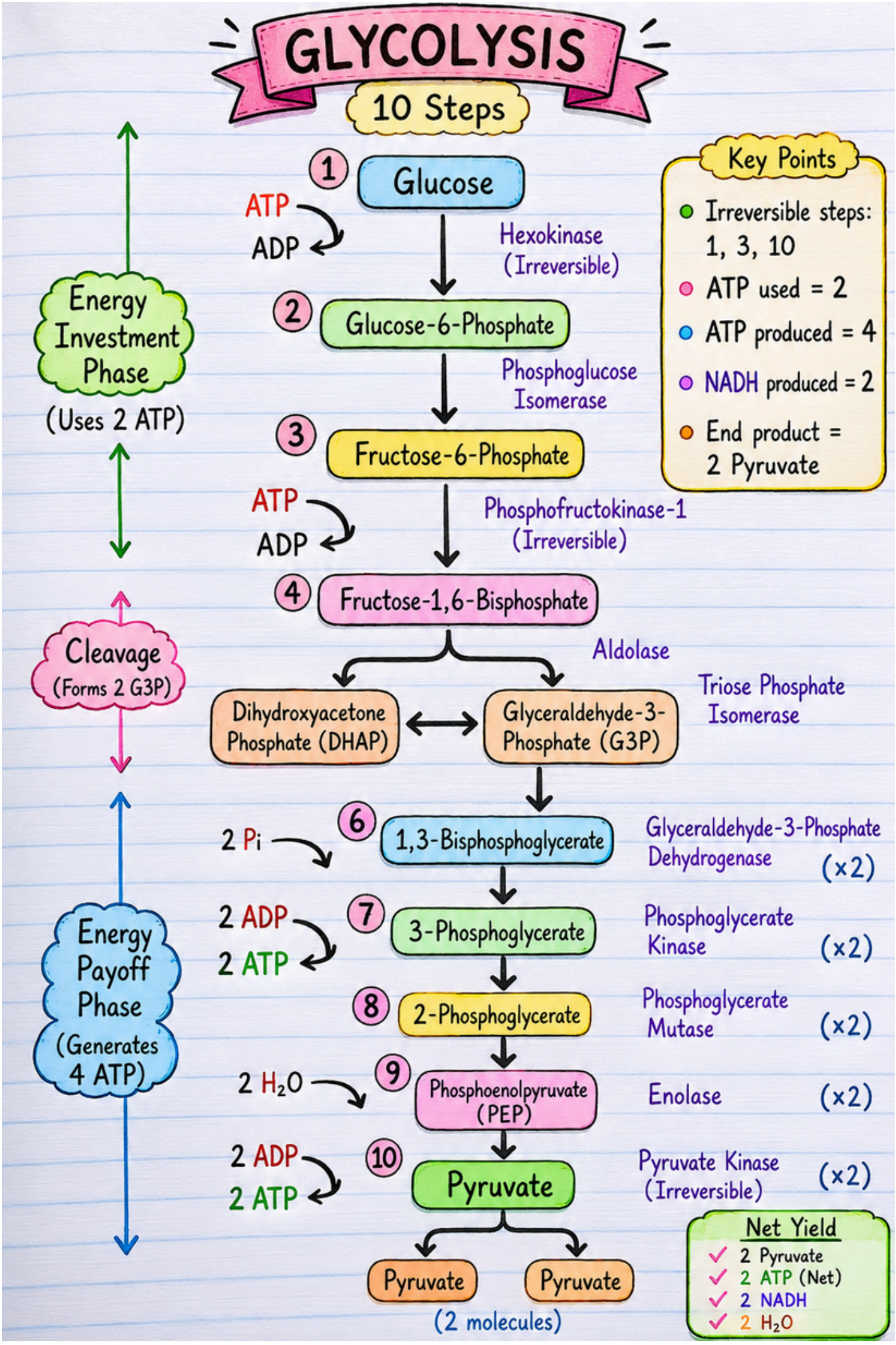

TCA CYCLE

(KREBS CYCLE)

8 Steps

Acetyl CoA + Oxaloacetate (OAA)

↓ Citrate Synthase

$NAD^+ \rightarrow NADH$ → Citrate

↓ Aconitase

$NAD^+ \rightarrow NADH$ → Isocitrate

↓ Isocitrate Dehydrogenase

α-Ketoglutarate

↓ α-KG Dehydrogenase

$NAD^+ \rightarrow NADH$ → Succinyl CoA

↓ Succinyl CoA

$GDP \rightarrow FADH_2$ → Succinyl CoA

↓ Succinyl CoA

$FAD \rightarrow FADH_2$ → Fumarate → GDP GTP

↓

Malate

↓ Fumarase

Malate

↓

Cycle repeats

Key Points

- Rate Limiting Step
  - Isocitrate Dehydrogenase
- Irreversible Steps:
  - Citrate Synthase
  - Isocitrate Dehydrogenase
  - α-KG Dehydrogenase

Energy Yield

- ✓ 3 NADH
- ✓ 1 $FADH_2$
- ✓ 1 GTP
- ✓ 2 CO_2

Clinical

Arsenic Poisoning

↓ Inhibits α-KG Dehydrogenase

Easy Memory:

Citrate Is Krebs' Starting Substance For Making Oxaloaceatete

Energy Yield

- ✓ 3 NADH
- ✓ 1 $FADH_2$
- ✓ 1 GTP
- ✓ 2 CO_2

Arsenic Poisoning

↓ Inhibits α-KG Dehydrogenase

HMP SHUNT

3 Steps

Glucose-6-Phosphate

↓

G6PD ☆ Rate Limiting

↓

6-Phosphogluconate

↓

Ribulose-5-Phosphate

↓

Ribose-5-P | Ribulose-5-P

↓

Succinyl CoA

↓

Ribose-5-P | Xylulose-5-P | Arabinoe-5-P

Key Points

- ☆ Rate Limiting Step
  - G6PD
- ✓ Produces NADPH for biosynthesis and antioxidant defense
- ✓ Makes Ribose-5-P for nucleotide synthesis
- ✓ Occurs in cytoplasm

Yield

- ✓ 3 NADH
- ✓ 1 $FADH_2$
- ✓ 1 GTP
- ✓ 2 CO_2

Easy Memory

Go Fish & Run

- G – Glucose-6-P
- F – 6-Phosphogluconate
- R – Ribulose-5-P

Ribose-5-P ↔ Xylulose-5-P — Arabinoe-5-P

Yield

- ✓ 3 NADH
- ✓ 1 $FADH_2$
- ✓ Ribose-for nucleotides

Clinical

- ✓ G6PD Deficiency
- ✓ Favism

GLYCOGENESIS

The Glycogen Synthesis Pathway

Glucose

↓ Hexokinase — ATP → ADP

G6P

↓ Phosphoglucomutase

G1P

↓ + UTP → UDP-Glucose Pyrophosphorylase

UDP-Glucose

↓ + UTP → + UDP + PPi

Primer Glycogenin → Glycogen

↓ Booster Glycogenin

Glycogen

IMPORTANT FACTS

- ⭐ Rate-limiting enzyme: Glycogen Synthase
- ⭐ Glycosidic bonds: α-1,4 and α-1.6
- ⭐ Glycogen Storage Diseases
  - GSD Type I
    - → Von Gierke Disease
      - → Glucose-6-Phosphatase Deficiency
  - ⭐ GSD Type II
    - → Pompe Disease
    - → McArdle Disease

HORMONAL REGULATION

- ✔ Insulin → Stimulates Glycogenesis
- ✘ Glucagon → Inhibits Glycogenesis
- ✘ Epinephrine → Inhibits Glycogenesis

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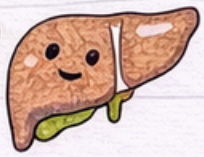
GLYCOGENOLYSIS

The Glycogen Breakdown Pathway



Glycogen

+ 1,6 Glucosidase

Glucogen-1-Phosphate

Rate-Limiting Enzyme

Phosphoglucomutase

G1P

Phosphoglucomutase

Glucose

Glucose-6-Phosphatase

Glucose

Glucose

+ 1,6 Glucosidase

EXAM QUICK FACTS

- Hormonal Control:
- → Glucagon & Epinephrine → Up
- ✗ Insulin → Down

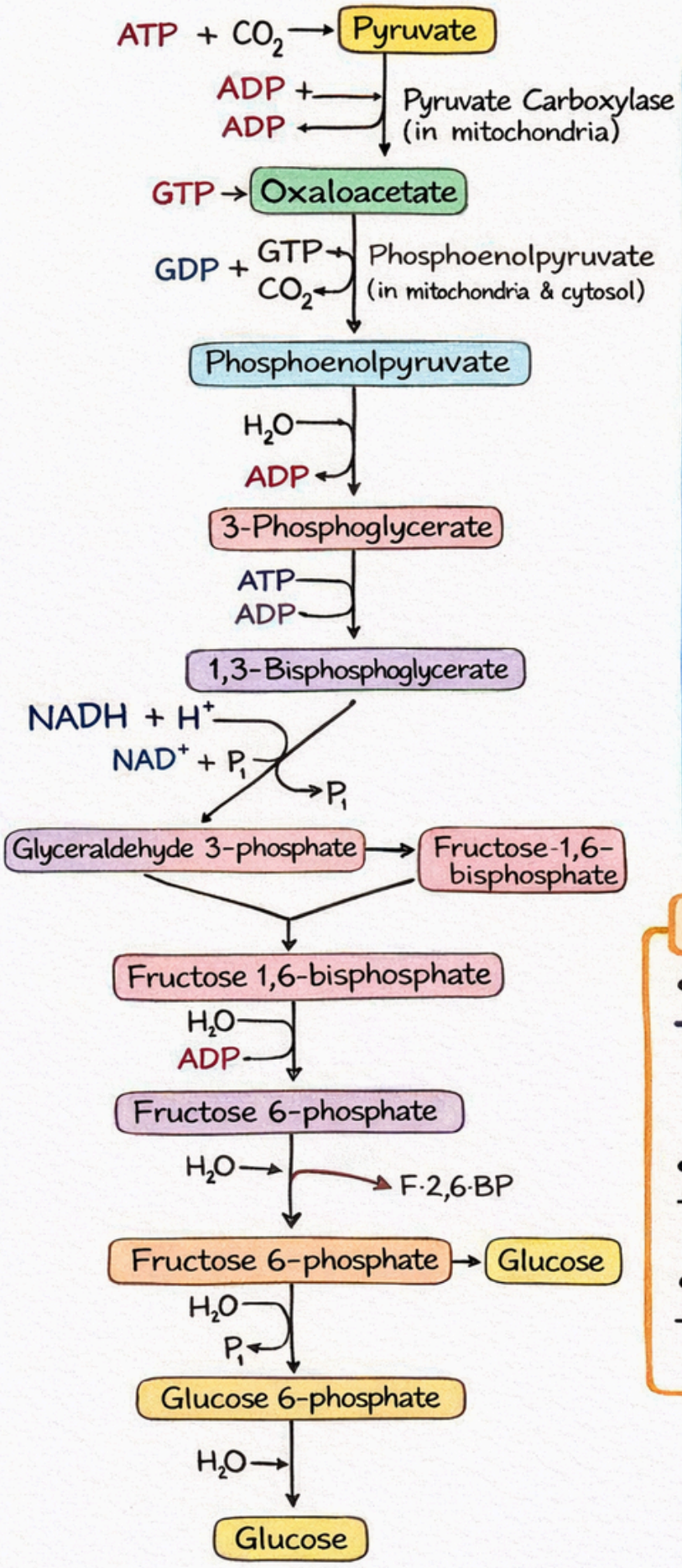
EXAM QUICK FACTS

- Hormonal Control:
- → Glucagon & Epinephrine → Up
- ✗ Insulin → Down
- Von Gieke Disease
  G6-Phosphatase Deficiency
- ✓ Final Product = Glucose

IMPORTANT POINTS

- ✓ Rate-Limiting Enzyme = Glycogen Phosphorylase
- ✓ Final Product = Glucose
- ✗ KEY Step → Glycogen → G1P

Gluconeogenesis



Regulation

- Inhibitors:
  - Pyruvate Carboxylase
    - ADP
  - PEP Carboxykinase
    - ADP
  - Fructose-1,6-Bisphosphatase
    - AMP
    - Fructose-2,6-Bisphosphate
- Activators:
  - Acetyl-CoA
  - Fructose-1,6-Bisphosphatase
    - ATP, Citrate

F-2,6-BP level is regulated by

PTK-2 → ↑ F2,6-BP

Insulin → ↓ F-2,6-BP

Glucagon → ↓ F2,6-BP

↓ FBPase-2 → ↓ F-2,6-BP

Clinical Importance

- **Fasting/Starvation:**
  - Necessary to maintain blood glucose. Brain & RBCs rely on glucose as primary energy source.
- **Diabetes Mellitus:**
  - Leads to hyperglycemia due to increased gluconeogenesis.
- **Hypoglycemia:**
  - Can result from defects in gluconeogenesis.

UREA CYCLE

(Ornithine Cycle)

$NH_3 + CO_2 + 2\,ATP$

Carbamoyl Phosphate

Carbamoyl Phosphate Synthetase I

Ornithine Transcarbamoylase

Citrulline

Argininosuccinate Synthetase

Argininosuccinate

Aspartate + ATP

Ornithine

Arginase

Arginine

Urea + Ornithine

CLINICAL IMPORTANCE

- Hyperammonemia
- Ornithine Transcarbamoylase (OTC Deficiency)
- Liver Cirrhosis
- Reye Syndrome

REGULATION

- ✓ N-Acetylglutamate activates CPS-I
- ✓ Urea cycle enhanced by Glucagon and ↓ by Acidosis

$NH_3 + CO_2 \rightarrow CONH_2$

REGULATION

- ✓ N-Acetylglutamate activates CPS-I
- ✗ Urea cycle enhanced by Glucagon and ↓ by Acidosis

$NH_3 + CONH_2 \rightarrow$ Urea + Ornithine

β-OXIDATION

Fatty Acid Breakdown Pathway

Fatty Acid

Acyl-CoA

Acyl-CoA Synthetase

ATP + AMP + PPi

ATP
PPi

Acyl-CoA Dehydrogenase

1

$FADH_2$

Fatty Acyl-CoA

Hydration

β-Oxidation

Acyl-CoA Dehydrogenase

2 Oxidation 1

NADH

3 β-Ketoacyl-CoA

Acyl-CoA Synthetase

4 Thiolysis

Carnitine Shuttle

$Acetl_2$

Fatty Acyl-CoA 2

Release

Fatty Acyl-CoA

Shortened Fatty Acyl-CoA (n-2)

Acetyl-CoA (2C)

CLINICAL IMPORTANCE

- Cpt I Deficiency (Carnitine Deficiency)
- MCAD Deficiency (Acyl-CoA Dehydrogenase Deficiency)
- Refsum Disease (Phytanic Acid Accumulation)
- Diabetic Ketoacidosis (Increased Ketone Body Formation)

REGULATION

- ✗ Malonyl-CoA inhibits CPT-1 (Carnitine Shuttle)
- ✓ Increased Beta-Oxidation with Fasting/Starvation

REGULATION

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- ✓ Increased Beta-Oxidation with Fasting/Starvation

FATTY ACID SYNTHESIS

Fatty Acid Biosynthesis Pathway

Carbohydrates
Glucose

Insulin ↑

ATP → ADP + Pi

Cytosolic Acetyl-CoA

Citrate

Citrate → OAA + AMA

Cytosolic Acetyl-CoA

Citrate Shuttle

OAA → Acetyl-CoA

Fatty Acid Synthase Complex

8O

Imacycles

1. Condensation
2. Reduction 1 - NADP↑
3. Dehydration - H_2O
4. Reduction 2 - NADPH

Palmitate (C16)

Release

Palmitate (C16)

Palmitate (C16)

CLINICAL IMPORTANCE

- Acetyl-CoA Carboxylase Deficiency (Acc. Deficiency)
- Obesity (↑ Fatty Acid Production)
- Metabolic Syndrome (↑ Fatty Acid Synthesis)

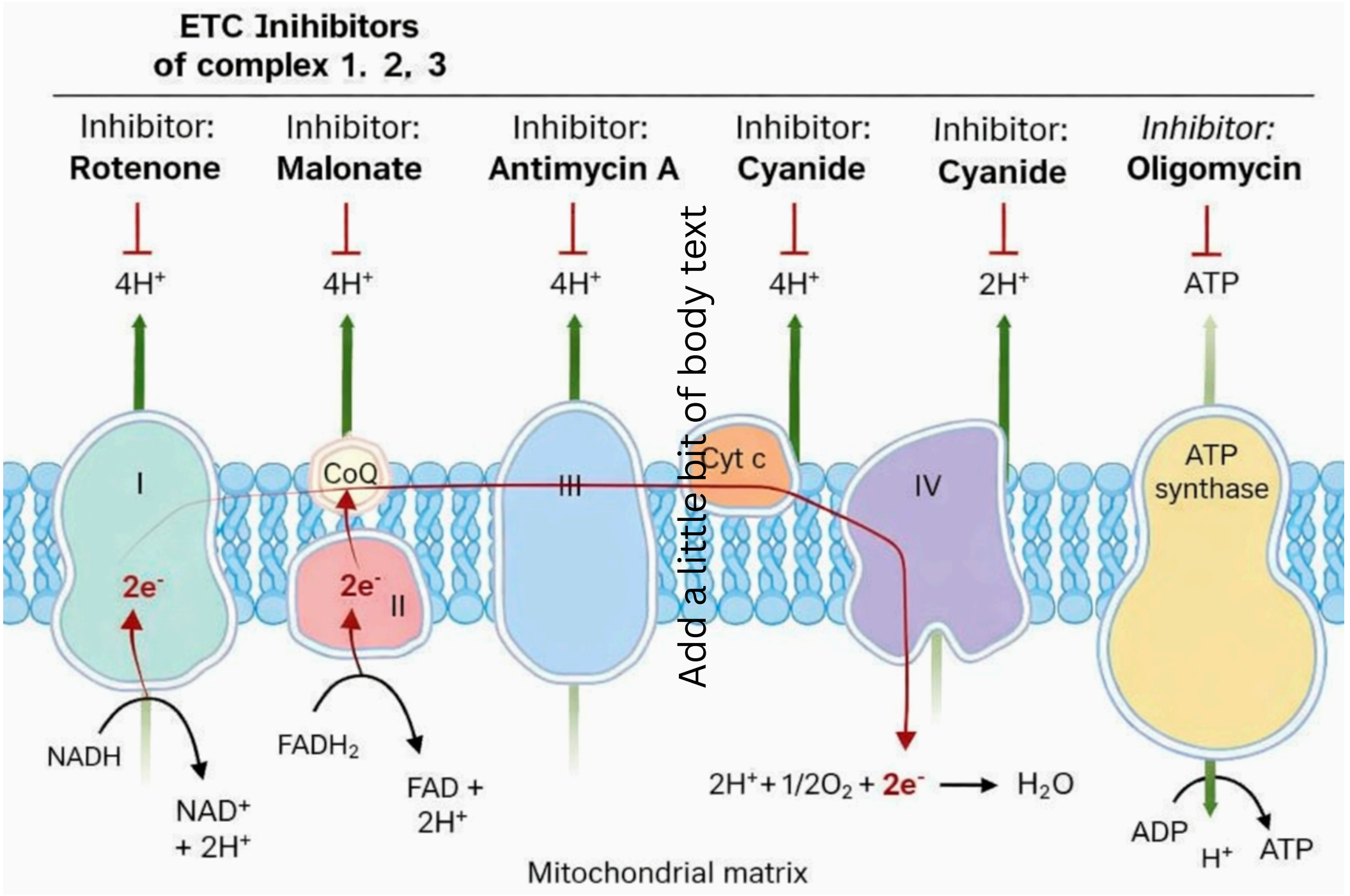
1. Citrate → Aetyl-CoA

CLINICAL IMPORTANCE

- Acetyl CoA Carboxylase Deficiency (Acc. Deficiency)
- Obesity (↑ Fatty Acid Production)
- Metabolic Syndrome (↑ Fatty Acid Synthesis)

REGULATION

- ✓ Malonyl CoA inhibits CPT-1 (Carnitine Shuttle)
- ✓ Citrate induces Acetyl-CoA Carboxylase
- ✓ Insulin induces Acetyl-CoA Carboxylase
- ✗ Glucagon & Epinephrine ↓ Acetyl-CoA Carboxylase



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