**Ch23**

**4. Proteins as Fuel during Fasting**

The amino acid will be transported to liver. In hepatocyte, the amino acid will lose their amino group and the glucogenic amino acid and others will be used to process glucose for brain and oxidized in mitochondria, respectively.

**6. Oxygen Consumption during Exercise**

(a) During the sprint, strenuous exercise induces higher demand of energy, which need higher rate of cell respiration to produce ATP.

(b) During the sprint, anaerobic respiration in muscle produce lots of lactate that will be transported to hepatocyte as the material of gluconeogenesis. Therefore, more energy is needed to synthesis glucose.

**7. Thiamine Deficiency and Brain Function**

Thiamine is a crucial coenzyme in catabolism of glucose and amino acid. Enzymes like pyruvate dehydrogenase or α-ketoglutarate dehydrogenase needs thiamine pyrophosphate (TPP). In brain, glucose is the main fuel to provide energy. Deficiency of glucose inhibit the oxidation of glucose, which cause the disorder of brain function.

**11. Metabolic Difference between Muscle and Liver in a “Fight-or-Flight” Situation**

**(a) + (b)** When organism meets this situation, it should make sure that all recourses can be used to move or fight. In this process, muscle or heart needs the highest energy to contract. So, glycogen in muscle is mainly consumed by muscle itself. This phenomenon is also caused by the absence of glucose 6-phosphatase. In liver, hepatocyte doesn’t need so much energy, so the glucose 6-phosphate is converted to glucose and released to bloodstream and transported to tissues requiring energy.

**12. Excessive Amount of Insulin Secretion: Hyperinsulinism**

(a) In liver, insulin stimulates the oxidation of glucose, inhibit gluconeogenesis, inhibits the synthesis of glycogen and stimulates the degradation of glycogen, also hepatocyte transport excessive glucose from blood. For amino acid and fatty acid, insulin inhibits their metabolism.

(b) Excessive amount of insulin makes glucose are concentrate to tissue that doesn’t need too much energy such as adipose tissue and liver. Tissues that really demand energy like neuron tissue couldn’t get enough glucose. In addition to this, glucose is the mainly fuel for neurons. In this case, neuron disorder above displays. If prolonged, it will lead to long-time deficiency of glucose in brain, further cause the brain damage.

**15. Sources of Glucose during Starvation**

In human body, during starvation, glucose is mainly maintained through gluconeogenesis. The precursors are glycerol, odd-number fatty acid and amino acid. Also, pyruvate and oxaloacetate can be the material of gluconeogenesis.

**19. Effects of a Deleted Insulin Receptor**

In these mice, insulin receptor is absent on liver, in this case, liver’s capacity to absorb glucose cannot be activated by insulin. In mammal, liver plays central role in acute hyperglycemia. In this case, without receptors on liver, elevation of blood glucose after fed couldn’t be controlled. However, as time passing, other tissues response to insulin absorb glucose, so the glycemia is not much higher than normal.

Glucose 6-phosphatase is to convert glucose 6-phosphate to glucose, which can be release to bloodstream. Without the insulin receptor, the expression of glucose 6-phosphatase cannot be inhibited by insulin signal pathway hence enzyme concentration is higher than normal.

Without liver receptors, mice’s capacity to regulate the glycemia is inhibited. The blood glucose concentration is higher and further stimulate the excretion of insulin. So, level of blood insulin is elevated.

**Extra questions:**

1. Ingestion large amounts of glucose before a marathon might seem to be a good way of increasing the fuel stores. However, experienced runners do not ingest glucose before a race. What is the biochemical reason for their avoidance of this potential fuel? (Hint: Consider the effect of glucose ingestion on the level of insulin.)

If runner ingests lots of glucose before race, his blood glucose will rapidly increase that stimulate the excretion of insulin. When the race begin, runner will be excited and epinephrine level will increase. However, effects of insulin are against the effects of epinephrine. In this case, blood glucose cannot elevate to an ideal level which influence the grade of runner.

2. Explain, in terms of enzyme kinetics, why glucokinase is responsible for channeling glucose into the glycogen synthesis pathway in the liver, and why hexokinase (an isozyme of glucokinase) regulates the entry of glucose into the glycolytic pathway in muscle.

According to the data, we know that compare to other hexokinase, glucokinase has two important properties. First, glucokinase’s Km is much higher than hexokinase indicating that glucokinase has lower affinity to its substrate --- glucose. Second, glucokinase is not inhibited by its product glucose 6-phosphate. These two properties make glucokinase mainly play a central role with high amount of glucose and the activity of enzyme is not regulated by the demand of product but supplement of substrate. These characters give glucokinase multiple advantages to catalyze the process of glycogen synthesis.