MAJOR METABOLIC PATHWAYS OF GLUCOSE AND GLUCOSE TRANSPORT

Color Index:

- **Original slides.**
- Important.
- 436 Notes
- **438 notes**
- **Extra information**

رابط التعديل:
https://docs.google.com/document/d/1WvdeC1atp7J-ZKWOUSukSLsEcosjZ0AqV4z2VcH2TA0/edit?usp=sharing

Biochemistry team 438

Objectives:

- **Define a metabolic pathway.**
- **Describe the general metabolic pathways for glucose (production and utilization)**
- **Briefly describe the HMP**
- **Recognize the mechanisms of glucose transport**

Metabolic Pathway

This slide is not that important (the important information here are explained in other lectures)

➢ Definition:

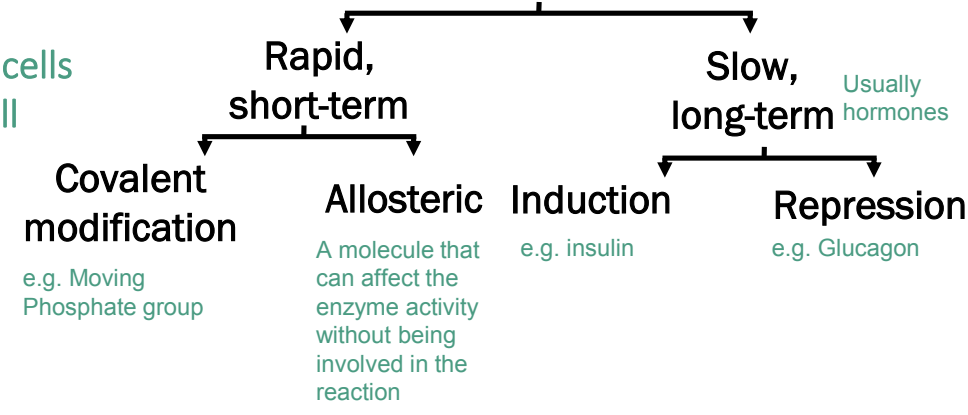
a sequence or a cascade of chemical reactions which results in a product that will be a substrate for the other reaction

"usually 1 or 2 pathways"

➢ Site:

- Cellular (tissue): signaling between cells
- Subcellular: reactions inside the cell

➢ Regulatory mechanism(s):



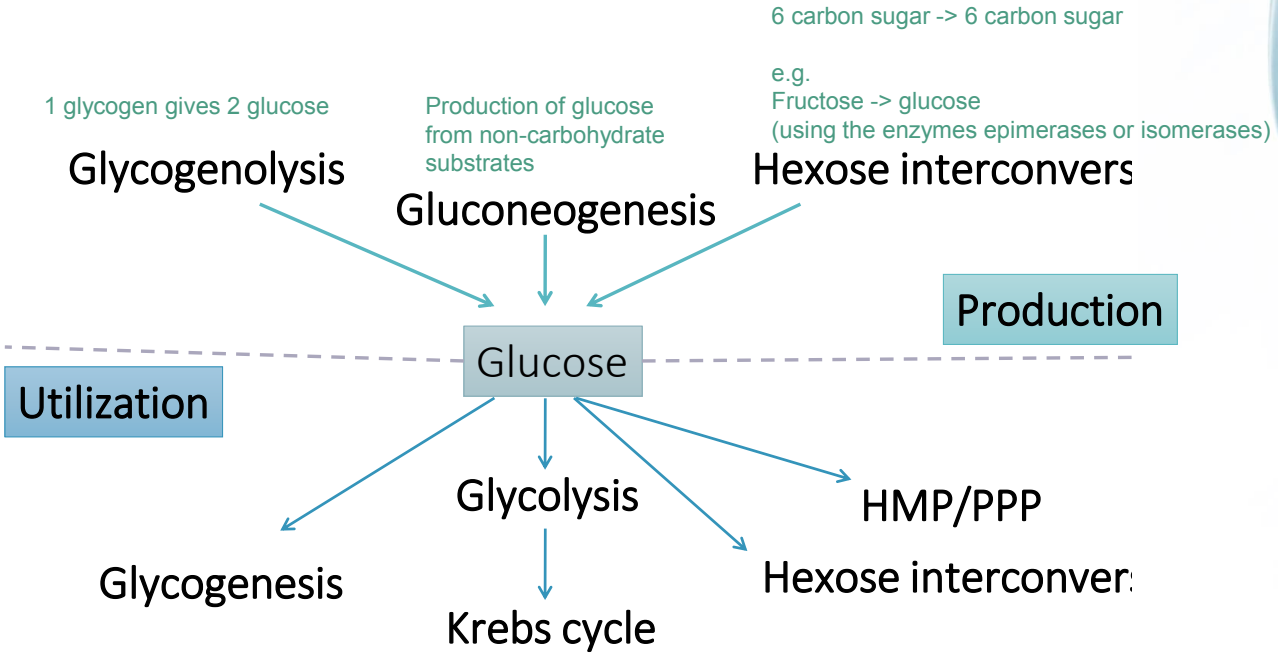
➢ Reactions

Rate-limiting enzyme(s)

(enyme that slows down the reaction)

Metabolic Pathways of Glucose:

production and utilization



Metabolic Pathways of Glucose:

catabolic and anabolic

Catabolic cycles:	Anabolic cycles:
Glycolysis (Mainly)	Gluconeogenesis
Krebs (Mainly)	
Glycogenolysis	Glycogenesis
HMP	

Glycolysis

- **Oxidation** of glucose to provide energy.
- Pyruvate is the end product of glycolysis in cells with mitochondria and an adequate supply of oxygen- aerobic glycolysis
- In absence of oxygen and in cells that lack mitochondria, the end product is lactate- anaerobic glycolysis

Glycogenesis and Glycogenolysis

Glycogenesis:

Synthesis of glycogen from glucose

Mainly liver and muscle, Cytosol

Glycogenolysis:

Degradation of glycogen into glucose

Mainly liver and muscle, Cytosol

Gluconeogenesis

The important information here are explained in gluconeogenesis lecture (lecture 15)

- Synthesis of glucose from non-carbohydrate precursors.
- The precursors could be lactate, pyruvate, glycerol and alpha-keto acids.
- It requires both mitochondria and cytosolic enzymes.
- Liver and kidney.

Hexose Monophosphate shunt(HMP) or Pentose Phosphate Pathway (PPP)

- HMP shunt is an alternative pathway of glucose oxidation.
- It is not involved in the generation of energy.
- Around 10% of glucose is entered in this pathway.
- In liver and kidney, this percentage is upto 30%.

This slide is important

HMP Biomedical Importance

It has two main functions-

1. Provides NADPH which is required for
   - synthesis of fatty acids, steroid and some amino acids
   - Detoxification of drugs by cytochrome p450
   - In scavenging the free radicals
2. Provides Pentoses
   - This pentose and its derivatives are useful in the synthesis of
     - Nucleic acids (DNA and RNA)
     - Nucleotides (ATP, NAD, FAD and CoA)

HMP Tissue Distribution

Location- Cytosol

- Liver
- Lactating mammary gland
- Adrenal cortex
- Gonads
- Adipose tissue
- Erythrocytes to reduce glutathione
- Lens and cornea

This slide is important

HMP shunt

2 phases	Oxidative (irreversible)	Non – oxidative (reversible)
Main outcomes	NADPH Have 3 benefit slide. 8	Ribose For DNA,NAD,etc
4 main enzymes	dehydrogenase	hydrolase Transketolase (transfers 2 carbons) Transaldolase (transfers 3 carbons)

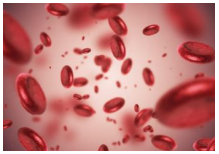
This slide is important

Phases of HMP shunt

PHASE	ENZYME
OXIDITIVE	Dehydrogenase Hydrolase
NON – OXIDITAIVE	Isomerase epimerase Trnasketolase Transaldolase

This slide is important

Clinical correlations



Hemolytic anemia

Kidney failure

***G-6-PD Deficiency**

Results in :

Neonatal jaundice

* Glucose 6- phosphate dehydrogenase

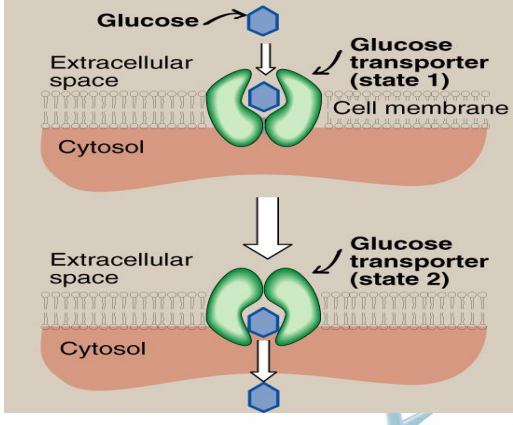
Glucose Transport

Na^+-Monosaccharide Cotransporter:

- Against concentration gradient
- Energy dependent
- Carrier-mediated
- Coupled to Na^+ transport
- Small intestine, renal tubules & choroid plexus

Na^+-Independent Facilitated Diffusion:

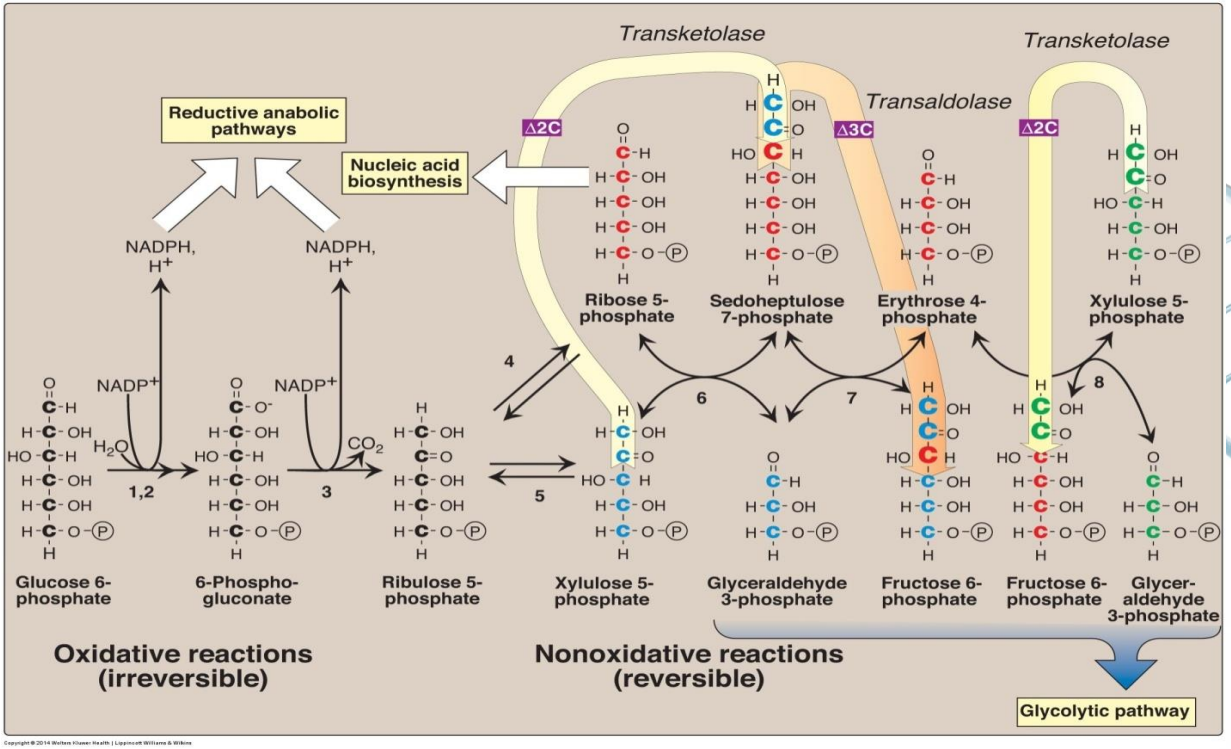
- Down the concentration gradient
- Energy Independent
- Glucose Transporters (GLUT 1-14)



This slide is VERY important

Glucose transporters

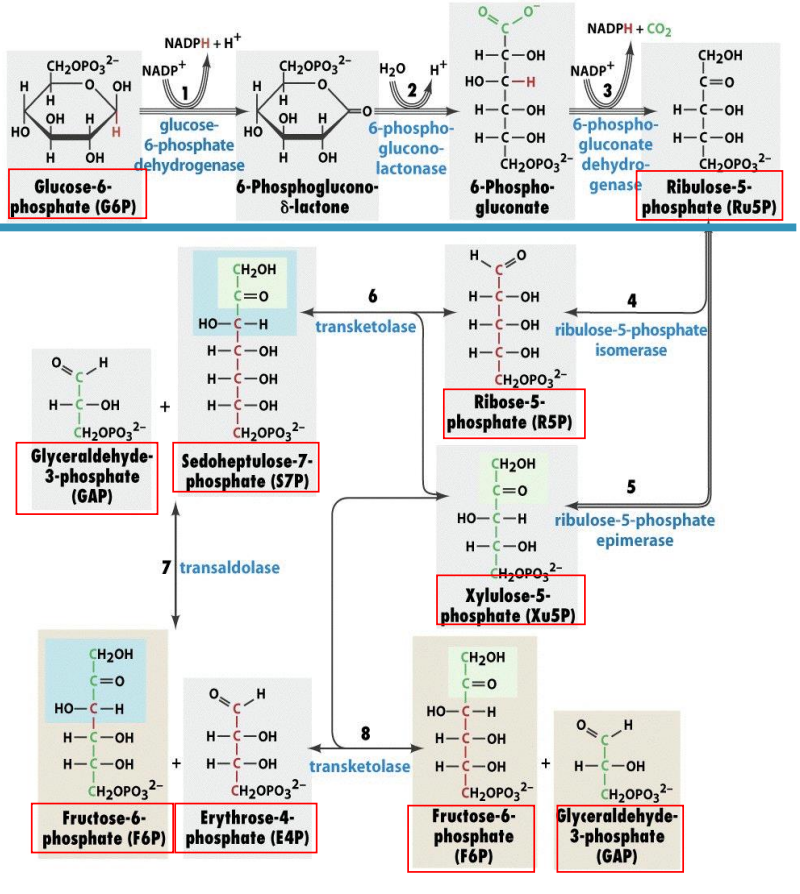
Transporter	Location	Function
GLUT -1	RBCs & Brain	Glucose uptake from blood
GLUT-2	Liver , Kidney & Pancreas	Blood & cells (either direction)
GLUR-3	Neurons	Glucose uptake from blood
GLUT-4	Adipose tissues & skeletal muscles	Glucose uptake from blood
GLUT-5	Small intestine & testes	Fructose transport
GLUT-7	Liver (ER – membrane)	-



Enzymes numbered above are: 1, 2) *glucose 6-phosphate dehydrogenase* and 6-*phosphogluconolactone hydrolase,* 3) *6-phosphogluconate dehydrogenase,* 4) *ribose 5-phosphate isomerase,* 5) *phosphopentose epimerase,* 6 and 8) *transketolase* (coenzyme: thiamine pyrophosphate), and 7) *transaldolase*.

Oxidative (irreversible)

Non – oxidative (reversible)



اهلا: امش معي حبه حبه:

1- اللي في المربع الاحمر مهم

2- اسماء الانزيمات مهمه

3- لا تركز في عدد الكربونات

4- العملية تطلع لك 2 NADPH

5- اذا فهمت الصورة لا تقرأ:

كل شيء تمام لما توصل ل 6 & 8

كمل بعد 6 يطلع ثنين بعدها يمرون في 7 يطلع ثنين

ثم الثنيين بتوع 7 يمرون في 8 ويطلع ثنين طيب ركز هنا

(من نواتج 8 F6P & من نواتج 7 E4P)

ممكن بالأنزيم رقم 8 يرجع بك ل (Xu5P)

يعني؟؟؟؟

انزيم رقم 8 يشتغل شغلتين (راتبه 8000) يا يحول لك نواتج انزيم 7 الى ناتجين

او

يمسك واحد من 7 وواحد من اللي سواهم قبل ويرجعهم ل Xu5P

لا شكر على واجب ☺

Take Home Messsage

- There are multiple pathways for glucose that can be grouped in to catabolic (utilizing glucose) or anabolic (producing glucose)
- Glycolysis is the major metabolic pathway of glucose breakdown to provide energy
- Alternative pathway for glucose oxidation but not meant for producing energy
- Has two phases- oxidative and non-oxidative
- During oxidative phase, glucose-6-P is oxidized with generation of 2 moles of NADPH, and one mole of pentose phosphate, with liberation of CO_2
- During non-oxidative phase, pentose phosphate is converted to intermediates of glycolysis

MCQs

Q1; which of the following enzymes is found in the oxidative phase

A- G6PD
B-Isomerase
C-epimerase
D-Transaldolase

Q2; GLUT-2 is found in:

A- RBCs
B-Liver
C- Neurons

Answer key:

1) A
2) B

❖ Girls team:

- أجيد آل رشود
- الوتين البلوي
- إيلاف المسيحل
- جود الخليفة
- جود العتيبي
- ريم القرني
- سارة الهلال
- شهد السلامه
- طيف العتيبي
- عبير الخضير
- غيداء البريثن
- لينا العصيمي
- نورة التركي
- نورة المزروع
- نوف الحميضي
- هيفاء الوايلي

❖ Boys team:

- بدر الشهري
- حميد حميد
- سهيل باسهيل
- عمر الغامدي
- مهند القرني
- نايف السبر

➢ Special thanks to:

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