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Chapter 1 : ectomycorrhizal - Wiktionary

The text is divided into three sections, the first focusing on primary nitrogen and carbon assimilation and carbon partitioning; the second looking at compartmentation, transport and whole plant interactions; and the third to related metabolism to provide a comprehensive and up-to-date account of this subject.

The authors have declared that no competing interests exist. Conceived and designed the experiments: Gave some advice and revised the manuscript: Received Jan 10; Accepted Jun This article has been cited by other articles in PMC. Abstract Molecular hydrogen H2 metabolism in bacteria and algae has been well studied from an industrial perspective because H2 is viewed as a potential future energy source. A number of clinical trials have recently reported that H2 is a therapeutic antioxidant and signaling molecule. Although H2 metabolism in higher plants was reported in some early studies, its biological effects remain unclear. In this report, the biological effects of H2 and its involvement in plant hormone signaling pathways and stress responses were determined. Antioxidant enzyme activity was found to be increased and the transcription of corresponding genes altered when the effects of H2 on the germination of mung bean seeds treated with phytohormones was investigated. In addition, upregulation of several phytohormone receptor genes and genes that encode a few key factors involved in plant signaling pathways was detected in rice seedlings treated with HW. The transcription of putative rice hydrogenase genes, hydrogenase activity, and endogenous H2 production were also determined. H2 production was found to be induced by abscisic acid, ethylene, and jasmonate acid, salt, and drought stress and was consistent with hydrogenase activity and the expression of putative hydrogenase genes in rice seedlings. Together, these results suggest that H2 may have an effect on rice stress tolerance by modulating the output of hormone signaling pathways. Hydrogen gas H2 is colorless, odorless, and tasteless, and it has been known as a reducing agent since when it was first produced by Robert Boyle [1]. However, H2 is rare on earth, constituting less than 1 part per million of the atmosphere, and the majority of hydrogen atoms are found in water and organic compounds [2] ; nonetheless, it is believed to have been highly concentrated in the atmosphere of the early Earth [3]. H2 is considered to be a physiologically inert gas, and it is generally regarded as a potential future energy source and an alternative to limited fossil fuel resources [4]. H2 has recently received worldwide attention due to its potential exploitation as a therapeutic medical gas. In , Dole et al. After 25 years, another study reported that hyperbaric H2 could alleviate schistosomiasis-associated chronic liver inflammation [6]. In , Ohsawa et al. They suggested that this antioxidant activity could have preventive and therapeutic applications [7]. These reports greatly changed the stereotype of H2 and attracted worldwide attention. More than papers describing therapeutic uses of H2 have been published since then. The accumulated evidence from a variety of biomedical fields and clinical and experimental models of many diseases indicate that H2 administered by gas inhalation or by oral ingestion of H2-saturated water acts as a therapeutic agent [8]. These studies have targeted a diverse range of disorders and organ systems including the nervous, digestive, cardiovascular, and respiratory systems [8]. The effects of H2 on various diseases have been documented for 63 disease models and human diseases in recent years [9]. It has long been known that microbes ranging from ancient bacteria to eukaryotic microalgae are capable of producing hydrogen through photosynthetic and nonphotosynthetic processes [14] , [15] , [16]. H2 metabolism in bacteria and algae has been well studied [17] , [18]. However, only a few studies have reported H2 metabolism in higher plants. In , Boichenko studied H2 evolution in isolated chloroplasts and postulated the existence of hydrogenase in some higher plants [19]. Although it is well known that cyanobacteria and eukaryotic microalgae can photobiologically produce H2 using either hydrogenase or nitrogenase [20] , [21] , whether hydrogenase is present in higher plants or not remains unclear. Based on the fact that hydrogenase is found in many different microorganisms and algae as well as on the presumption of its important role in the reducing environment of the atmosphere of the primitive Earth, Renwick et al. However, no reports have been published to support the above deduction in plants. Here, we present data to support the physiological functions of H_2 in plants, its interactions with the metabolism and signaling of plant hormones, its production in rice seedlings, and its involvement in response to abiotic stress. Lengths of shoots and roots were then measured respectively. To our surprise, we found a remarkable difference between HW-treated and control plants Figure 1a, b. The growth of mung bean shoots and roots was accelerated by a relatively low concentration of HW and was suppressed by a relatively high concentration of HW Figure 1a. The growth of rice seedlings was inhibited by HW Figure 1b. These results suggested that H_2 may have biological effects on plants.

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Chapter 2 : A molecular approach to primary metabolism in higher plants

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MIFLIN Rothamsted Experimental Station, Harpenden, Herts The synthesis of amino acids depends upon the supply of reduced nitrogen and the provision of carbon skeletons, usually in the form of r-keto acids. The nitrogen supplied to leaves is either as nitrate or as amino acids. The nitrogen from the latter can be incorporated into other amino acids via transamination; this reduction and the subsequent incorporation of ammonia into a-amino nitrogen is strongly light-dependent [l]. Although isolated intact chloroplasts cannot fix 14C02 into amino acids in any significant amount [Z], they can reduce and incorporate nitrite The enzymes required for this process and also ace- tolactate synthase, which is required for the synthesis of the car- bon skeletons of leucine, isoleucine and valine, have been shown by density gradient separation techniques to be present in chloroplasts [4]. Although chloroplasts contain low levels of glutamate dehydrogenase [S], the level of glutamine synthase is much higher. The K,s of the extracted enzymes also favour ammonia assimilation into glutamine rather than glutamate. It has recently been shown that the amido group of glutamine can be transferred to the amino group of glutamate by a ferredoxin- dependent glutamate synthase [6]. It is considered that this pathway, which does not involve glutamate dehydrogenase, is the major route of nitrogen assimilation in leaves. Asparagine Metabolism in Higher Plants P. A review of the literature has shown that asparagine is formed when there is excess ammonia in the plant, either as a result of protein degradation followed by oxidation of amino acids, or by exter- nal application [l]. Ammonia is converted to asparagine as a detoxification process; the ratio of 2N atoms to 4C atoms makes the molecule very economic for the storage of super- fluous nitrogen. Fumar- ate, malate and, in particular, succinate have been shown to be the main precursors of asparagine when applied externally [2,3]. Although numerous attempts have been made to detect the presence of an enzyme capable of converting aspartate to asparagine, only Streeter [3] and Rognes [4] were able to demonstrate a very unstable enzyme in crude preparations uti- lizing the amide group of glutamine. A glutamine-dependent asparagine synthetase has recently been purified and character- ized from 6-day-old lupin seedlings, the enzyme has a very low K, for glutamine compared to ammonia [S]. As glutamine is now thought to be the main entry point of ammonia into amino acids [6], the direct transfer of the amide group to aspartate would liberate glutamate for the acceptance of a further ammonia molecule. Evidence from radioactive tracer studies have shown that asparagine is not metabolized in seedlings [7], although early work has shown that asparagine is metabolized in leaves in the light, and disappears in legumes during fruit formation [l]. Enzymes capable of transaminating asparagine to form r-keto- succinamic acid have been known for some years [S] but their role in asparagine breakdown is not understood: Although asparagine is metabolized by isolated chlor- oplasts in the light, it is not a substrate for the transfer of the amide group to r-oxoglutarate in the presence of reduced ferre- doxin [6]. However, attempts in this labora- tory to demonstrate a reduced coenzyme dependent transfer of the amide group to acceptor Z-0x0 acids in various plant extracts have so far been unsuccessful. The enzyme alliin lyase E. The enzyme from each source is specific for the sulphoxide struc- ture, having no activity on the thioether analogue. Pyridoxal phosphate appears to be a necessary cofactor. The enzymes differ as to their pH optima. The garlic and onion enzymes have similar Michaelis constants for the same substrates, but differ from the Brassica enzyme. Brassica species also can cleave L- cystine to cysteine persulfide, pyruvate, and ammonia [4]. At least two isoenzymes have been found which have cystine lyase and alliin lyase activity [S]. An enzyme in the hypocotyls of Recommended.

Chapter 3 : Sourceâ€“Sink Relationships

Book: A molecular approach to primary metabolism in higher plants. calendrierdelascience.com + pp. Abstract: This book discusses and explains advances in understanding of carbon and nitrogen interaction in plant metabolism given by application of molecular genetic techniques.

Atropine[edit] Atropine is a type of secondary metabolite called a tropane alkaloid. Alkaloids contain nitrogens, frequently in a ring structure, and are derived from amino acids. Tropane is an organic compound containing nitrogen and it is from tropane that atropine is derived. Atropine is synthesized by a reaction between tropine and tropate, catalyzed by atropinase. Within Atropa belladonna atropine synthesis has been found to take place primarily in the root of the plant. Typically, secondary metabolites are not necessary for normal functioning of cells within the organism meaning the synthetic sites are not required throughout the organism. As atropine is not a primary metabolite , it does not interact specifically with any part of the organism, allowing it to travel throughout the plant. Flavonoids[edit] Flavonoids are one class of secondary plant metabolites that are also known as Vitamin P or citrin. These metabolites are mostly used in plants to produce yellow and other pigments which play a big role in coloring the plants. In addition, Flavonoids are readily ingested by humans and they seem to display important anti-inflammatory, anti-allergic and anti-cancer activities. Flavonoids are also found to be powerful anti-oxidants and researchers are looking into their ability to prevent cancer and cardiovascular diseases. Flavonoids help prevent cancer by inducing certain mechanisms that may help to kill cancer cells, and researches believe that when the body processes extra flavonoid compounds, it triggers specific enzymes that fight carcinogens. Good dietary sources of Flavonoids are all citrus fruits, which contain the specific flavanoids hesperidins, quercitrin ,and rutin , berries, tea, dark chocolate and red wine and many of the health benefits attributed to these foods come from the Flavonoids they contain. Flavonoids are synthesized by the phenylpropanoid metabolic pathway where the amino acid phenylalanine is used to produce 4-coumaryol-CoA, and this is then combined with malonyl-CoA to produce chalcones which are backbones of Flavonoids [6] Chalcones are aromatic ketones with two phenyl rings that are important in many biological compounds. The closure of chalcones causes the formation of the flavonoid structure. Flavonoids are also closely related to flavones which are actually a sub class of flavonoids, and are the yellow pigments in plants. In addition to flavones, 11 other subclasses of Flavonoids including, isoflavones, flavans, flavanones, flavanols, flavanolols, anthocyanidins, catechins including proanthocyanidins , leukoanthocyanidins, dihydrochalcones, and aurones. Cyanogenic glycoside[edit] Many plants have adapted to iodine-deficient terrestrial environment by removing iodine from their metabolism, in fact iodine is essential only for animal cells. Many plant pesticides are cyanogenic glycoside which liberate cyanide , which, blocking cytochrome c oxidase and NIS, is poisonous only for a large part of parasites and herbivores and not for the plant cells in which it seems useful in seed dormancy phase. The compounds of these secondary metabolites As seen in Figure 1 are found in over plant species. Its structure allows the release of cyanide , a poison produced by certain bacteria, fungi, and algae that is found in numerous plants. Animals and humans possess the ability to detoxify cyanide from their systems naturally. Therefore, cyanogenic glycosides can be used for positive benefits in animal systems always. For example, the larvae of the southern armyworm consumes plants that contain this certain metabolite and have shown a better growth rate with this metabolite in their diet, as opposed to other secondary metabolite-containing plants. Although this example shows cyanogenic glycosides being beneficial to the larvae many still argue that this metabolite can do harm. To help in determining whether cyanogenic glycosides are harmful or helpful researchers look closer at its biosynthetic pathway Figure 2. Past research suggests that cyanogenic glucosides stored in the seed of the plant are metabolized during germination to release nitrogen for seedling to grow. With this, it can be inferred that cyanogenic glycosides play various roles in plant metabolism. Though subject to change with future research, there is no evidence showing that cyanogenic glycosides are responsible for infections in plants. Phytic acid[

edit] Phytic acid is the main method of phosphorus storage in plant seeds, but is not readily absorbed by many animals only absorbed by ruminant animals. Not only is phytic acid a phosphorus storage unit, but it also is a source of energy and cations , a natural antioxidant for plants, and can be a source of myoinositol which is one of the preliminary pieces for cell walls. Phytic acid is also known to bond with many different minerals, and by doing so prevents those minerals from being absorbed; making phytic acid an anti-nutrient. In preparing foods with high phytic acid concentrations, it is recommended they be soaked in after being ground to increase the surface area. Cooking can also reduce the amount of phytic acid in food but soaking is much more effective. Phytic acid is an antioxidant found in plant cells that most likely serves the purpose of preservation. This preservation is removed when soaked, reducing the phytic acid and allowing the germination and growth of the seed. When added to foods it can help prevent discoloration by inhibiting lipid peroxidation. It can exist in three forms: All of these forms have very similar biological properties. Gossypol is a type of aldehyde, meaning that it has a formyl group. The formation of gossypol occurs through an isoprenoid pathway. Isoprenoid pathways are common among secondary metabolites. Extensive studies have shown that gossypol has other functions. Many of the more popular studies on gossypol discuss how it can act as a male contraceptive. Gossypol has also been linked to causing hypokalemic paralysis. Hypokalemic paralysis is a disease characterized by muscle weakness or paralysis with a matching fall in potassium levels in the blood. Hypokalemic paralysis associated with gossypol in-take usually occurs in March, when vegetables are in short supply, and in September, when people are sweating a lot. This side effect of gossypol in-take is very rare however. Gossypol induced hypokalemic paralysis is easily treatable with potassium repletion. One such group of metabolites is phytoestrogens , found in nuts, oilseeds, soy, and other foods. This has a negative result, because there are various abilities of the phytoestrogen which estrogen does not do. Its effects the communication pathways between cells and has effects on other parts of the body where estrogen normally does not play a role. But, one role of estrogens which phytoestrogens mimic is its protective behavior for the heart. So, an intake of phytoestrogens has also been seen to reduce the risk of cardiovascular disease. Resveratrol , a phytoestrogen found in grapes is responsible for this. For example, the French suffer relatively little heart disease despite the average French diet being relatively high in fat. One proposed reason for this is the resveratrol found in red wine, which has been linked to decreased risk of cardiovascular disease. They are also found in some organisms such as algae, fungi, some bacteria, and certain species of aphids. There are over known carotenoids. They are split into two classes, xanthophylls and carotenes. Xanthophylls are carotenoids with molecules containing oxygen, such as lutein and zeaxanthin. Carotenoids have two important functions in plants. First, they can contribute to photosynthesis. They do this by transferring some of the light energy they absorb to chlorophylls , which then uses this energy for photosynthesis. Second, they can protect plants which are over-exposed to sunlight. They do this by harmlessly dissipating excess light energy which they absorb as heat. In the absence of carotenoids, this excess light energy could destroy proteins, membranes, and other molecules. Some plant physiologists believe that carotenoids may have an additional function as regulators of certain developmental responses in plants. Carotenoids involved in photosynthesis are formed in chloroplasts; Others are formed in plastids. Carotenoids formed in fungi are presumably formed from mevalonic acid precursors. Phenols, Polyphenols and Tannins: Occurrence, Structure and Role in the Human Diet. Annual Plant Reviews Volume Blackwell Publishing Professional, A Challenge to the Evolution of Terrestrial Life? Journal of Physiology and Biochemistry. Smith 25 September The Journal of Biological Chemistry. Annual Review of Pharmacology and Toxicology. Leegood, Per Lea Plant Biochemistry and Molecular Biology.

Chapter 4 : Asparagine metabolism in higher plants - [PDF Document]

A molecular approach to primary metabolism in higher plants / edited by Christine H. Foyer and W. Paul Quick. QK M58 Plant metabolomics / edited by K. Saito, R.A. Dixon, and L. Willmitzer.

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Chapter 5 : A molecular approach to primary metabolism in higher plants.

A molecular approach to primary metabolism in higher plants [] Foyer, C.H. Quick, W.P. (eds.) (Correspondence address: Institute of Grassland and Environmental Research, Aberystwyth (United Kingdom)).

Chapter 6 : A Molecular Approach To Primary Metabolism In Higher Plants - CRC Press Book

A Molecular Approach To Primary Metabolism In Higher Plants - CRC Press Book Discusses and explains the major advances that the new technology of applying molecular genetic techniques of modifying carbon and nitrogen in plants has provided, giving insights into its applications for the benefits of agriculture, the environment and man.

Chapter 7 : Molecular Hydrogen Is Involved in Phytohormone Signaling and Stress Responses in Plants

Discusses and explains the major advances that the new technology of applying molecular genetic techniques of modifying carbon and nitrogen in plants has provided, giving insights into its.

Chapter 8 : Plant secondary metabolism - Wikipedia

A molecular approach to primary metabolism in higher plants. [Christine H Foyer; W Paul Quick;] -- Discusses and explains the major advances that the new technology of applying molecular genetic techniques of modifying carbon and nitrogen in plants has provided, giving insights into its.