Facts	Ideas	Learning Outcomes	Actions
1. 23-year old man developed an irregular heart rhythm, complained lethargy, tremor of hands and arms	1. What are these symptoms related to? 2. What is the possible treatment? 3. What are the regular and irregular heart rhythm? 4. How to take heartbeat reading? 5. How to prevent irregular heart rhythm?	1. Glycolysis 2. Krebs cycle 3. Electron transport system 4. Hypoglycaemia 5. Glucose level in blood	**Idea 1:** Irregular heartbeat or arrhythmia can be caused by multitude of reasons. The irregular heartbeat is caused by the unregulated electrical impulses that control the beating of the heart. Mayoclinic.org website stated that the condition is due to high blood pressure, diabetes, coronary artery disease (CAD), hyperthyroidism, hypothyroidism, alteration of heart's structure and many more to be listed. Arrhythmia occurs to someone that reached the peak of aging or getting old, so does their cardiovascular systems. Compromised cardiovascular systems lead to the loss of elasticity of blood vessels and diastolic dysfunctions which is the abnormality of left ventricular diastolic function. Lethargy or tiredness is also closely related to the arrhythmia while shakiness is related to diabetes type 1. **Idea 2:** NHS.uk suggests that a proper medication could stop or prevent arrhythmia while a more common treatment could be pacemaker and ICD device that regulates heartbeat. **Idea 3:** A normal heartbeat is between 60 to 100 beats per minute while irregular heartbeat can be classified into two types that are tachycardia which the heartbeat is more than 100 and bradycardia which is the heartbeat is less than 60. **Idea 4:** Healthline.com suggests four ways to measures heartbeat. The first way is to measure heartbeat through radial artery just below the thumb. The second way is through carotid pulse that is below jawline. Next is pedal pulse that is on top of your foot. Lastly is through brachial pulse which is at the crook of the elbow. Count the pulse in 15 second and multiply it by 4 to get the actual heart rate. Mayoclinic.org recommended a healthy diet, regular exercise, avoiding alcohol and drugs to prevent such symptoms to develop into a much more serious complication. **Idea 5:** You can tell how fast your heart is beating by feeling your pulse. You can feel your pulse on your wrist or neck. Place the tips of your index and middle fingers on the inner wrist of your other arm, just below the base of your thumb. Or, place the tips of your index and middle fingers on your lower neck, on either side of your windpipe. Press lightly with your fingers until you feel the blood pulsing beneath your fingers. You may need to move your fingers around slightly up or down until you feel the pulsing. You can count the number of beats in 10 seconds and multiply by 6 to determine your heart rate in beats per minute. A normal heart rate when at rest is 50 to 100 beats per minute. To understand better, this is the formula to measure heart rate. Your Heart Rate = Pulse in 10 seconds x 6

			Beside than using manual ways, heartbeat readings can also be measured by using heart's electrical system where each beat of the heart is represented on the electrocardiogram (EKG or ECG) by a wave arm. If the heart rhythm is normal or normal sinus rhythm, the electrical activity in the heart will follow the normal pathway. This shows that the rhythm is regular, and the node is normal around 50 to 100 beats per minute as stated previously. Fast heart rhythm which is greater than 100 beats per minute is called tachycardia and slow heart rhythm which is less than 60 beats per minute is called bradycardia.
2. Complained about anxiety, sweating and hunger	1. What are these symptoms related to? 2. What is the possible treatment?		**Idea 1:** Based on the trigger, it stated that the man complained about the anxiety, sweating and hunger. This may cause by triggering the release of hormone such as epinephrine and norepinephrine. These hormones act as neurotransmitters the brain will relies on these hormones to control blood sugar levels. However, having a high or low level of these hormones, can cause person to experienced stressful conditions such as sweating and anxiety. Besides, it also can affect the sugar intake of a person. This can be proven by article found from the medical news today.com, where it shows that the symptoms (anxiety, hunger and sweating) indicates the person is diagnosed with hypoglycemia which is low in blood sugar level due to imbalanced of the hormones. Regarding on these three symptoms it can be found that it can be linked to hypoglycemia diseases. **Idea 2:** To treat these symptoms, If you have symptoms of anxiety, hunger and sweating, firstly the person itself need to immediately eat or drink 15 to 20 grams of fast-acting carbohydrates. This is because sugary foods without protein or fat that are easily converted to sugar in the body, which helps in increasing blood sugar level. Sugary food such as glucose tablets or gel, fruit juice. Next, it also can be treated by always recheck blood sugar levels 15 minutes after treatment. It can be proven by the book titled 'Diagnosis in Chinese Medicine' by Giovanni Maciocia, it stated that if the blood sugar levels are still under 70 mg/dL (3.9 mmol/L), eat or drink another 15 to 20 grams of fast-acting carbohydrate, and recheck the blood sugar level again in 15 minutes. Repeat these steps until the blood sugar is above 70 mg/dL (3.9 mmol/L). The last treatment for the symptoms, based on my finding is by having a snack or meal. Once your blood sugar is normal, eating a snack or meal can help stabilize it and replenish your body's glycogen stores. It is advisable for a person itself to seek treatment from doctor immediately. This is because the doctor needs to identify the underlying condition and treat it. Depending on the underlying cause, treatment may involve such as medications. If a medication is the cause of a person to get hypoglycemia, then the doctor will likely suggest changing or stopping the medication or adjusting the dosage.
3. Biochemical investigation on blood	1. How it is conducted and what are the materials needed?		**Idea 1:** Centers for disease control and prevention in 2020 stated that blood analysis can be measured by using a blood sugar meter which can also be called as glucometer or a continuous glucose monitor

	2. How long is the time taken for the result to come out? 3. What is the function of blood analysis?		(CGM). This instrument is used to check blood sugar. A blood sugar meter measures the amount of sugar in a small sample of blood, usually from a fingertip. A CGM uses a sensor inserted under the skin to measure the blood sugar every few minutes. If a CGM is used, a test daily with a blood sugar meter to make sure the CGM readings are accurate. This diagram shows you the glucometer.  Besides, the A1C test can also be used. It is a simple blood test that measures the average blood sugar levels or the amount of glucose that is stuck to the hemoglobin (part of red blood cells) over the past two or three months. The test is done at a lab or the doctor's office instead of testing the regular blood sugar yourself. The A1C testing is part of the ABCs of diabetes. The ABCs has important steps that can be taken to prevent or delay health complications down the road where their meanings are as follow. A: Get a regular **A**1C test. B: Try to keep your **b**lood pressure below 140/90 mm Hg (or the target your doctor sets). C: Manage your **c**holesterol levels. s: Stop **s**moking or do not start at all. The A1C goal for most adults with diabetes is between 7% and 8%, but this goal may be different depending on someone's age, other health conditions, medicines they are taking and other factors. They can work with their doctor to establish a personal A1C goal suitable for them. **Idea 2:** According to Healthline in 2018, the duration to get the result is around 10 - 20 seconds for home test, the glucometer. This table shows you the meaning of blood sugar test results. The results of blood sugar test do not similar with everyone. It depends on the condition and the timing of test. However, the blood sugar levels should be in the target ranges listed here.

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<table>
<tr><th>Time</th><th>People without diabetes</th><th>People with diabetes</th></tr>
<tr><td>Before breakfast</td><td>Under 70-99 mg/dL</td><td>80-130 mg/dL</td></tr>
<tr><td>Before lunch, dinner and snacks</td><td>Under 70-99 mg/dL</td><td>80-130 mg/dL</td></tr>
<tr><td>Two hours after eating</td><td>Under 140 mg/dL</td><td>Under 180 mg/dL</td></tr>
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Idea 3:
According to Britannica which is a health line website, it stated that blood analysis, is a laboratory examination of a sample of blood that is help to obtain information about its physical and chemical properties Besides blood analysis is commonly carried out on a sample of blood drawn from the vein of the arm, the finger, or the earlobe; in some cases, the blood cells of the bone marrow may also be examined. In this case, it is recommended for a 23-year-old man to take blood analysis. This is because, we need to get his history check-up such as his blood glucose level and to indicate on what type of diseases related to his medical check-up history. That is all from me regarding on the last ideas for this fact. Anyone wants to add on?
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<td>4. Blood sugar levels is 2.7 mmol/L</td>
<td>1. What is the ideal blood sugar level according to a 23 years old man?
2. What are the symptoms for a person having high or low sugar level in blood?
3. What happen to glycolysis when blood sugar level is low?
4. What are the ways to maintain normal blood sugar level?
5. What is the importance of ideal blood sugar level?</td>
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Idea 1:
For the first idea, 'what is the ideal blood sugar level according to a 23-year old’s man?’. Based on Ministry of Health Malaysia (KKM), two tests are used in the determination of blood sugar level and each test have different normal blood sugar level. Random Blood Sugar (RBS) test can be done anytime of the time regardless of diet taken. The normal range for random blood glucose is 7.8 mmol/L -11.1 mmol/L. Next is the Fasting Blood Sugar (FBS) test where it is taken after an 8-12 hour or overnight fasting. Fasting blood glucose level for a normal healthy individual is below 7.0 mmol/L. Based on my finding, no minimum FBS level found but need to note that blood glucose level below 3.9 mmol/L is considered hypoglycemia.

Idea 2:
Based on National Diabetes Institute (NADI), high blood sugar (hyperglycemia) causes symptoms such as increased thirst, constant hunger, frequent urination, extreme weight loss and constant tiredness. Whilst low blood sugar (hypoglycemia) causes symptoms such as rapid heart rate, cold sweats, hunger, tremor, tiredness and behavior changes: irritable, impatient, confused.

Idea 3:
In the regulation of blood glucose, high blood sugar promotes the release of insulin, which stimulates the glucose uptake from blood to cells which then lowers the blood sugar. When glucose level falls too low, glucagon is secreted by the pancreas to raises the blood glucose again. Glucagon reaches the liver and stimulates glycolysis, the breakdown of glycogen, and export glucose into the blood circulation. Here is a graphical pathway of the regulation of blood glucose level in the body.
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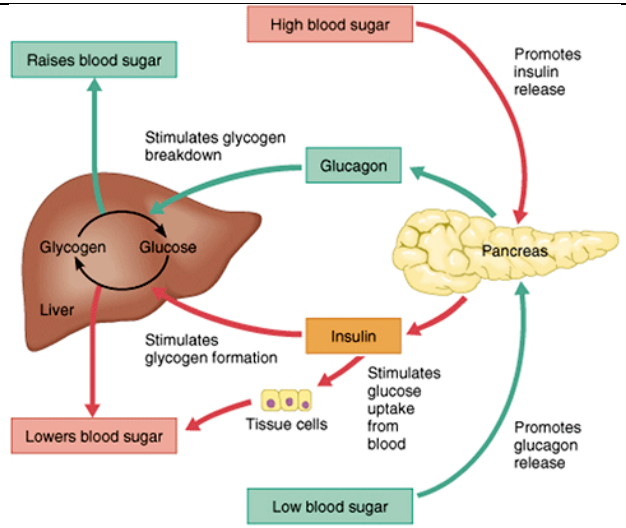
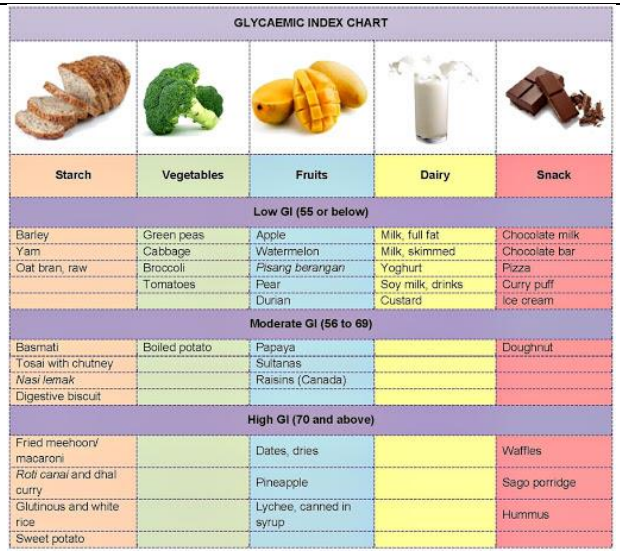
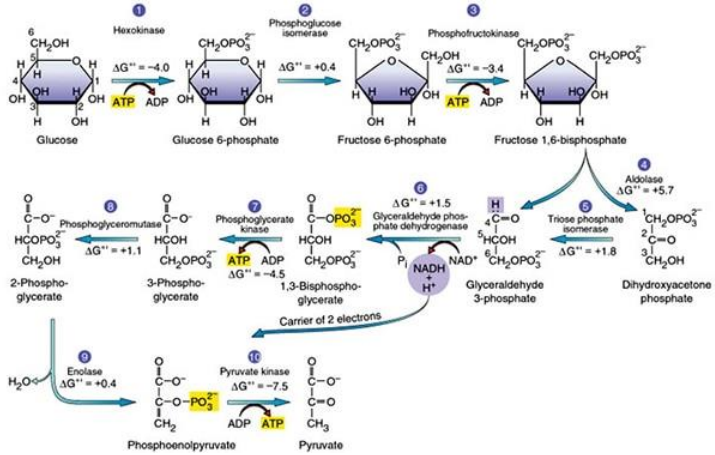


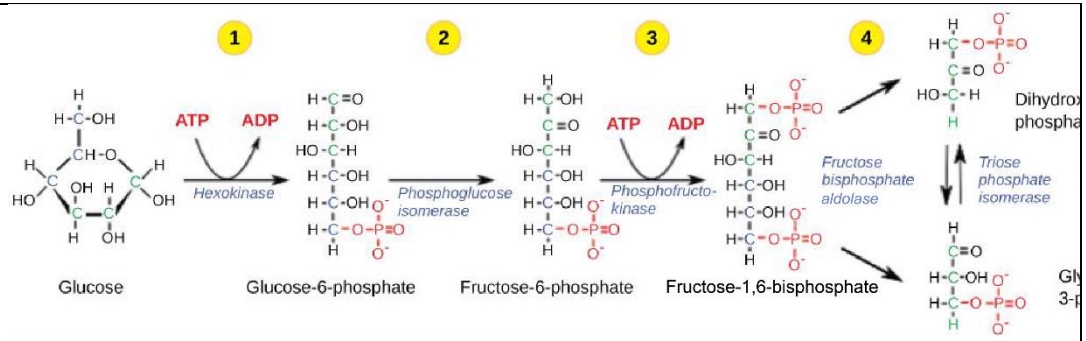
In the case of hypoglycemia, when a person has hypoglycemia, it affects the delivery of glucose into the cell as well as glycolysis. It is because once glucose enters the cell it serves as the principle substrate of glycolysis. When the delivery of glucose is delayed, cells will starve. Hypoglycemia increase the ratio of Krebs cycle to glycolytic fluxes, indicates enhance of oxidative metabolism compare to glycolysis. Acute episode of hypoglycemia inhibits glycolysis.

Idea 4:

There are many ways to maintain normal blood sugar level and I will only explain part of it. Firstly, eating a healthy diet can maintain the blood sugar level. A low-carb diet as suggested by The American Diabetes Association (ADA) help to reduce blood sugar level and prevent blood sugar spikes. A high-fiber diet slows down carb digestion and sugar absorption, which promotes a more gradual rise in blood sugar levels Besides avoiding processed food and focus on high quality whole foods such as vegetables, fruits, nuts, and meat. Processed foods are high in sugar, refined grains and carbs, artificial ingredients and flavoring. However, choosing food with a low glycemic index is important in avoiding food that will disrupt the blood sugar levels. This is an example of glycemic index chart which is adapted from Ministry of Health Malaysia (http://www.myhealth.gov.my/en/glycaemic-index-and-glycaemic-load/).

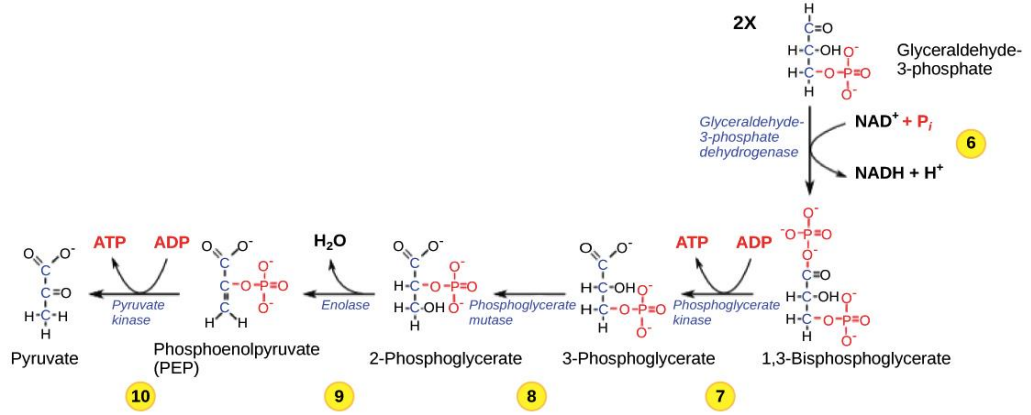
			 Secondly, drinking enough water helps the kidneys flush out the excess blood sugar through urine. Additionally, getting at least 150 minutes of moderate- to- intense exercise each week help to maintain a healthy weight and increase insulin sensitivity. Increase in insulin sensitivity increase the glucose uptake from the blood to cells. Not to forget that regular blood glucose monitoring by using glucometer is important to keep ideal blood glucose level especially for diabetes control. **Idea 5:** One of the major importance of an ideal blood sugar level is to prevent diseases which is diabetes and heart diseases. Maintaining an ideal blood sugar levels is a very important part of avoiding long-term health issues by managing your weight and just feeling good. If the blood sugar level cannot be maintained well, then we may experience a lot of health problems related to blood sugar (such as hypoglycemia or hyperglycemia) that can lead to imbalances growing burden that is reaching epidemic proportions. This can be proven by The American Diabetes Association where they estimate over 100 million people in the U.S. alone have health problems related to blood sugar imbalances, and staggeringly, that over 80% of these people don't know it. The health costs of conditions related to blood sugar imbalance are estimated to be over $250 billion per year in medical costs and reduced productivity. These worrying numbers are also reflected in an ever-growing number of countries around the world, making this one of the biggest issues facing public health today. For the trigger, it is believed that the 23-year-old man does not maintained his blood sugar level properly, this may be due to his sugar intake is very low, that causes his energy dropped., and it can be inferred that he may experience particular diseases such as hypoglycemia.

5. Hypothesis: This man has hypoglycaemia	1. What is the process(es) or cycle(s) involve in glucose synthesis?		**Idea 1:** First step in breakdown of glucose to extract energy for cellular metabolism is glycolysis. Glycolysis is a metabolic pathway that converts glucose, into 2 molecules of pyruvate, 2 molecules of adenosine triphosphate (ATP) and 2 molecules of nicotinamide adenine dinucleotide (NADH). Glycolysis has 10 steps and can be divided into 2 major phases which are preparation phase and ATP-generating phase. Here is a picture of overall process of glycolysis.  **Process of Glycolysis** In preparation phase, a phosphate group is transferred from ATP to glucose, producing glucose-6-phosphate. The reaction is catalyzed by hexokinase. Then, it will be converted into its isomer which is fructose-6-phosphate by catalysis of phosphoglucose isomerase. Next, a phosphate group from ATP is transferred to fructose-6-phosphate, forming fructose-1,6-bisphosphate. It is catalyzed by phosphofructokinase, which an enzyme that can regulate speeds of glycolysis pathway. In next step, fructose-1,6-bisphosphate splits to form two 3C sugars, which are dihydroxyacetone phosphate (DHAP) and glyceraldehyde-3-phosphate. They both are isomers to each other but only glyceraldehyde-3-phosphate will be directly move to the next step of glycolysis. Next, DHAP is converted into glyceraldehyde-3-phosphate.

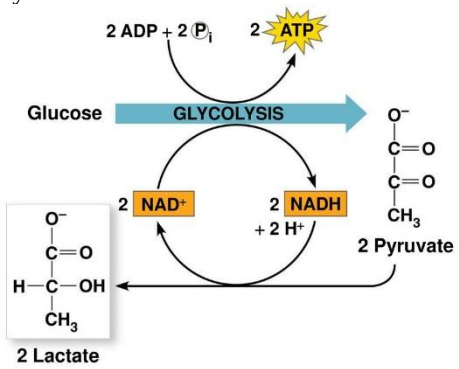
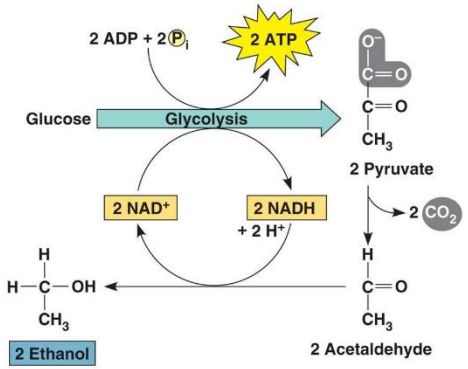


Preparation Phase

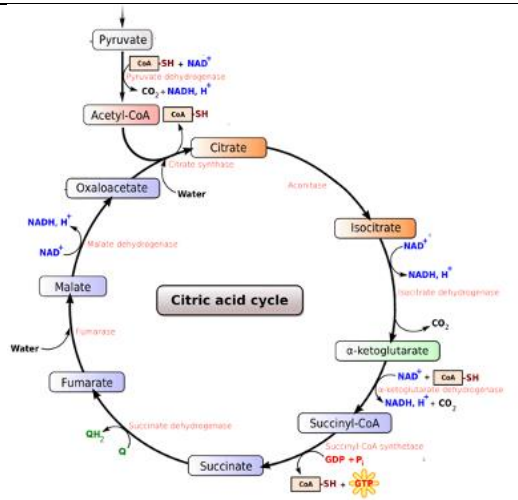
Moving on to ATP-generating phase. In step 6, there will be two half reactions that will occur simultaneously. First, glyceraldehyde-3-phosphate is oxidized and second, NAD^+ is reduced to NADH and H^+. The whole reaction is exergonic, releasing energy that will be use in phosphorylation of molecule into 1,3-bisphosphoglycerate. Next, 1,3-bisphosphoglycerate will be donating one of its phosphate groups to ADP, producing an ATP molecule and turns it into 3-phosphoglycerate. In step 8, 3-phosphoglycerate will be converted into its isomer which is 2-phosphoglycerate. Then, 2-phosphoglycerate will lose a molecule of water, converting it into phosphoenolpyruvate (PEP). In last step, PEP will donate its phosphate group to ADP, producing a second molecule of ATP and converted into pyruvate.

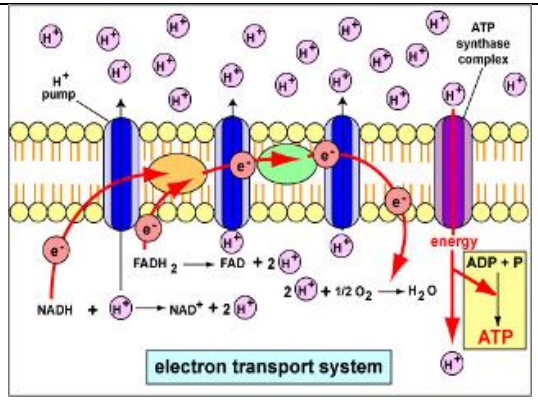


Energy/ATP-generating Phase

			There will be two possible fates for breakdown of pyruvate and NADH molecules from glycolysis, which are anaerobic (lactic acid & alcoholic fermentation) and aerobic oxidation (Krebs Cycle). Under anaerobic conditions, NADH is re-oxidised to NAD^+, providing additional NAD^+ for glycolysis. In lactic acid fermentation, electrons of NADH is transferred to pyruvate, generating a byproduct of lactate. Lactate is deprotonated form of lactic acid that commonly be found in vigorous contracting muscles, erythrocytes and some cells.  Lactic Acid Fermentation Another fermentation carried out is alcohol fermentation, which in this process, NADH donate its electrons to a derivative of pyruvate, producing ethanol. There will be two steps. In the first step, a carboxyl group is removed from pyruvate and released as carbon dioxide, CO_2 and producing a molecule called acetaldehyde. Then, NADH will transfer its electrons to acetaldehyde, regenerating NAD^+ and forming ethanol.  Alcoholic Fermentation

			When oxygen is present, most organism will undergo two crucial steps, which are Krebs Cycle and Electron Transport System in order to produce ATP. Pyruvate is first altered in transition reaction by removal of carbon dioxide, CO_2. After the removal, the energy is given off and NAD^+ is converted into higher form of energy of NADH. Next, coenzyme A will attach to acetyl unit, producing acetyl CoA. This process is a prelude to Krebs cycle. Krebs cycle or also known as citric acid cycle take place in the matrix of mitochondria. It is a closed loop cycle, which the last part of the pathway will reforms the molecule used in the first step. Krebs cycle converts pyruvate into CO_2, NADH, $FADH_2$ and GTP/ATP. In the first step, acetyl CoA will be attached to oxaloacetate, causing the CoA group to be released and forming a citrate molecule. Then, citrate molecule will be converted into its isomer which is isocitrate. In the third step, isocitrate is oxidized and releases a molecule of carbon dioxide, leaving behind α-ketoglutarate. During this step, NAD^+ is reduced to form NADH. The enzyme catalyzing this step is isocitrate dehydrogenase that can regulate the speed of the citric acid cycle. The fourth step is like the third. In this case, it's α-ketoglutarate that's oxidized, reducing NADH and releasing a molecule of carbon dioxide in the process. The remaining four-carbon molecule will be picked up Coenzyme A, forming the unstable compound succinyl CoA. The enzyme catalyzing this step, α-ketoglutarate dehydrogenase, is also important in regulation of the citric acid cycle. In step five, the NADH replaced by a phosphate group, which is then transferred to ADP to make ATP. In some cells, guanosine diphosphate is used instead of guanosine triphosphate as a product. The four-carbon molecule produced in this step is called succinate. In step six, succinate is oxidized, forming another four-carbon molecule called fumarate. In this reaction, two hydrogen atoms with their electrons are transferred to $FADH_2$. The enzyme that carries out this step is embedded in the inner membrane of the mitochondrion, so $FADH_2$ can transfer its electrons directly into the electron transport chain. In step seven, water is added to the four-carbon molecule fumarate, converting it into malate. In the last step of the citric acid cycle, oxaloacetates regenerated by oxidation of malate.

			 Krebs Cycle (Citric Acid Cycle) In the Electron Transport System (ETS), NADH and $FADH_2$ are used to produce ATP in cytochromes. The energy released in form of ATP will be captured by ADP. Next, ADP is reduced to ATP by gaining electrons in oxidative phosphorylation step. Oxidative phosphorylation is the gradient exchange of H+ ions across the inner mitochondrial membrane. It made up of two closely connected components, which are electron transport and chemiosmosis. In the electron transport chain, electrons are passed from one molecule to another and the energy released in the electron transfer will be used to form an electrochemical gradient. In chemiosmosis, the energy stored in the gradient will be used to make ATP. At the end of ETS, 2 protons, 2 electrons and water molecule (combination of half of oxygen molecule) will be produced.

			 Electron Transport System