Distinguish between catabolism and anabolism

Cells are important constituents of any organism. Numerous chemical reactions take place in these cells in order to carry out different actions. All the reactions are together referred to as metabolism. The chemicals that are involved in metabolism are known as metabolites. Metabolism as biochemical processes, are important in many contexts. They are important for maintaining life. These processes provide the necessary mechanisms for growth, reproduction, repair damage and many more. The reaction of metabolism are organized into metabolic pathways like in a metabolic pathway known as glycolysis, glucose is converted into pyruvate and produce ATP. During the chemical reactions, energy is involved. It is either taken in or released. Metabolism is responsible for managing material and energy resources of the cell. In catabolism more complex organic molecules break down into simpler substances. These reactions usually result in release of energy which is further used to drive chemical reactions. Example of Catabolism Fuels (carbohydrates, fats, proteins) -> CO_2 +H_2O + useful energy Organisms are classified on the basis of type of Catabolism – Organotrophs - Organisms which use organic sources as a source of energy Lithotrophs - Organisms which use inorganic substrates Phototrophs – Organisms which use sunlight as chemical energy On the other hand, in anabolism reactions, simpler substances combine to form complex molecules. These reactions generally require energy to take place. In this context, anabolism and catabolism can be considered as just opposite of each other. Thus, anabolism can be referred to as 'building up', whereas catabolism can be referred to as 'breaking down'. The energy released by catabolic reactions is used for carrying out anabolic reactions. Example of Anabolism Useful energy + small molecules ->complex molecules Metabolism comprises of both catabolism and metabolism. In this way, it balances both the activities that take place simultaneously. Catabolism is also known as destructive metabolism. On the other hand, anabolism is also known as constructive metabolism. Comparison between Metabolism, Catabolism and Anabolism: Metabolism Catabolism Anabolism Definition Metabolism refers to the bio-chemical reactions that take place in an organism. It consists of two processes – Catabolism and Anabolism Catabolism deals with energy releasing processes. Anabolism is related to energy-using processes. Origin of Word From Greek: μεταβολή metabolē, "change" or Greek: μεταβολισμός metabolismos, "outthrow" From Greek kata = downward + ballein = to throw From Greek: ανά "upward" and βάλλειν "to throw" Type Includes catabolism and anabolism It breaks things and releases energy It builds things and consumes energy Importance Growth and division Maintaining cellular structures Sense/respond to environment The energy released provides fuel for anabolism, heats the body, and enables the muscles to contract and the body to move. It supports growth of new cells It helps in maintenance of body tissues It supports the storage of energy for future use Energy Form Includes enegy forms of catabolism and metabolism Energy is released as kinetic energy Energy is used and stored as potential energy Example Includes examples of catabolism and anabolism Cell Respiration, Digestion, Excretion Photosynthesis in plants, assimilation in animals Catabolic reactions that break complex molecules provide the energy needed by anabolic reactions to produce complex molecules. Differentiate between anabolism and catabolism Key Takeaways Key Points Catabolism is the process of transforming chemical fuels such as glucose into ATP (energy). Anabolism, the process of cell differentiation and growth, requires energy (ATP). Anabolism takes a few, basic raw materials and produces a wide variety of products such as peptides, proteins, polysaccharides, lipids, and nucleic acids. Catabolism and anabolism have separate metabolic pathways controlled by a distinct set of hormones. Growth hormone, testosterone, and estrogen are anabolic hormones. Adrenaline, cortisol, and glucagon are catabolic hormones. Glucose metabolism fluctuates with an individual's circadian rhythms which regulate anabolism and catabolism. Adrenaline, cortisol, and glucagon are catabolic hormones. Glucose metabolism fluctuates with an individual's circadian rhythms which regulate anabolism and catabolism. Key Terms anabolism: The constructive metabolism of the body, as distinguished from catabolism. circadian rhythms: A circadian rhythm is any biological process that displays an endogenous, entrainable oscillation of about 24 hours. catabolism: The destructive metabolism, usually including the release of energy and breakdown of materials. Babies experience a tremendous amount of growth during their first years, requiring that enough fuel be converted to the energy needed to facilitate this growth. Hence the reason that when most babies aren't sleeping, they are usually eating. Anabolic reactions require energy. The chemical reaction where ATP changes to ADP supplies energy for this metabolic process. Cells can combine anabolic reactions with catabolic reactions that release energy to form an efficient energy cycle. The catabolic reactions transform chemical fuels into cellular energy, which is then used to initiate the energy-requiring anabolic reactions. ATP, a high energy molecule, couples anabolism by the release of free energy. This energy does not come through the breakage of phosphate bonds; instead, it is released from the hydration of the phosphate group. Anabolism and Catabolism: Catabolic reactions release energy, while anabolic reactions use up energy. Anabolism is the opposite of catabolism. For example, synthesizing glucose is an anabolic process, whereas the breaking down of glucose is a catabolic process. Anabolism requires the input of energy, described as an energy intake ("uphill") process. Catabolism is a "downhill" process where energy is released as the organism uses up energy. Anabolism and catabolism must be regulated to avoid the two processes occurring simultaneously. Each process has its own set of hormones that switch these processes on and off. Anabolic hormones include growth hormone, testosterone and estrogen. Catabolic hormones include adrenaline, cortisol and glucagon. The balance between anabolism and catabolism is also regulated by circadian rhythms, with processes such as glucose metabolism fluctuating to match an animal's normal periods of activity throughout the day. Anabolism can be viewed as a set of metabolic processes in which the synthesis of complex molecules is initiated by energy released through catabolism. These complex molecules are produced through a systematic process from small and simple precursors. For example, an anabolic reaction can begin with relatively simple precursor molecules (created previously by catabolic reactions) and end with fairly complex products such as sugar, certain lipids, or even DNA, which has an extremely complex physical structure. The increased complexity of the products of anabolic reactions also means they are more energy-rich than their simple precursors. Anabolic reactions constitute divergent processes. That is, relatively few types of raw materials are used to synthesize a wide variety of end products, resulting in an increase in cellular size, complexity, or both. Anabolic processes are responsible for cell differentiation and increases in body size. Bone mineralization and muscle mass are attributed to these processes. Anabolic processes produce peptides, proteins, polysaccharides, lipids and nucleic acids. These molecules comprise all the materials of living cells such as membranes and chromosomes, as well as specialized products of specific types of cells, such as enzymes, antibodies, hormones and neurotransmitters. When the gastrointestinal tract is full, anabolism exceeds catabolism; this is the absorptive state. Differentiate among the nutrients in the absorptive state Key Takeaways Key Points During the absorptive state, anabolic processes use glucose in a variety of ways. In the liver, glucose is converted to glycogen or fat, which store energy for future use. Fat is also stored in adipose tissue and glycogen in muscle tissue. Glucose is also carried in the bloodstream to cells where it will be used to provide energy for cellular processes. Also during the absorptive state, chylomicrons, the product of fat digestion, are reconstituted to fat and stored in adipose tissue or, in a low carb environment, are used as an energy source. The liver deaminates amino acids to keto acids which can be used in the krebs cycle to produce ATP, or can be converted to fat, or can be used by other body cells to create proteins. Key Terms absorptive state: The period during digestion when anabolism exceeds catabolism. Kreb's cycle: The Kreb's cycle is a series of chemical reactions used by all aerobic organisms to generate energy through the oxidization of acetate derived from carbohydrates, fats and proteins into carbon dioxide. glycogen: A polysaccharide that is the main form of carbohydrate storage in animals; converted to glucose as needed. The baby who has finished nursing has a full tummy and now will probably fall asleep. During this sleep period, anabolic processes are busy building up stores of fats and glycogen that will be needed in the future to provide energy for the growing baby. Absorptive state is the period in which the gastrointestinal tract is full and the anabolic processes exceed catabolism. The fuel used for this process is glucose. Carbohydrates Simple sugars are sent to the liver where they are converted to glucose. The glucose then travels to the blood or is converted to glycogen and fat (triglyceride) for energy storage. The glycogen and fat will be stored in the liver and adipose tissue, respectively, as reserves for the post-absorptive state. The remaining glucose is taken in for use by body cells or stored in skeletal muscle as glycogen. Triglycerides Chylomicrons are lipoprotein particles that consist of triglycerides (85-92%), phospholipids (6-12%), cholesterol (1-3%) and proteins (1–2%). This main product of fat digestion is first broken down to fatty acids and glycerol through hydrolysis using lipoprotein lipase. This allows them to pass freely through capillary walls. Most of this will be reconstituted as triglycerides and stored in adipose tissue. The rest will be used for energy in adipose cells, skeletal muscle and hepatocytes. In a low carb environment, other cells of the body will also begin to use triglycerides as energy sources. Amino acids The liver deaminates amino acids to keto acids to be used in the Kreb's cycle in order to generate energy in the form of ATP. They may also be converted to fat for energy storage. Some are used to make plasma proteins, but most leave through liver sinusoids to be used by body cells to construct proteins. Glucose Metabolism: Glucose metabolism and various forms of it in the process. The post-absorptive state occurs around three to five hours after a meal has been completely digested and absorbed. Describe the postabsorptive state Key Takeaways Key Points Once a meal has been completely absorbed (typically three to five hours after a meal), the metabolism changes to a fasting state, which is synonymous with " post-absorptive state," in contrast to the "post-prandial" state of ongoing digestion. Post-absorptive plasma glucose concentration has been discovered to be physiologically maintained within the range of 70 mg/dl [3.9 mmol/l] to 110 mg/dl [6.1 mmol/l] in humans. This is accomplished via increased glucose levels from glucagon and decreased glucose levels from insulin. Chronic insulin and glucagon deficiencies have been proven to cause hyperglycemia and, therefore, suggesting that insulin is the predominant factor of postabsorptive glucose levels. Key Terms post-absorptive state: The metabolic state achieved after complete digestion and absorption of a meal. Three to five hours after nursing, the baby wakes up ready to nurse again. In a physiological context, fasting may refer to: The metabolic status of a person who has not eaten overnight. The metabolic state achieved after complete digestion and absorption of a meal. Several metabolic adjustments occur during fasting, and some diagnostic tests are used to determine a fasting state. For example, a person is assumed to be fasting after 8–12 hours. Metabolic changes toward the fasting state begin after absorption of a meal (typically three to five hours after a meal); "post-absorptive state" is synonymous with this usage, in contrast to the "post-prandial" state of ongoing digestion. A diagnostic fast refers to prolonged fasting (from 8–72 hours depending on age) conducted under observation for investigation of a problem, usually hypoglycemia. Finally, extended fasting has been recommended as therapy for various conditions by health professionals of most cultures, throughout history, from ancient to modern. During fasting, post-absorptive state, fatty acid oxidation contributes proportionately more to energy expenditure than does carbohydrate oxidation. This phenomenon is due largely to greater lipid and lower carbohydrate availability, as plasma non-esterified fatty acid (NEFA) concentrations rise in response to lower insulin and higher counter-regulatory hormone concentrations. Post-absorptive plasma glucose concentration has been discovered to be physiologically maintained within the range of 70 mg/dl [3.9 mmol/l] to 110 mg/dl [6.1 mmol/l] in humans. This is accomplished via increased glucose levels from glucagon and decreased glucose levels from insulin. However, there has not yet been any convincing evidence of the involvement of glucagon in post-absorptive plasma glucose concentration maintenance. The flactuations of glucose and insulin in human during the course of a day: The fluctuation of blood sugar (red) and the sugar-lowering hormone insulin (blue) in humans during the course of a day with three meals. One of the effects of a sugar-rich vs a starch-rich meal is highlighted. Postabsorptive State: Resting after absorption of meal. Combined deficiency of insulin and glucagon results in an initial drop in plasma glucose levels, but is followed by an increase in plasma glucose levels. This indicates that there is support of post-absorptive plasma glucose concentrations from glucagon, when in concert with insulin. Changes in plasma glucose concentrations also result from changes in glucose production, but not from glucose utilization. Furthermore, during insulin and partial glucagon deficiency, and the exclusive partial deficiency of glucagon, the rate of glucose appearance increases to a point greater than the rate of glucose disappearance. This rate increase seems to be even larger than during insulin and glucagon deficiency, as well as when glucagon is made exclusively deficient. Both scenarios result in much higher plasma glucose concentrations. Increases in plasma glucose levels are ultimately followed by plateaus. These plateaus occur within a postabsorptive physiological range, and after octreotide-induced suppression of insulin and glucagon secretion. It has been determined that hormones and additional factors are involved in postabsorptive glucose level maintenance, after short periods of time. However, chronic insulin and glucagon deficiencies still remain victims of diabetes. Therefore, insulin has been proven to contribute to the maintenance of postabsorptive plasma glucose concentrations, while high levels of glucagon are not required to onset diabetes. These findings do not distinguish the individual roles of insulin and of glucagon. However, chronic insulin and glucagon deficiencies have been proven to cause hyperglycemia and, therefore, strongly suggest that insulin is the predominant factor of postabsorptive glucose levels.