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Chapter 1 : Glycogen - Wikipedia

Carbohydrates are a group of macromolecules that are a vital energy source for the cell and provide structural support to plant cells, fungi, and all of the arthropods that include lobsters, crabs, shrimp, insects, and spiders.

Please enable iFrames to view this content or visit Interactive Activity. Polysaccharides are excellent energy storage molecules because they are easily built and broken down by enzymes. Forming fairly compact structures, polysaccharides allow energy storage without the space required by a pool of free glucose monomers. Other polysaccharides form strong fibers that provide protection and structural support in both plants and animals. With small differences in the bond between monomers, polymers can function as compact energy storage units in starch and glycogen or as strong, protective fibers in cellulose and chitin. Understanding the structure, synthesis, and breakdown of carbohydrate polymers provides a framework for understanding their function in living cells. Animals, including humans, create glucose polymers called glycogen. The position of the glycosidic linkage between glucose monomers causes glycogen polymers to coil into spiral shapes. Glycogen polymers are significantly branched, with several monomers in the primary chain containing a second glycosidic linkage to a different glucose. The second attachment sites allow shorter glucose chains to branch away from the main chain, packing more glucose units into the compact coiled structure. Animals initiate enzyme-driven hydrolysis reactions to break down glycogen when energy is needed. For quick access to energy, glycogen is stored primarily in two locations in humans, the liver for easy delivery into the bloodstream and muscles for direct use as needed. Plants synthesize two types of polysaccharides, starch and cellulose. The glycosidic bonds between glucose units in plant starch are similar to those in animal glycogen. Accordingly, starch molecules are structurally similar, forming compact coils, and play a similar role in energy storage for plants. Unlike glycogen, starch molecules vary widely in the level of branching. Most plants form a mixture of starch polymers with little to no branching and polymers with extensive branching. In addition to providing energy for the plants that synthesize them, starches serve as the main food source for many animals. Humans and other animals produce enzymes that degrade starch molecules into small fragments during digestion. In humans, this digestion begins in the mouth by an enzyme called amylase, which degrades starch polymers into disaccharides maltose. To experience starch digestion yourself, try chewing an unsalted cracker for a long time. After a while, did the cracker begin to taste sweet? This is the formation of maltose disaccharides in your mouth as the starch is digested. Salt may disguise many other tastes, so this mini-experiment works best with unsalted crackers. Plants synthesize a structural polysaccharide called cellulose. Although cellulose is made with glucose, the glycosidic linkages between glucose monomers are different from the bonds in glycogen and starch. This unique bond structure causes cellulose chains to form linear flat strands instead of coils. The flat cellulose strands are able to form tightly packed bundles. Strong and rigid fibers result as hydrogen bonds form between polar hydroxyl groups in the bundled polymers. Cellulose fibers provide structural support to plants. Without cellulose, flower stems and tree trunks could not maintain their rigid, straight height. Enzymes such as amylase cannot break down cellulose polymers. Some animals, including cows and termites, digest cellulose by hosting special microorganisms in their digestive tracts that produce cellulose-degrading enzymes. However, humans and most animals do not make an enzyme capable of degrading cellulose, leaving cellulose fibers undigested as they pass through the body. Humans do exploit plant cellulose in non-dietary ways by processing trees, cotton, and other plants to make paper, clothing, and many other common materials. Humans also harvest large trees to build structures with the cellulose-rich lumber. Some animals synthesize a special polysaccharide, chitin, which forms a protective exoskeleton shell. The glycosidic linkages in chitin are very similar to cellulose bonds, causing chitin to also form linear, well-packed sheets of strong fibers. Unlike cellulose, chitin is synthesized from a modified monosaccharide called an amino sugar. The chitin monomer is derived from glucose by replacing one hydroxyl group with a nitrogen-containing functional group. Chitin provides protection and structural support for many living organisms, including forming the exoskeletons of shellfish and insects and the cell walls of fungi.

Chapter 2 : Carbohydrates (article) | Macromolecules | Khan Academy

Synthesis and Mobilization of Storage and Structural Carbohydrates. By Caroline Bowsher, Martin Steer, Synthesis and Mobilization of Storage and Structural.

Glycogenesis Glycogen synthesis is, unlike its breakdown, endergonic â€"it requires the input of energy. Energy for glycogen synthesis comes from uridine triphosphate UTP , which reacts with glucosephosphate , forming UDP-glucose , in a reaction catalysed by UTPâ€"glucosephosphate uridylyltransferase. Glycogen is synthesized from monomers of UDP-glucose initially by the protein glycogenin , which has two tyrosine anchors for the reducing end of glycogen, since glycogenin is a homodimer. The branching enzyme can act upon only a branch having at least 11 residues, and the enzyme may transfer to the same glucose chain or adjacent glucose chains. Glycogenolysis Glycogen is cleaved from the nonreducing ends of the chain by the enzyme glycogen phosphorylase to produce monomers of glucosephosphate: In vivo, phosphorolysis proceeds in the direction of glycogen breakdown because the ratio of phosphate and glucosephosphate is usually greater than The G6P monomers produced have three possible fates: G6P can continue on the glycolysis pathway and be used as fuel. G6P can enter the pentose phosphate pathway via the enzyme glucosephosphate dehydrogenase to produce NADPH and 5-carbon sugars. In the liver and kidney, G6P can be dephosphorylated back to glucose by the enzyme glucose 6-phosphatase. This is the final step in the gluconeogenesis pathway. Clinical relevance[edit] Disorders of glycogen metabolism[edit] The most common disease in which glycogen metabolism becomes abnormal is diabetes , in which, because of abnormal amounts of insulin, liver glycogen can be abnormally accumulated or depleted. Restoration of normal glucose metabolism usually normalizes glycogen metabolism, as well. In hypoglycemia caused by excessive insulin, liver glycogen levels are high, but the high insulin levels prevent the glycogenolysis necessary to maintain normal blood sugar levels. Glucagon is a common treatment for this type of hypoglycemia. Various inborn errors of metabolism are caused by deficiencies of enzymes necessary for glycogen synthesis or breakdown. These are collectively referred to as glycogen storage diseases. Glycogen depletion and endurance exercise[edit] See also: This phenomenon is referred to as " hitting the wall ". Glycogen depletion can be forestalled in three possible ways. First, during exercise, carbohydrates with the highest possible rate of conversion to blood glucose high glycemic index are ingested continuously. Second, through endurance training adaptations and specialized regimens e. Third, by consuming large quantities of carbohydrates after depleting glycogen stores as a result of exercise or diet, the body can increase storage capacity of intramuscular glycogen stores. In general, glycemic index of carbohydrate source does not matter since muscular insulin sensitivity is increased as a result of temporary glycogen depletion. As a reference, the very best professional cyclists in the world will usually finish a 4- to 5-hr stage race right at the limit of glycogen depletion using the first three strategies. When athletes ingest both carbohydrate and caffeine following exhaustive exercise, their glycogen stores tend to be replenished more rapidly; [28] [29] [30] however, the minimum dose of caffeine at which there is a clinically significant effect on glycogen repletion has not been established.

Chapter 3 : Glycogen - Definition, Structure, Function & Examples | Biology Dictionary

In higher plants, hexose phosphates are formed in photosynthesis and gluconeogenesis, and also from the breakdown of storage carbohydrates; they are consumed by glycolysis and the oxidative pentose phosphate pathway, and also in the synthesis of oligo- and polysaccharides.

Mobilization of fatty acids In times of stress when the body requires energy, fatty acids are released from adipose cells and mobilized for use. The process begins when levels of glucagon and adrenaline in the blood increase and these hormones bind to specific receptors on the surface of adipose cells. This binding action starts a cascade of reactions in the cell that results in the activation of yet another lipase that hydrolyzes triglyceride in the fat droplet to produce free fatty acids. These fatty acids are released into the circulatory system and delivered to skeletal and heart muscle as well as to the liver. In the blood the fatty acids are bound to a protein called serum albumin; in muscle tissue they are taken up by the cells and oxidized to carbon dioxide CO2 and water to produce energy, as described below. It is not clear whether a special transport mechanism is required for enabling free fatty acids to enter cells from the circulation. When hormones signal the need for energy, fatty acids and glycerol are released from triglycerides stored in fat cells adipocytes and are delivered to organs and tissues in the body. The liver takes up a large fraction of the fatty acids. There they are in part resynthesized into triglycerides and are transported in VLDL lipoproteins to muscle and other tissues. A fraction is also converted to small ketone molecules that are exported via the circulation to peripheral tissues, where they are metabolized to yield energy. Oxidation of fatty acids Inside the muscle cell, free fatty acids are converted to a thioester of a molecule called coenzyme A , or CoA. A thioester is a compound in which the linking oxygen in an ester is replaced by a sulfur atom. Oxidation of the fatty acidâ€"CoA thioesters actually takes place in discrete vesicular bodies called mitochondria. Most cells contain many mitochondria, each roughly the size of a bacterium, ranging from 0. The mitochondrion is surrounded by a double membrane system enclosing a fluid interior space called the matrix. In the matrix are found the enzymes that convert the fatty acidâ€"CoA thioesters into CO2 and water the chemical waste products of oxidation and also adenosine triphosphate ATP , the energy currency of living systems. The process consists of four sequential steps. The first step is the transport of the fatty acid across the innermost of the two concentric mitochondrial membranes. The outer membrane is very porous so that the CoA thioesters freely permeate through it. The impermeable inner membrane is a different matter; here the fatty acid chains are transported across in the following way. On the cytoplasmic side of the membrane, an enzyme catalyzes the transfer of the fatty acid from CoA to a molecule of carnitine , a hydroxy amino acid. The carnitine ester is transported across the membrane by a transferase protein located in the membrane, and on the matrix side a second enzyme catalyzes the transfer of the fatty acid from carnitine back to CoA. The carnitine that is re-formed by loss of the attached fatty acid is transferred back to the cytoplasmic side of the mitochondrial membrane to be reused. The transfer of a fatty acid from the cytoplasm to the mitochondrial matrix thus occurs without the transfer of CoA itself from one compartment to the other. No energy is generated or consumed in this transport process, although energy is required for the initial formation of the fatty acidâ€"CoA thioester in the cytoplasm. The second step is the oxidation of the fatty acid to a set of two-carbon acetate fragments with thioester linkages to CoA. Since most biological fatty acids have an even number of carbons, the number of acetyl-CoA fragments derived from a specific fatty acid is equal to one-half the number of carbons in the acyl chain. For example, palmitic acid C16 yields eight acetyl-CoA thioesters. In the case of rare unbranched fatty acids with an odd number of carbons, one three-carbon CoA ester is formed as well as the two-carbon acetyl-CoA thioesters. Thus, a C 17 acid yields seven acetyl and one three-carbon CoA thioester. The energy in the successive oxidation steps is conserved by chemical reduction the opposite of oxidation of molecules that can subsequently be used to form ATP. ATP is the common fuel used in all the machinery of the cell e. This process is carried out in a series of nine enzymatically catalyzed reactions in the mitochondrial matrix space. The reactions form a closed cycle, often called the citric acid , tricarboxylic acid , or Krebs cycle after its discoverer, Nobelist Sir Hans Krebs. All the participating enzymes are located inside the mitochondrial inner membraneâ€"except one, which is trapped in the space between the inner and outer membranes. The electrons then pass down the series of oxidation-reduction reactions and in the last reaction reduce molecular oxygen O2 to water H2O. This part of oxidative phosphorylation is called electron transport. Essentially an electrical battery is created, with the cytoplasm acting as the positive pole and the mitochondrial matrix as the negative pole. Peter Mitchell received the Nobel Prize for Chemistry in for his discovery of the conversion of electron transport energy into a transmembrane battery and the use of this battery to generate ATP. It is interesting that a similar process forms the basis of photosynthesisâ€"the mechanism by which green plants convert light energy from the Sun into carbohydrates and fats, the basic foods of both plants and animals. Many of the molecular details of the oxidative phosphorylation system are now known, but there is still much to learn about it and the equally complex process of photosynthesis. In these cases fatty acids are oxidized to CO2 and water, but the energy is released as heat. The biochemical details and physiological functions of these organelles are not well understood. The concentrations of free fatty acids in the blood are hormone-regulated, with glucagon stimulating and insulin inhibiting fatty acid release from adipose tissue. The utilization in muscle of acetyl-CoA depends upon the activity of the citric acid cycle and oxidative phosphorylationâ€"whose rates in turn reflect the demand for ATP. In the liver the metabolism of free fatty acids reflects the metabolic state of the animal. In well-fed animals the liver converts excess carbohydrates to fatty acids, whereas in fasting animals fatty acid oxidation is the predominant activity, along with the formation of ketones. Although the details are not completely understood, it is clear that in the liver the metabolism of fatty acids is tightly linked to fatty acid synthesis so that a wasteful closed cycle of fatty acid synthesis from and metabolism back to acetyl-CoA is prevented. Lipids in biological membranes Biological membranes separate the cell from its environment and compartmentalize the cell interior. The various membranes playing these vital roles are composed of roughly equal weight percent protein and lipid, with carbohydrates constituting less than 10 percent in a few membranes. Although many hundreds of molecular species are present in any one membrane, the general organization of the generic components is known. All the lipids are amphipathic, with their hydrophilic polar and hydrophobic nonpolar portions located at separate parts of each molecule. As a result, the lipid components of membranes are arranged in what may be called a continuous bimolecular leaflet, or bilayer. The polar portions of the constituent molecules lie in the two bilayer faces, while the nonpolar portions constitute the interior of the bilayer. The lipid bilayer structure forms an impermeable barrier for essential water-soluble substances in the cell and provides the basis for the compartmentalizing function of biological membranes. Extrinsic proteins are loosely bound to the hydrophilic polar surfaces, which face the watery medium both inside and outside the cell. Some protein components are inserted into the bilayer, and most span this structure. These so-called integral , or intrinsic , membrane proteins have amino acids with nonpolar side chains at the interface between the protein and the nonpolar central region of the lipid bilayer. A second class of proteins is associated with the polar surfaces of the bilayer and with the intrinsic membrane proteins. The protein components are specific for each type of membrane and determine their predominant physiological functions. The lipid component, apart from its critical barrier function, is for the most part physiologically silent, although derivatives of certain membrane lipids can serve as intracellular messengers. The most remarkable feature of the general biomembrane structure is that the lipid and the protein components are not covalently bonded to one another or to molecules of the other group. This sheetlike structure, formed only by molecular associations, is less than 10 nm in thickness but many orders of magnitude larger in its other two dimensions. Membranes are surprisingly strong mechanically, yet they exhibit fluidlike properties. Although the surfaces of membranes contain polar units, they act as an electric insulator and can withstand several hundred thousand volts without breakdown. Experimental and theoretical studies have established that the structure and these unusual properties are conferred on biological membranes by the lipid bilayer. Composition of the lipid bilayer Most biological membranes contain a variety of lipids, including the various glycerophospholipids such as phosphatidyl-choline, -ethanolamine, -serine, -inositol , and -glycerol as well as sphingomyelin and, in some membranes, glycosphingolipids. These compounds are described in the section Fatty acid derivatives. Cholesterol, ergosterol , and sitosterol described in the section Cholesterol and its derivatives are sterols found in many membranes. The relative amounts of these lipids differ even in the same type of cell in different organisms, as shown in the table on the lipid composition of red blood cell membranes from different mammalian species. Even in a single cell, the lipid compositions of the membrane surrounding the cell the plasma membrane and the membranes of the various organelles within the cell such as the microsomes, mitochondria, and nucleus are different, as shown in the table on various membranes in a rat liver cell. Organelle membrane lipid composition by weight percent of rat liver cells Source:

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Chapter 4 : Seed Cell Wall Storage Polysaccharides: Models to Understand Cell Wall Biosynthesis and De

Tonini PP, Purgato E, Buckeridge MS. (b) Effects of abscisic acid, ethylene and sugars on the mobilization of storage proteins and carbohydrates in seeds of the tropical tree Sesbania virgata (Leguminosae).

They can be divided into three categories. They are carbohydrates, proteins and lipids. A carbohydrate consists of carbon C , hydrogen H , and oxygen O atoms, usually with a hydrogenâ€"oxygen atom ratio of 2: Carbohydrates are further divided into three groups including monosaccharides, disaccharides, and polysaccharides. Both monosaccharides and disaccharides are water soluble whereas polysaccharides are not soluble in water. In contrast, lipids are a diverse group of naturally occurring molecules that include fats, waxes, sterols, fat-soluble vitamins such as vitamins A, D, E, and K , monoglycerides, diglycerides, triglycerides, phospholipids, and others. All these compounds are not soluble in water. This is the main difference between carbohydrates and lipids. Both carbohydrates and lipids act as the main fuels and energy storage compounds of the human body. The biochemical metabolism of carbohydrates and lipids are closely interconnected, but these macronutrients have different purposes. What are Carbohydrates A carbohydrate is a macronutrient consisting of carbon C , hydrogen H and oxygen O atoms. Similar to a water molecule, it has a hydrogenâ€"oxygen atom ratio of 2: Carbohydrates are also known as hydrates of carbon, and it mainly exists as polyhydroxy aldehydes and ketones. The glycemic index GI and glycemic load concepts have been developed to characterize carbohydrate-rich food behavior during human digestion to identify the speed and extent of their effect on blood glucose levels. What are Lipids Lipids are macronutrient mainly consisting of carbon C , hydrogen H and oxygen O atoms. It is a hydrophobic or small amphiphilic molecule that is not soluble in water. Biological lipids are from two distinct types of biochemical subunits known as ketoacyl and isoprene groups. Difference Between Carbohydrates and Lipids The differences between carbohydrates and lipids can be divided into following categories. They are; Categories and Examples Monosaccharides â€" glucose, fructose , galactose, xylose Disaccharides â€" sucrose, lactose, maltose, trehalose Polyols â€" sorbitol, mannitol Oligosaccharides â€" maltodextrins, raffinose, stachyose, fructo-oligosaccharides Polysaccharides â€" amylose, cellulose , amylopectin, modified starches, hemicellulose, pectins, hydrocolloids Lipid: Lipids are categorized into following subgroups; Fatty acids â€" arachidonic acid, eicosapentaenoic acid, docosahexaenoic acid Glycerolipids Glycerophospholipids â€" phosphatidylcholine, phosphatidylethanolamine, and phosphatidylserine Sphingolipids â€" sphingomyelins, cerebrosides, and gangliosides. Sterol lipids â€" testosterone and androsterone Prenol lipids â€" quinones and hydroquinones Saccharolipids Polyketides â€" erythromycins, tetracyclines, avermectins Caloric Content Carbohydrates: Lipids provide more than twice the number of calories compared to carbohydrates. Majority of carbohydrates groups except polysaccharides are soluble in water, and they are hydrophilic in nature Lipid: Lipids are not soluble in water because they are hydrophobic in nature Digestion and Absorption Carbohydrates: Digestive enzymes from saliva, pancreas and small intestine act directly on sugars and starches in the foods and break down carbohydrates into simple sugars known as monosaccharides, which are absorbed into the bloodstream for distribution to organs and tissues. Cells absorb the simple sugar with the assistance of the hormone insulin. Lipid has a complex digestive process. The gallbladder releases the bile acid into small intestine after food ingestion and bile contributes to breaking down large lipid globules into microscopic droplets, which are consequently digested by enzymes from the pancreas. Then the lining cells of small intestine absorb the digested fat particles and transported by carrier proteins. Major Digestive Enzyme Carbohydrates: The major digestive enzyme is Lipase. Primary Functions in the Living Organisms Carbohydrates: Primary functions of dietary carbohydrates are as follows; Providing energy for body organs and tissues Creating structural components in animals and plants e. Primary functions of dietary lipids are as follows; Storing energy in the cells Facilitating the absorption and distribution of fat-soluble vitamins Providing structural stability for cells and cushioning vital organs like kidney, liver, Cell signaling mechanisms Primary functions in industry

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Carbohydrates: Primary functions of carbohydrates are as follows; The complex carbohydrate starch used as the main ingredient in bakery products, noodles, and pasta production Starch is used as a thickening agent in sauces Simple carbohydrates, such as sugar used in beverages, candy, jams, and desserts production Lipid: Primary functions of lipids are as follows; Used for cosmetic production Used as a lubricant in many industrial applications Used for emulsion production Cooking oil and spreads production Natural Food Sources Wheat, maize, rice, barley contains starch polysaccharides Fruits contain fructose and dietary fiber Milk contains lactose Nuts such as peanuts, cashew nuts, almonds, walnut Fruits such as avocado Seeds such as sunflower, flax, rapeseed seeds legumes soy Health Effects Carbohydrates: Excess consumption of refined sugars is associated with increased risk of metabolic syndrome, type II diabetes, cancers, cardiovascular diseases and obesity Consumption of dietary fiber such as cellulose, hemicellulose, pectins, hydrocolloids can reduce the risk of colon cancers, constipation, type II diabetes, and obesity Lipids: High amount of saturated fats consumption may increase LDL cholesterol and risk of heart disease, and increase risk of type II diabetes and obesity Unsaturated fats are associated with various health benefits including the reduction of the risk of cancer development, prevention of cardiovascular disease, platelet aggregation, and hypertension. They have anti-inflammatory properties and lower markers of inflammation in the blood. However, some unsaturated fats have both pro-inflammatory and anti-inflammatory properties. In conclusion, carbohydrates and lipids are primarily essential macronutrients, and they offer important nutrients to the daily diet. Carbohydrates are considered as a ready source of fuel to cells, whereas lipids can store energy in fat tissue for future use. However, excess consumption of these macronutrients may associate with detrimental health effects. References Carbohydrates in human nutrition â€” Chapter 1 â€" The role of carbohydrates in nutrition. Food and Agriculture Organization of the United Nations. Advanced Nutrition and Human Metabolism. Human Biology and Health. Biochemistry of Lipids, Lipoproteins and Membranes. Sharing what she learned is a passion of hers and enjoys writing.

Chapter 5 : Lipid - Mobilization of fatty acids | calendrierdelascience.com

*Effects of abscisic acid, ethylene and sugars on the mobilization of storage proteins and carbohydrates in seeds of the tropical tree Sesbania virgata (Leguminosae) Patricia Pinho Tonini, 1 Eduardo Purgatto, 2 and Marcos Silveira Buckeridge 1, *.*

Abstract Background and Aims Endospermic legumes are abundant in tropical forests and their establishment is closely related to the mobilization of cell-wall storage polysaccharides. Endosperm cells also store large numbers of protein bodies that play an important role as a nitrogen reserve in this seed. In this work, a systems approach was adopted to evaluate some of the changes in carbohydrates and hormones during the development of seedlings of the rain forest tree Sesbania virgata during the period of establishment. Furthermore, the detection of endogenous ABA and ethylene production during the period of storage mobilization and the changes observed in the production of these endogenous hormones in the presence of glucose and sucrose, suggested a correlation between the signalling pathway of these hormones and the sugars. Conclusions These findings suggest that ABA, ethylene and sugars play a role in the control of the hydrolytic enzyme activities in seeds of S. This is thought to ensure a balanced flow of the carbon and nitrogen for seedling development. These polymers, which can be proteins and carbohydrates, are mobilized during development and their products are used for several purposes such as energy generation and production of raw material for building cells and tissues Buckeridge et al. The physiological performance of the seed is essential for successful plant establishment. This phase of plant growth is thought to be the weakest in the life cycle of plants Stebbins, The seeds of many legumes are known to accumulate a large number of protein bodies in the cytoplasm of endosperm cells, which play a major role as a nitrogen reserve in the seed. Besides protein bodies, seeds of legumes and also from species of many other plant families can accumulate cell-wall storage polysaccharides galactomannan, xyloglucan and arabinogalactan Buckeridge and Dietrich, ; Buckeridge et al. A number of species, including guar Cyamopsis tetragonoloba , locust bean or carob Ceratonia siliqua , fenugreek Trigonella foenum-graecum and the tropical fast-growing tree Sesbania virgata, have been used as a model to understand physiological and biochemical aspects of galactomannan mobilization as a cell-wall storage polysaccharide. In contrast to carob, seeds of S. Sesbania virgata is a legume tree that occurs mainly in moist and flooded regions in the gallery forests of the Neotropical regions and is thought to be associated with early stages of ecological succession Potomati and Buckeridge, View large Download slide Transverse sections of seeds of S. A a resistant testa t and a massive endosperm e surrounding the embryo em and B an aleurone layer asterisk between the testa [divided into exotesta ex , mesotesta me , endotesta en] and the endosperm e with protein bodies arrow and thick walls. Pictures reproduced from Tonini et al. Three hydrolytic enzymes are involved in galactomannan degradation: Abscisic acid ABA is a potent inhibitor of storage protein mobilization Garciarrubio et al. High concentrations of ABA have been detected in seeds of S. These authors found that most of the ABA in quiescent seeds is present in the testa and during germination it decreases with a concomitant increase in the endosperm and embryo. Furthermore, exogenous ABA has been shown to inhibit storage mobilization in seeds of S. The presence of ABA in the testa of some species, has suggested that the powerful inhibitory effect of this tissue may play a role in the dormancy and germination of seeds Van Staden et al. Ethylene, in an antagonistic way, stimulates seed germination of many species, such as Arabidopsis thaliana Beaudoin et al. In seeds of A. However, sugars may also directly inhibit ethylene signalling Rolland et al. Such a complex control system probably avoids the accumulation of an excess of reducing sugars in seed and seedling tissues, avoiding sugar leakage and ensuring an efficient flow of the carbon and nitrogen to the developing seedling. In the present work, a systems approach was adopted to produce evidence in favour of the hypothesis that ABA, ethylene and sugars all have a role in a network system that modulates storage mobilization of galactomannan and proteins in seeds of S. Imbibition of the seeds was complete in all solutions after 24 h. The percentage of germination and measurements of fresh weight of seeds, testa and endosperm in each experiment were recorded daily to evaluate seedling growth. Measurements of endogenous ABA Seeds incubated in water and glucose and sucrose solutions were harvested from the first to the fifth day after imbibition began 20 seeds per plate and dissected to separate the testa and endosperm. The peak area detected of endogenous ABA and internal standard ions and the initial concentration of the internal standard were used to calculate the ABA concentrations in the samples, as described by Chen et al. Measurements of endogenous ethylene Seeds which imbibed water, glucose and sucrose in sealed flasks were used from the first to the fifth day after the beginning of imbibition ten seeds per plate to measure endogenous ethylene. Ethylene identification and quantification were based on the peak area of a C2H4 standard. Measurements of endogenous glucose and sucrose Seeds incubated in water, glucose and sucrose were harvested from the first to the fifth day after imbibition began ten seeds per plate and dissected to separate testa and endosperm. Glucose and sucrose identification and quantification were based on the peak area of these sugars standards. There were small differences in germination speed, but this was not investigated further in this work since the focus was on seedling development. Thus, these experiments were performed to assure that no strong effect on germination would have influenced germination speed to the point that storage mobilization would be influenced by the germination process. During germination and seedling establishment, an increase in the seed fresh mass was observed from the second to the fifth day, i. The seeds which imbibed ABA presented a proportionally lower increase in fresh mass on the second day after imbibition when compared with the seeds which imbibed water. Furthermore, the marked increase observed at the fifth day after imbibition did not occur in ABA Fig.