Biochemistry Unit 2 Review

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Which combination of fatty acids would produce the most stable bilayer phospholipid membrane at high temperatures?

A) Phospholipids made with saturated fatty acids
B) Phospholipids made with linolenic acid
C) Phospholipids made with saturated fatty acids + cholesterol
D) Phospholipids made with cis-monounsaturated fatty acids + cholesterol

A) Phospholipids made with saturated fatty acids

- Cholesterol helps to stabilize membranes by limiting free rotation

B) Phospholipids made with linolenic acid

- Linolenic acid is a PUFA (3 cis). The double bonds form a kink that prevent compact membrane formation. Linolenic acid is a essential PUFA.

C) Phospholipids made with saturated fatty acids + cholesterol

- Saturated fatty acids allow for maximal compaction and the cholesterol helps to limit degrees to disorder; decreased fluidity.

D) Phospholipids made with cis-monounsaturated fatty acids + cholesterol

- Compared to trans-bonds, cis-bonds have a permanent kink that cause the membrane to be more fluid

A 2-month old boy comes into the office for a follow-up appointment. The patient is in the 80th percentile for weight and 60th percentile for height. Since birth, the patient has been gaining weight on a diet of breast milk. Postprandially, the synthesis of fatty acids from glucose in the liver is best described by which one of the following?

A) The pathway occurs solely in the mitochondria
B) It requires a covalently bound derivative of pantothenic acid
C) It requires NADPH derived solely from the pentose phosphate pathway
D) The pathway is regulated only by citrate and palmitate
E) Malonyl-CoA inhibits the synthesis

A) The pathway occurs solely in the mitochondria
- Majority of the synthesis actually occurs in the cytosol. Acetyl-CoA, in the form of citrate, is shuttled across the membrane of the mitochondria, by the citrate transporter, and is converted into oxaloacetate and acetyl-CoA, by ATP citrate lyase.

B) It requires a covalently bound derivative of pantothenic acid
- CoA is formed using pantothenic acid (from vit B5)

C) It requires NADPH derived solely from the pentose phosphate pathway
- Majority of a cell's NADPH is derived from the PPP, however, NAPDH can also be derived from malic enzyme, one of the two pathways malate can take.

D) The pathway is regulated only by citrate and palmitate
- Citrate upregulates Acetly-CoA Carboxylase and palmitate downregulates.
- PKA, induced by glucagon and epinephrine signaling, phosphorylate ACC to turn it off
- Phosphatase, induced by insulin signaling, will active ACC

E) Malonyl-CoA inhibits the synthesis
- Malonyl-CoA inhibit beta-oxidation, specifically carnitine acyl-transferase I

A 45 year-old male comes to the office with complaints of sudden weight loss. He is 5’ 10” and previously had a BMI of 42 at his last visit 6 months ago. He is currently at a BMI of 38. The patient states that he is always very thirsty despite drinking a gallon of water a day. His fasting glucose today was 242 mmol/L. Compared to 6 months ago, the amount of fat around his abdomen is less than before. What is a possible reason for this patient's inability to store up fat in his adipose cells?

a) The small intestine is not packaging fat into chylomicrons
b) Liver does not have glycerol for TAG synthesis
c) Adipose cells do not have DHAP
d) Malonyl-CoA is inhibiting synthesis

a) The small intestine is not packaging fat into chylomicrons
   - The man has diabetes mellitus. DM is a problem with insulin. Chylomicrons will still be formed at the level of the small intestine.

b) Liver does not have glycerol for TAG synthesis
   - Glycerol is not a limiting factor in TAG synthesis of the liver.

c) Adipose cells do not have DHAP
   - Insulin promotes the movement of GLUT-4 transporters to the plasma membrane, allowing for glucose to move into the cell, be broken down to DHAP and synthesized to glycerol.

d) Malonyl-CoA is inhibiting synthesis
   - Malonyl-CoA inhibit beta-oxidation, specifically carnitine acyl-transferase I

A group of researchers are studying the metabolism of fat. They want to know how to lose weight quickly (good luck…). They noticed that when they fed their cell culture with very-long chain fatty acids it took a lot longer for the fatty acid to reach the mitochondria than when they fed the cells short chain fatty acids. What is the mechanism for this observed difference?

a) VLCFA must be attatched to carnitine first
b) SCFA are oxidized by peroxisomes first
c) VLCFA must be metabolized into LCFA first
d) SCFA have a higher affinity for carnitine acyltransferase

a) VLCFA must be attatched to carnitine first

b) SCFA are oxidized by peroxisomes first
   - VLCFA must be oxidized by peroxisome. SCFA are capable of difusing across the membrane

c) VLCFA must be metabolized into LCFA first
   - VLCFA must be first metabolized in peroxisomes to LCFA. LCFA can then be attached to carnitine to enter into the mitochondria.

d) SCFA have a higher affinity for carnitine acyltransferase

You are still on a crusade to lose weight after struggling to meet your New Years resolution. To understand weight loss, you want to know how much energy you need to burn off to loss fat. How much ATP is generated from 1 palmitoyl-CoA?

a) 106
b) 32
c) 175
d) 40
e) 7
f) 2800
g) 900000

You are still on a crusade to lose weight after struggling to meet your New Years resolution. To understand weight loss, you want to know how much energy you need to burn off to loss fat. How much ATP is generated from 1 palmitoyl-CoA?

1 palmitoyl-CoA is 18 carbons.

Palmitoyl-CoA to acetly-CoA will generate (1 FADH and 1 NADH)*8

All 9 acetyl-CoA will yield (1 FADH + 3 NADH)*9 + 1 GTP*9

17 FADH * 1.5 ATP/FAPH + 17 NADH *2.5 ATP/NADH + 9 GTP = 106 ATP

An 8-month-old girl is brought to the office for evaluation of irritability and regression of motor skills. Her birth was unremarkable and she appeared to develop normally, but she can no longer sit or roll over. Her parents have also noticed that she startles easily with loud noises. Head circumference measurement is consistent with macrocephaly. Bilateral funduscopic evaluation shows a bright red fovea centralis that is surrounded by a contracting white macula. Peripheral vision is decreased. Abdominal examination is normal. Accumulation of which of the following metabolites is most likely present in this patient's tissues?

A) Galactocerebroside
B) Globotriaosylceramide
C) Glucocerebroside
D) Glycogen
E) GM2 ganglioside
F) Heparan sulfate
G) Sphingomyelin

Patient is displaying Tay-Sachs. One of the giveaways is the cherry-red macular spot on during funduscopic examination as well as the cognitive degeneration. Tay-Sachs is a deficiency in Hexamidase A, leading to the build up to GM2 ganglioside.

Better question! What is the name of the disease for each of the answer choices and the enzyme?

A) Galactocerebroside
B) Globotriaosylceramide
C) Glucocerebroside
D) Sphingomyelin

Galactocerebroside	Krabbe	Galactocerebrosidase
Globotriaosylceramide (Fable's have 3 parts)	Fabry's	a-Galactosidase A
Glucocerebroside	Gaucher	glucocerebrosidase
Sphingomyelin ("No man picks his nose with his sphinger")	Neimann-Pick	sphingomylinase

A 60-year-old male comes into the office with complaints muscle fatigue. For the past 2 months, he has been having increasing difficulties making it up the flight of stairs to his apartment. He states that there is no pain and he does not feel short of breath going up the stairs. 3 months ago, he had an occlusion of his left anterior descending coronary artery that was quickly stented before significant myocardial loss. Since the incident, he is taking aspirin, clopidogrel, lovastatin, metoprolol, and lisinopril. On physical exam, there are no rales, HR is 68 bpm, and blood pressure is 125/65 mmHg. What is the best reason for this patient's muscle fatigue?

a) Aspirin irreversibly inhibiting prostaglandin synthesis
b) Metoprolol decreasing cAMP levels in the heart
c) Post-operative complication after stent placement
d) Non-compliance with medication
e) Lovastatin inhibiting the production of CoQ

a) Aspirin irreversibly inhibiting prostaglandin synthesis
   - COX inhibition in aspirin is very important post-MI because it irreversibly inhibits the production of Thromboxane A2, which enhances platelet aggregation and clot formation

b) Metoprolol decreasing cAMP levels in the heart
   - Metoprolol is a β-blocker, which means ut decreases levels of cAMP in cells. Remember cAMP is an important secondary mediator in the signaling pathway to turn off ACC. Interestingly, glucagon causes an increase in cAMP and can be used to reverse the effects of a β-blocker.

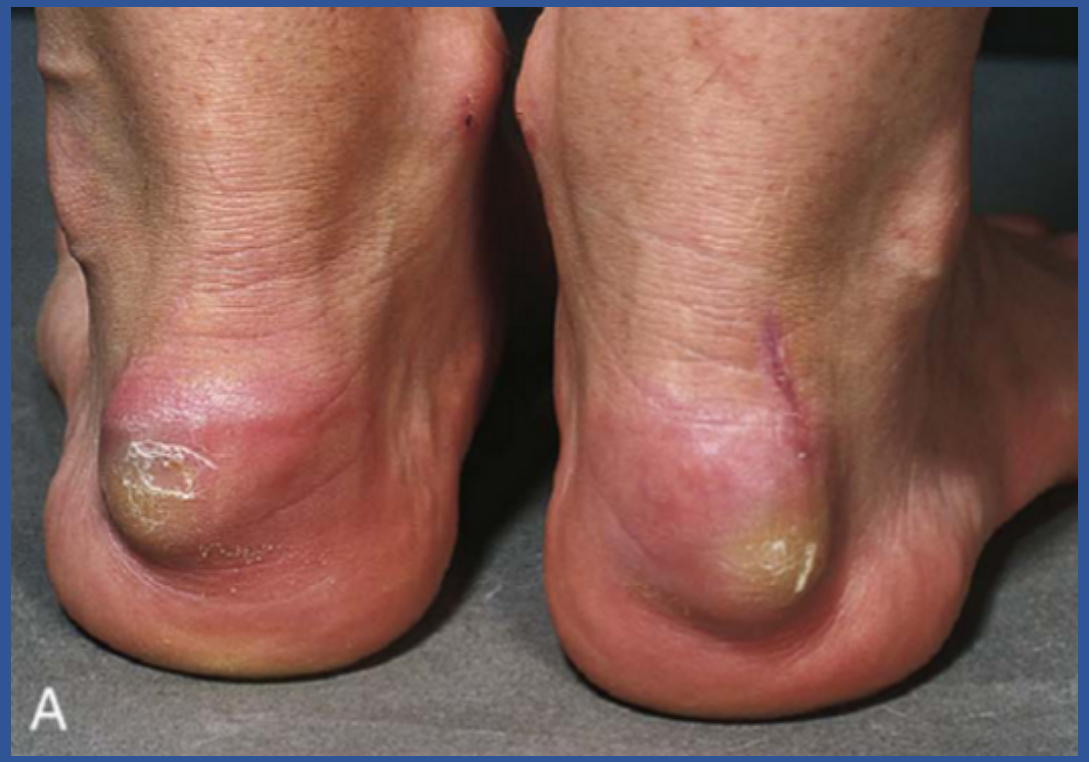
c) Post-operative complication after stent placement

d) Non-compliance with medication

e) Lovastatin inhibiting the production of CoQ
   - Lovastatin is a HMG-CoA reductase inhibitor. HMG-CoA reductase inhibitors are very important because it slows down the progression of atherosclerosis, the most likely cause of the patient's MI. CoQ, a important electron shuttle in the ETC is one of the off-shoot products in cholesterol synthesis.

Later on during the exam, the patient mentions that he heard there are patients with high cholesterol levels that develop atherosclerosis as early as a teenager. You remember back to your days of residency when you saw a patient who had such a disease. The patient had serum cholesterol levels over 1000mg/dl and had xanthomas full of cholesterol at their Achilles tendon. What was the mutation in the patient from your residency?

a) Hyperactive HMG-CoA reductase
b) Overproduction of chylomicrons
c) Inactive cholesterol ester transfer protein
d) Mutated LDL receptors
e) Mutated scavenger receptors



a) Hyperactive HMG-CoA reductase

b) Overproduction of chylomicrons

c) Inactive cholesterol ester transfer protein

d) Mutated LDL receptors

- The patient described has Familial hypercholesterolemia. Majority of patients with familial hypercholesterolemia is an autosomal codominant disease of the LDL receptor. The mutated LDL receptor is unable to bind to the B100 ligand of LDL, leading to elevated levels of serum LDL.

e) Mutated scavenger receptors

- The scavenger receptors are on macrophages and smooth muscle cells. The scavenger receptors help macrophages and SMC eat up LDL that is made under the intima leading to the formation of foam cells.

A 38-year-old woman is taken to the emergency department by her husband due to episodes of leg spasms and coughing up blood. She had recently immigrated from China where she was diagnosed with liver cirrhosis due to Hepatitis B. You suspect that that the astrocytes in her brain are swollen and are not functioning correctly. What is accumulating in the astrocytes?

a) Water
b) Neurofillary tangles
c) Prions
d) Phenylalanine
e) Glutamine

a) Water
b) Neurofillary tangles
c) Prions
d) Phenylalanine
e) Glutamine
   - Astrocytes are responsible for the removal of glutamate form the neurosynapes in the brain. Glutamate is converted into glutamine and stored until the neurons need more. In liver cirrhosis, NH_3 levels build up in the system leading to excess conversion to glutamine cause astrocyte swelling and inability of the astrocytes to give glutamine to neurons.

A 1-week-old girl comes into the emergency room with seizures. Her birth was unremarkable and the test results from the genetic testing facility has yet to come back. On examination, the girl is very fair skinned and has a musty order. You decide that she will start on a low phenylalanine diet and high tyrosine diet. What neurotransmitters was the girl unable to produce?

a) Serotonin
b) Histamine
c) Epinephrine
d) NO
e) GABA

a) Serotonin
   - Serotonin is synthesized from tryptophan

b) Histamine
   - Histamine is synthesized from histidine

c) Epinephrine
   - This child has phenylketouria, evidenced by the seizures, fair skin, and musty order (from aromatic amino acid metabolism). Tyrosine is not an essential amino acid normally, but for people with PKU, tyrosine is essential. These patients are unable to produce tyrosine from phenylalanine. Since there is no tyrosine, dopamine, epinephrine, and norepinephrine cannot be produced.

d) NO
   - NO is formed from the cleavage of arginine. NO is important for vasodilation

e) GABA
   - GABA is synthesized from glutamate

A 1-week-old Amish boy comes to the emergency room due to several episodes of poor feeding and vomiting. His mother reports that the boy's urine has also smelled very sweet, also like maple syrup. What amino acids is the boy unable to metabolize?

a) Leucine
b) Tyrosine
c) Isoleucine
d) Alanine
e) Proline
f) Histadine
g) Valine
h) Cysteine

A) Leucine , C) Isleucine, and G) Valine. This boy has maple syrup urine disease. Maple syrup urine disease has a higher prevalence in Amish populations and is characterized by the maple syrup-like smell of the urine. Maple syrup urine disease is a defect in branched chain α-ketoacid dehydrogenase.

A 5-day-old boy is brought to the emergency department after a tonic-clonic seizure at home. The infant is the product of a full-term, uneventful pregnancy, and was normal until two days prior to presentation. The mother reports irritability and poor feeding at home, and the infant was difficult to rouse this morning before suffering the seizure. On physical examination, the infant is tachypneic to 75/min, has icteric sclerae, and has poor muscle tone throughout. Laboratory studies show the following levels:

plasma ammonia, 300 µmol/L (normal = 10-40 µmol/L);

blood urea nitrogen, 1.5 mg/dL;

creatinine, 0.4 mg/dL

A plasma amino acid analysis fails to detect citrulline. Urine amino acids demonstrate elevated orotic acid levels. This patient suffers from a deficiency of which of the following enzymes?

A) Aldolase B

B) Galactose 1-phosphate uridylyltransferase

C) a-Galactosidase A

D) Ornithine transcarbamylase

A) Aldolase B

- Aldose B is an enzyme in the glycolysis pathway responsible for the conversion of fructose 1,6-bisphosphate to glyceraldehyde 3-P and DHAP. Aldoase B def is also responsible for fluctose intolerance.

B) Galactose 1-phosphate uridylyltransferase

- Galactose 1-phosphate uridylyltransferase deficiency is a AR disease found in classic galactosemia. Patients with classic galactosemia will present with cataracts, failure to thrive, and hepatomegaly.

C) α-Galactosidase A

- α-Galactosidase A deficiency is a X-linked recessive glycogen storage disease. Patients will present with hypohidrosis, peripheral neuropathy, and angiokeratomas.

D) Ornithine transcarbamylase

- Ornithine transcarbamylase is the first enzyme involved the urea cycle. It takes carbonyl phosphate and combines it with ornithine to make citrulline. Deficiencies in ornithine transcarbamylse leads carbonyl phosphate to be used toward the synthesis of pyridmadines. The build up of ammonium leads to depletion of α-ketogluterate, inhibiting TCA. (alanine from muscle gets converted to pyruvate in the liver/kidney and the NH3 gets put onto α-ketogluterate)

Methotrexate is a commonly used chemotherapeutic agent. Methotrexate is a folate analog and competitively inhibits dihydrofolate reductase. As an inhibitor of dihydrofolate reductase, what does methotrexate halt the production of?

a) Uracil
b) Phosphomembranes
c) Tyrosine
d) dTMP
e) ATP

a) Uracil

b) Phosphomembranes

c) Tyrosine

- Tyrosine is synthesized from phenylalanine by phenylalanine hydroxylase.

d) dTMP

- The main mechanism of action of methotrexate is the inhibition of dTMP production. Dihydrofolate is able to be reduced to tetrahydrofolate, which is then methylated to become an intermediate for methyl transfer. Without the methyl, dUMP can not be converted to dTMP, thus inhibiting the synthesis of DNA.

e) ATP

A 24-year-old male reports to the clinic with complaints of shortness of breath. In this patient, mature erythrocytes are found to be unable to synthesize heme even though they contain all the cytoplasmic enzymes necessary. The RBCs lack of which cellular organelle is responsible for their inability to synthesis heme?

a) sER
b) Nucleus
c) Proteasomes
d) Golgi apparatus
e) Mitochondria

a) sER
b) Nucleus
c) Proteasomes
d) Golgi apparatus
e) Mitochondria
   - The mitochondria is responsible for the first and the last two steps of heme synthesis. Of note, the last step of Fe insertion occurs in the mitochondria.

A 7-hour-old boy is being treated in the NICU. He was born at 29-weeks gestation and was noted to be very yellow. Due to fears of possible kernicterus, the baby is placed under blue light. What classification of jaundice is the child suspected of having?

A) Prehapatic
B) Intrahepatic
C) Posthepatic

A) Prehepatic

- It is possible that increased RBC lysis can lead to increased bilirubin, but the scenario does not suggest any hemolysis

B) Intrahepatic

- The worry is for intrahepatic jaundice. Babies, especially premature ones, have reduced conjugation function. The unconjugated bilirubin can make its way to the brain, through an immature blood-brain-barrier, and cause kernicterus.

C) Posthepatic

- Posthepatic jaundice will display increased amounts of conjugated bilirubin.

Patients with Lesch-Nyhan Syndrome have hyperuricemia, indicating an increased biosynthesis of purine nucleotides, and markedly decreased levels of hypoxanthine phosphoribosyl transferase (HPRT). The hyperuricemia can be explained on the basis of a direct decrease in which of the following?

a) ATP
b) GDP
c) Glutamine
d) IMP
e) PRPP

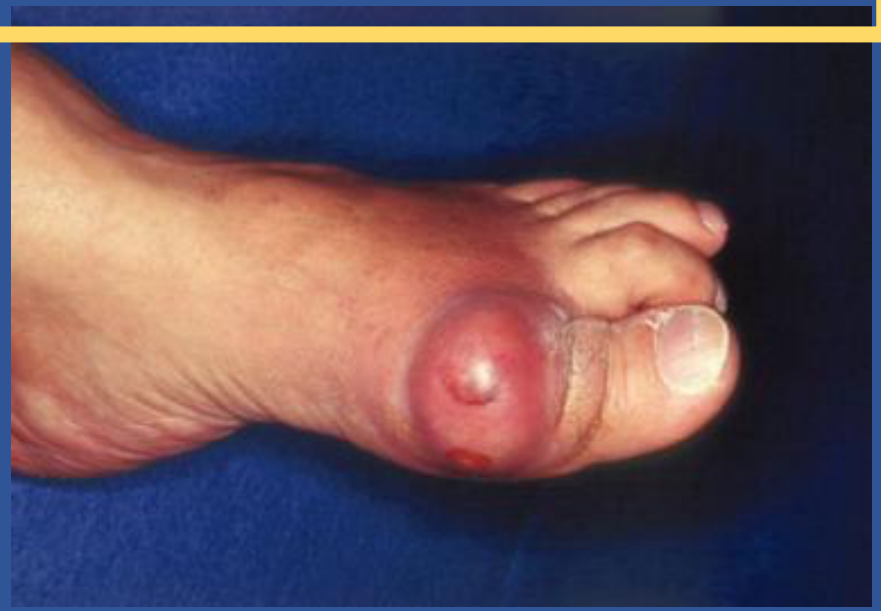
a) ATP

b) GDP

c) Glutamine

d) IMP
   - HGPRT is responsible for taking hypoxanthine and guanine and converting it into IMP and GMP in the salvage pathway. Without HGPRT, hypoxanthine and guanine get converted into uric acid, leading to gout.

e) PRPP
   - Although PRPP does build up, it is not directly related to hyperuricemia



A collection of tan fat-containing tissue is found around the kidneys and adrenal glands of a newborn during surgery. Surgical removal of the tissue would most likely contribute to:

a) Fasting hypoglycemia
b) Hypercholesterolemia
c) Fasting ketonemia
d) Lactic acidosis
e) Hypothermia

a) Fasting hypoglycemia
b) Hypercholesterolemia
c) Fasting ketonemia
d) Lactic acidosis
e) Hypothermia
   - Brown adipose tissue is full of mitochondria that are uncoupled (thermogenin), leading to heat production. Heat production is signaled from the posterior hypothalamus nucleus(!) via the sympathetic nervous system. Norepinepherine is released onto β-receptors, a GPCR with Gs, leading to increases in cellular cAMP.

- Just FYI, α-receptors act via Gq, which leads to an increase in IP3 and DAG

In a recent journal article studying the effects of major weight loss for contestants of the Biggest Loser, it was suggested that the body might have an internal set point for body weight. What might be a contribution factor to gaining some weight after massive weight loss?

a) Gherlin levels are high
b) Leptin levels are high
c) NYP levels are low
d) ARP level are low
e) AMPK activation is low
f) POMC neurons are hyperactive

a) Gherlin levels are high
   - Gherlin actives ARP/NRP neurons while inhibiting POMC neurons to induce hunger

b) Leptin levels are high
   - Leptin is released from adipose cells to sign to the hypothalamus satiety

c) NYP levels are low

d) ARP level are low

e) AMPK activation is low
   - AMPK is activated when there is a low ratio of AMP/ATP. During times of eating, AMPK activity is decreased.

f) POMC neurons are hyperactive
   - POMC neurons sign for satiety

Right after waking up from a full night’s rest, your brain is consuming what for energy?

a) Glucose
b) Glycogen
c) Ketones
d) Lipids
e) Strawberries

a) Glucose

b) Glycogen
   - Glycogen stores are depleted in prolonged states of fasting

c) Ketones
   - After a prolonged period of fasting, your liver has expended its store of glycogen. Lipids are then broken down and formed into ketone bodies (β-hydroxybutyrate) which the neurons convert into 2 acetyl-CoAs.

d) Lipids
   - Technically, if you choose lipids you aren't completely wrong. However, neurons are not directly using lipids, they are using ketones.

e) Strawberries
   - Sorry, but you are just wrong.

A 6-year-old boy is brought to his pediatrician's office by his parents, who report that the child has been unusually thirsty for the past week. He also has increased urinary frequency and has wet the bed three times in the past two weeks. A random blood glucose level is 215 mg/dL. The pediatrician suspects that the child has type 1 diabetes mellitus. Which of the following is the transporter for glucose to enter liver cells?

a) GLUT 1
b) GLUT 2
c) GLUT 4
d) Simple diffusion

a) GLUT 1

b) GLUT 2
   - The liver as well as the β-cells use GLUT2 to transport glucose. This is insulin independent.

c) GLUT 4
   - GLUT4 is the glucose transporter induced by insulin.

d) Simple diffusion