The Vital Earth News

Agricultural Edition

Volume XV1, Number 1 | Vital Earth Resources • Gladewater, Texas | Winter, 2010

Molecular Motors

The Organic Machines That Power Cells

By Paul W. Syltie, Ph.D.

motor (mot'er) n. a machine for converting electrical energy into mechanical energy.[1]

Motors in cells? Perhaps the idea sounds preposterous, but it has been a hot topic recently in molecular biology research labs across the earth. It has been found that "motor proteins" perform functions in cells that heretofore have been unexplainable.

Molecular motors are biological molecular machines that are essential agents for moving things within cells[2]. While a motor is usually thought of as a machine that converts electrical energy to mechanical motion, that definition can be extended to the tiny molecular scale, as "a device that consumes energy in one form and converts it into motion or mechanical work", such as in many protein based motors that harness the chemical energy released by the hydrolysis of ATP to perform mechanical work.[3]

There are a number of important molecular motors in the cells of both plants and animals; four are discussed below.

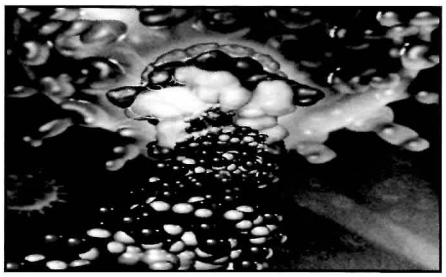
1. Cytoskeletal motors.

- ***Myosin***, a protein especially prominent in muscles, converts chemical energy as ATP (adenosine triphosphate) to mechanical energy, thus generating force and movement. Myosin is also important in the movements of nonmuscular cells during cell division, the carrying of molecular cargoes in microtubules and membrane vesicles, and cell crawling.[4]
- ***Kinesin*** moves cargo inside cells away from the nucleus along microtubules.
- ***Dynein*** produces the beating of cilia and flagella, and transports cargo along microtubules towards the cell nucleus.

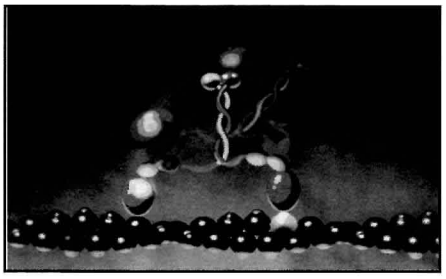
2. Polymerization motors.

- ***Actin*** protein polymerization generates forces for propulsion.
- Microtubule polymerization uses GTP (guanosine triphosphate).
- ***Dynamin*** is responsible for the separation of clathrin buds from the plasma membrane.

3. Rotary motors.



The yellow "mushrooms" are molecular motors pushing nucleic acids into a spherical virus capsule.



A cross-country runner? No, this is a myosin molecular motor that is helping propel a muscle fibril into action.

See Molecular Motors...Essential, page 2

Plants Made Sick By Pesticides

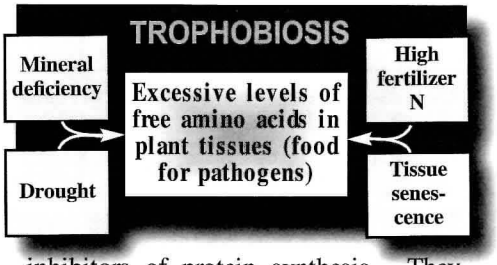
Trophobiosis and Francis Chaboussou

Francis Chaboussou

[From Chapter 4 of Healthy Crops, a New Agricultural Revolution, *The Gaia Foundation, 2007; translated from French.]*

Generally speaking, the failure of pesticides confirms once again the nutritional relationships between the plant and its parasites. This has been confirmed by detailed analysis of the relations between bacterial diseases and the host plant. This analysis also shows that susceptibility to disease is linked to proteolysis and, in particular, the soluble nitrogen content of the tissue.

This also shows that the great majority of chemical pesticides, especially with multiple applications, act as



inhibitors of protein synthesis. They render crops susceptible to various parasites, with viruses and bacterial diseases forming no exception to the rule.

To an overwhelming degree, chemical pesticides are based on nitrogen, from which they are synthesized. They are also chlorinated. This explains why they interfere with certain micronutrients, such as copper and boron.

This perspective is based on data from field trials: for instance, interference with copper by nitrate fertilizers. There is also the fact that, according to our theory of trophobiosis, the analogy between symptoms of deficiency and symptoms

See Protein Synthesis Must, page 3

Molecular Motors...Essential to Life

Continued from page 1

- **F0F1-ATP synthase** generates ATP using a protein gradient inside mitochondria.
- The bacterial flagellum used by E. coli and other bacteria for swimming and tumbling is powered by a rotary motor.

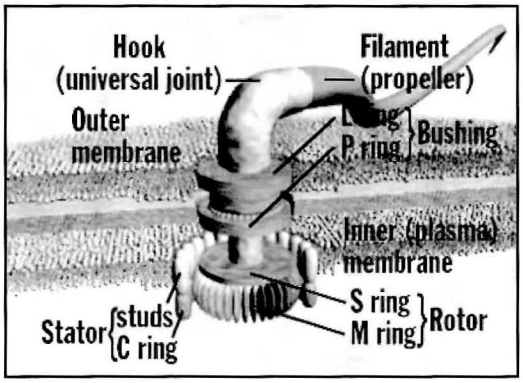
4. Nucleic acid motors.

- **RNA polymerase** transcribes RNA from a DNA template.
- **DNA polymerase** turns single-stranded DNA into double-stranded DNA.
- **Viral DNA packaging motors** inject viral DNA into viral capsids.

How the Motors Work in Plants

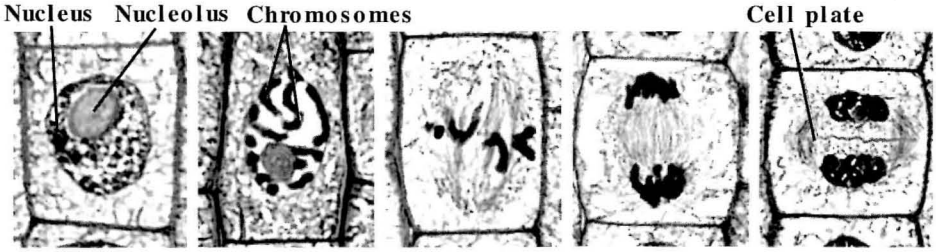
How does a motor protein work? We may envision a rotating coil within an electrical field that powers an electrical motor, and in cellular motors there are indeed electrical forces involved in these molecular movements. Electrons and energy transformations are integral to their operation.

Energy-rich compounds such as ATP (adenosine triphosphate) are tapped by the biochemical machinery to move the proteins and structural units in the cell which are positioned for the motion. The exact nature of this energy transfer into mechanical motion has not yet been elucidated, but there are theoretical models that have been designed.



The molecular motor for a flagellum can be likened very closely to a mechanical motor, complete with a rotor, bearings, bushings, and universal joint. Are mankind's inventions merely mimicking the created world?

Whereas animal cells use many dynein motors, plants have none. Instead, they contain a large number of kinesin motors.[5] These kinesins are specific for different plant species, and are especially important for cell mitosis.



Prophase
The chromatin condenses, and the nucleolus begins to disappear. The mitotic spindle begins to form.

Prometaphase
Discrete chromosomes are seen, having identical sister chromatids. The nuclear envelope fragments.

Metaphase
The spindle is complete, and the chromosomes, attached to their microtubules, are at the plate.

Anaphase
Chromatids separate, and daughter chromosomes move to the ends of the cell as microtubules shorten.

Telophase
Daughter nuclei form. The cell plate, dividing the cell in two, grows toward the perimeter of the parent cell.

Since plant cells have cell walls — unlike animal cells — the new cell wall is built by the formation of a cell plate starting at the center of the cell. This process is aided by a microtubule array (a "phragmoplast") unique to plant cell mitosis. The microtubules pull apart the replicated individual cell parts to create two identical daughter cells. Note the series of pictures above that illustrate the mitotic process, in which molecular motors play an integral part, especially in the microtubule separation of the chromatids.

Molecular Motors in Viruses

Of particular interest is a recently discovered molecular motor of viruses which is responsible for "stuffing" the DNA, which has replicated using a host cell, into its own capsid; see page 1 for a view of one such virus motor. Researchers from Purdue University and The Catholic University of America propose that parts of the motor move in sequence, like the pistons of a car engine, progressively drawing the genetic material into the virus' head. The motor is powered by ATP energy.

Cytoplasmic Streaming

Of great interest is the role of molecular motors, especially actin/myosin complexes, in the movement of cellular organelles. For example, how does one explain the movement of chloroplasts against the general flow of cell streaming? It is thought that calcium, through a protein called calmodulin, plays a key role in the function of actin and microtubule-based motors in plants.[6] These are exciting times as more secrets of plant cell operations are made clearer.

References

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3. C. Bustamonte, Y. Chemla, N. Forde, and D. Izhaky, Mechanical processes in biology, *Annual Rev. Biochem.* 73:705-748, 2004.
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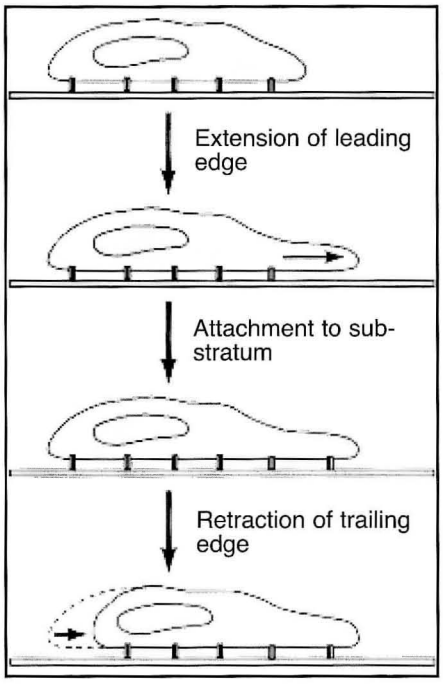


An amoeba places fibrils to the substratum, upon which molecular motors act to move the cell along.

Protein Synthesis Must Be Rapid!

Continued from page 1

of disease, especially bacterial and viral disease, can be explained simply by cause and effect.

In the first place, there is the problem of assessing how pesticides and especially fungicides actually function. In our opinion, for example, the effects of mineral products such as copper or zinc on bacterial diseases, as well as certain other diseases, can be explained by the reaction of the host plant. In other words, this would apparently involve a positive effect on protein synthesis.... We are able to make two points ... :

1) The very objectives of control efforts are questionable. It is useless to try to destroy bacteria through toxic procedures. The toxicity of chemical pesticides affects the plant itself.

Such instances of 'poisoning', some of which appear to be benign, have the physiological effect of inhibiting protein synthesis. The first stage may be interference with elements such as copper and boron. The failure of these new chemical fungicides (anilids and others) can be explained by an initial step in metabolism that relates to deficiencies. This would also explain, at the same time, the similarity between the symptoms of deficiencies and those of disease.

The first measure that should be taken is to prohibit the use of all chemical pesticides (fungicides, insecticides, acaricides, and growth hormones) where the possible harmful effects of their nitrogen and chlorine contents are not known. This includes, in fact, all synthetic chemical pesticides, all the more so because we do not know the cumulative effect of these pesticides when used in multiple treatments throughout the season, particularly for perennial plants.

2) If there is a fairly direct relationship between the disease and one or two deficiencies, we should be able to detect possible deficiencies in order to correct them. This can be achieved by appropriate analyses, carried out especially during susceptible periods in the annual evolutionary cycle, such as the flowering period.

On this subject, we have some reliable figures on which to base our hypothesis. These relate especially to micronutrients such as boron, whose great importance we have seen, above all to its relation to nitrogen. Just as the deficiency can come from the soil's original composition, it can also arise from lack of availability due to the phenomena of interference by nitrogenous fertilizers, or through a deficiency in organic matter.

Apart from micronutrient deficiencies, we should also consider the balance of cationic elements which, as we have seen, are also quite important. One criterion that seems fundamental is the K/Ca ratio. It is well known that the relationship of calcium to other micronutrients is very close. Boron is known to keep calcium in a soluble form, which is easily assimilated and therefore physiologically active.

On the other hand, just as with cationic elements, we can grasp the relations between the elements themselves. ... boron is only active in combination with manganese, magnesium, and molybdenum. This appears to explain the attraction and effectiveness of the 'micronutrient complexes' advanced by some companies that produce phytosanitary products.

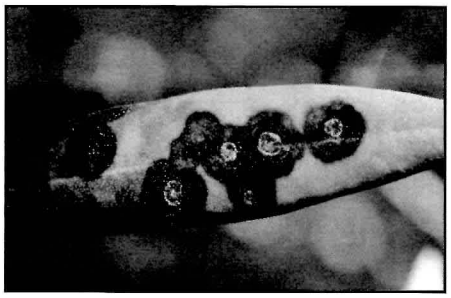
In grapevines with a boron deficiency, for instance, the practice of using foliar sprays with a micronutrient base has led, in two years, to an increase in the ratio of B/Zn from 11 to 47, along with disappearance of the phenomenon of failure to set fruit.

"The first measure that should be taken is to prohibit the use of all chemical pesticides ... where the possible harmful effects of their nitrogen and chlorine contents are not known."

Moreover, it is normal to find (whether with sunflowers or with grapevines) that the beneficial effects of boron begin at the flowering stage. This is in fact, as we have seen, the sensitive period of the cycle where proteolysis predominates. This proteolysis can to a degree be arrested by applications of boron to the tissues. In the same way, this could explain the beneficial effects of cupric sprays in late autumn against various cryptogramic as well as bacterial diseases.

Finally, it seems that the results of research into correction of deficiencies, with the aim of stimulating protein synthesis and obtaining maximum resistance to various parasites, conform with a biochemical state that also characterizes varietal resistance — in other words, the genetic effect.

Thus, in the case of apple scab, Williams and Boone recorded 'The variety called Cortland, which is susceptible to all strains of *Venturia inaqualis*, contains asparagine levels of 1.969 (an amino acid necessary for the growth of pathogenic fungi), while the resistant variety, Macintosh, only has levels of 0.756'. This would seem to confirm clearly that, in this case too, resistance and a high level of protein synthesis go together.



Peacock Spot in olives may be as much a symptom of nutrient deficiency as it is a fungal disease.

However, we should also remember the statement: 'The gene can only express itself in relation to other factors in the environment'. We have seen this confirmed by climate, stock, and the physiological cycle of the plant, as well as with the soil, fertilization, and finally the effects of pesticides. That is to say, genetic factors are only one element and their action can be thwarted by a whole series of others, most importantly by the effects of chemical pesticides.

It is conceivable that such factors, especially chemical treatments, could counteract varietal resistance, quite apart from effects on the plant's physiology. In contrast, control based on adequate'nutritional conditioning' can only be advantageous. ***Through it, one would attempt to recreate a 'natural' state of physiological resistance.*** Results achieved in antifungal control by means of 'nutritional sprays' further encourage us to continue with this line of study for controlling bacterial and viral diseases. It becomes more and more clear that this is the only course of conduct that makes sense. ❐

15-Minute Soils Course

Lesson 30:

Calcium (Ca): Part II The Plant Phase

Last month we discussed the uptake of calcium by roots, and its effects on soil structure, plus correcting deficiencies. This lesson we will look at calcium use within the plant.

20	40.078
Calcium	
839	1484
Ca	

Calcium is taken up by roots as the divalent Ca++ ion, and is transported in the transpiration stream, up the xylem to the leaves. Once incorporated into leaf and other above-ground tissue, this calcium, like magnesium and micronutrients such as zinc, copper, iron, and manganese, tends to stay where it is placed. Nitrogen, sulfur, and potassium, on the other hand, can move in the phloem to other parts of the plant if required.

The use of calcium in plants has similarities to its use in people and animals. It is essential for optimum growth and structure, and its translocation is tied to a large degree to boron. Boron acts as a carrier for calcium as it makes its way into the plant from the roots to the leaves.

The means by which this element works to promote growth and structure are listed in the lower left box. Not only does this element provide strength and integrity for cell walls, but it also stabilizes cell membranes and is involved in cell secretory and growth processes. Without calcium the cell could not maintain a proper osmotic pressure or cation-anion balance. Note the weak skins and blossom-end rot of the deficient tomato plant above.

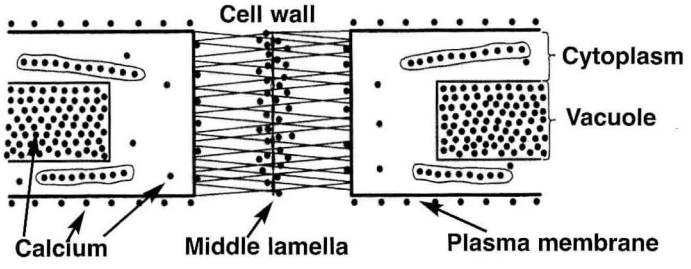
Calcium even acts as a "secondary messenger", seeping out in channels from the high-calcium sinks in vacuoles in response to growth regulators, pathogen infection, winds and other stresses, or injury. This effect triggers growth responses, like shortening the plant if the wind is strong.

Calcium is usually higher in the tissues of dicots (broadleafed plants having complex, branched leaf veins) than in monocots (grasses like corn and wheat, with straight leaf veins). The calcium in alfalfa, a dicot, may be 1.3%, but corn may have only 0.4%. The parts of cells that contain various calcium forms are shown in the figure below, and it is mostly found as Ca-pectate, then as water soluble forms, and thirdly as Ca-phosphate and Ca-oxalate.

Functions of Calcium in Plants

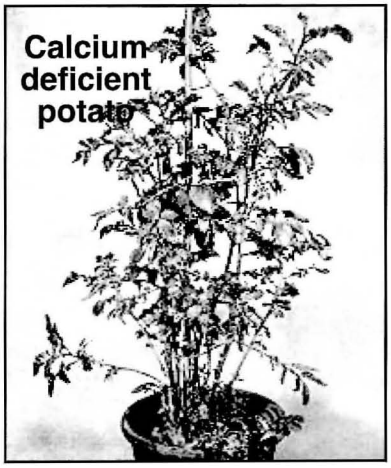
1. Formation of the integral structure of calcium pectates to give strength to cell walls and tissues
2. Storage in cell vacuoles, the endoplasmic reticulum, and other cell parts as oxalates and phosphates, for later use
3. Cell extension and cell secretion processes
4. Cell membrane stabilization
5. Regulation of cell osmotic pressure and cation-anion balance
6. Operation as a "second messenger"

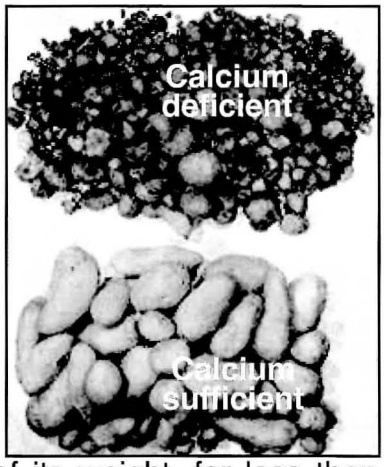
Two Adjacent Cells and Calcium Distribution



15-Minute Soils Course

In nature, calcium returns to the soil through leaf fall of trees and grasses, but in field crops much calcium is removed at harvest, especially with hay crops containing legumes when the whole plant is harvested; recall that dicots tend to be high in calcium. Thus, it is important to replace lost calcium over time with limestone or gypsum.





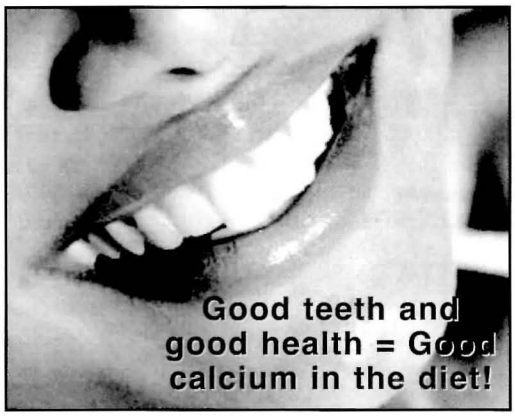
Calcium and Nutrition

As with plants, calcium is essential for all creatures, including man. It is important that plants are raised on soils having a proper balance of calcium, magnesium, potassium, sodium, nitrogen, sulfur, phosphorous, and micronutrients. using the Albrecht cation balancing system, where the optimum base saturation for calcium is 62 to 65%, will help plants take up proper levels of this vital element. Also important is maintaining an active microbial population to help solubilize and make available this and other nutrients. A well-structured soil high in organic matter will facilitate the uptake of calcium as well, since available forms move along water films on soil particle surfaces.

Foods High in Calcium

Collards.....357 mg/cup	Cheese...175 to 390 mg/oz
Rhubarb.....211 mg/cup	Milk, whole.....291 mg/cup
Kale.....206 mg/cup	Yogurt, plain....475 mg/8 oz
Mustard.....193 mg/cup	Sardines.....372 mg/3 oz
Spinach.....200 mg/cup	Almonds.....304 mg/cup
Turnip greens...252 mg/cup	

Nutritional Value of Foods, USDA, Home and Garden Bulletin No. 72, 1977.



In the human body, calcium makes up 1.5% of its weight, far less than carbon, hydrogen, oxygen, nitrogen, phosphorous, and sulfur that make up 97.9% Only 20 to 30% of the calcium we eat is absorbed by the body, and sometimes only 10%, mainly in the acidic first half of the intestine.

In order to properly utilize calcium it is essential that there be adequate sunshine on the skin for Vitamin D conversion, since that vitamin stimulates calcium absorption in the intestine. Adequate boron and phosphorous in the diet are also important, and regular exercise that stresses bones to signal the body to deposit calcium in them for strong bone structure. ❐

See What You Learned

1. Calcium is higher in the tissues of _____ than in monocots.
2. The cell walls of plants are high in calcium pectate, which helps provide plant structure: T or F
3. Calcium is taken up by roots as the ion of
a. Ca^{++} b. Ca^{+3} c. Ca^{+} d. Mg^{++}
4. In nature, calcium is returned to the soil mainly from _____.
5. It is essential that our diets contain a certain minimum content of calcium. T or F
6. The following foods are high in calcium. a. Sardines. b. Butter c. Kale d. Cheese
7. In order to properly utilize calcium, the body must have a proper amount of Vitamin ____.

Answers: T. dicots; 2. T; 3. a; 4. leaf fall; 5. T; 6. a, c, d; 7. D.

Top Foods for Healthy Immune Response

Extracted from Dr. Joseph Mercola (*www.mercola.com*, December 8, 2009)

Staying well while those around you sniffle and sneeze requires that you extract as much nutrition from your diet as you can, loading up on the foods that pack the biggest nutritional punch.

Avoiding processed foods, grains, and sugar will go a long way toward strengthening your immune system. However, you can do even more by selecting foods that are loaded with specific immune boosting nutrients.

Unpasteurized Grass-Fed Organic Milk

Raw organic milk from grass-fed cows contains beneficial bacteria that prime your immune system and can reduce allergies. It is an outstanding source of vitamins, especially vitamin A, zinc, and enzymes. Raw organic milk is not associated with any of the health problems of pasteurized milk such as rheumatoid arthritis, skin rashes, diarrhea and cramps.

Fermented Foods

One of the most healthful fermented foods is kefir. Kefir is an ancient cultured, enzyme-rich food full of friendly microorganisms that balance your "inner ecosystem" and strengthen immunity. Others include natto, kimchee, miso, tempeh, pickles, sauerkraut, yogurt (watch for sugar), and olives. Friendly bacteria have a powerful, beneficial effect on your gut's immune system, your first line of defense against pathogens, and aid in the production of antibodies.

Locally Grown Organic Vegetables

When it comes to fighting off pathogens, you simply can't do any better than eating a variety of fresh, organic and preferably raw vegetables for the vitamins, minerals, antioxidants, and enzymes they contain. Make sure the veggies you choose are fresh. The nutrient value drops to almost zero for canned fruits or vegetables. Choose foods with a high ORAC value.

Herbs and Spices

Herbs and spices are at the top of the list of high ORAC value foods on planet Earth. There are simply too many good ones to summarize here! All of these have very high ORAC values: garlic (ORAC of 5,346), honeysuckle and chrysanthemum, artemisia, andrographis, licorice, turmeric (ORAC of 159,277!), black pepper, oregano (ORAC of 13,970), cinnamon (ORAC of 267,536!), and cloves (ORAC of 14,446!!!).

Blueberries and Raspberries

Blueberries and raspberries rate very high in antioxidant capacity (ORAC of 6,520), compared to other fruits and vegetables. Wild blueberries in particular are potent immune boosters. They contain powerful phytochemical pigments, such as anthocyanin.

ORAC Values

ORAC = Oxygen Radical Absorbance Capacity. An ORAC unit is a standardized method of measuring the antioxidant capacity of different foods and supplements. The higher the ORAC score, the more effective a food is at neutralizing free radicals. The fewer free radicals you have, the healthier you will be.

Raw Organic Eggs from Free-Range Chickens

Before you wrinkle up your nose, raw eggs are an inexpensive and amazing source of high-quality nutrients that many people are deficient in, especially high-quality protein and fat.

Coconuts and Coconut Oil

Besides being excellent for your thyroid and your metabolism, coconut oil is rich in lauric acid, which converts in your body to monolaurin. Monolaurin is the compound found in breast milk that strengthens a baby's immunity. This medium-chain fatty acid (MCFA) disrupts the lipid membranes of offending organisms.

Teas

The two best types of tea for fending off microinvaders are Matcha green tea and tulsi tea. Matcha comes from Japan and has up to seventeen times the antioxidants of wild blueberries. Green teas are rich in polyphenols (catechins), which can be 25 to 100 times more potent than antioxidant vitamins C and E. Matcha is more than 100 times as potent in the powerful catechin epigallocatechin in regular brewed green tea. Tulsi tea, from India, supports your immune health, memory, heart health, and vision.

Propolis

Propolis is a bee resin, one of the most broad-spectrum antimicrobial compounds in the world. It is also the richest source of caffeic acid and apigenin, two very important phenolic compounds that aid in immune response.

Grass-Fed Beef or Organ Meats

This recommendation is only valid if you are a protein or mixed nutritional type as carb types really should not be eating beef. Grass-fed beef results in far greater health benefits for you and for the environment, very high in vitamins A and E, omega-3 fatty acids, beta carotene, zinc and CLA. CLA (conjugated linoleic acid, a fatty acid) is three to five times higher in grass-fed animals than grain-fed animals and is an immune system enhancer.

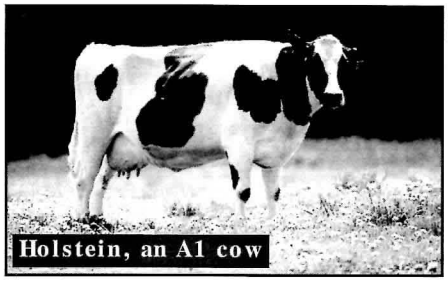
Chlorella

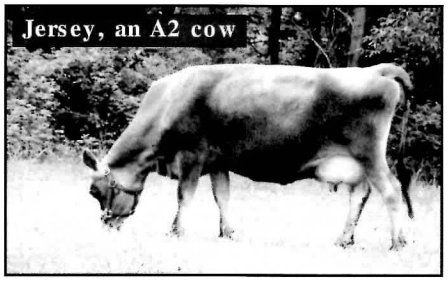
As foods go, chlorella is nearly perfect. It is a single-cell freshwater algae that is an efficient detoxification agent by binding to toxins, such as mercury, and carries them out of your system. The chlorophyll in chlorella makes it so powerful; it helps process more oxygen, cleanse your blood, and promote the growth and repair of tissues.

The Devil in the Milk: All Cows Not Equal

By Paul W. Syltie, Ph.D.

In his book *The Devil in the Milk* (Chelsea Green, 2009), Dr. Keith Woodford, makes clear that there is a basic difference in the milk produced by two groups of cows. Drinking the milk of one group can actually make you sick!


Holstein, an A1 cow


Jersey, an A2 cow

First, be aware that these two groups produce milk having certain differences in their amino acid spectrum. All proteins are long chains of amino acids. Beta casein is a chain 229 amino acids in length, and cows who produce this protein in their milk with a proline at number 67 are called A2 cows. These are the older breeds of cows like Jerseys, and Asian and African types. It is theorized that some 5,000 years ago a mutation occurred in some A2 cows to result in histidine instead of proline at number 67 of beta casein. Cows that have this mutated beta casein are called A1 cows, and include breeds like Holstein, from which most of our milk comes.

In the milk produced by A2 cows, proline in casein has a strong bond to a small protein called BCM 7, which helps keep it from being liberated in the GI tract during digestion. Thus, with this milk there is essentially no BCM 7 found in the urine, blood, or GI tract of the consumers. On the other hand, histidine, the mutated protein, only weakly bonds to BCM 7, so it is liberated in the GI tract of animals and humans who drink A1 cow milk.

BCM 7 has been shown to cause neurological impairment in animals and people exposed to it, especially autistic and schizophrenic changes. BCM 7 interferes with the immune response, and injecting BCM 7 in animal models has been shown to provoke type 1 diabetes. Dr. Woodford's book presents research showing a direct correlation between a population's exposure to A1 cow's milk and the incidence of autoimmune disease, heart disease, type 1 diabetes, autism, and schizophrenia.

Simply switching breeds of cows could result in great health benefits. ❐

Next Month! *Baking Soda for Agriculture and Health*

Wealth and Prosperity

You cannot legislate the poor into prosperity by legislating the wealthy out of prosperity. What one person receives without working for, another person must work for without receiving. The government cannot give to anyone anything that the government does not first take from someone else. When half of the people get the idea that they do not have to work because the other half is going to take care of them, and when the other half gets the idea that it does no good to work because somebody else is going to get what they work for, that, my dear friend, is the beginning of the end of any nation. You cannot multiply wealth by dividing it. Adrian Rogers

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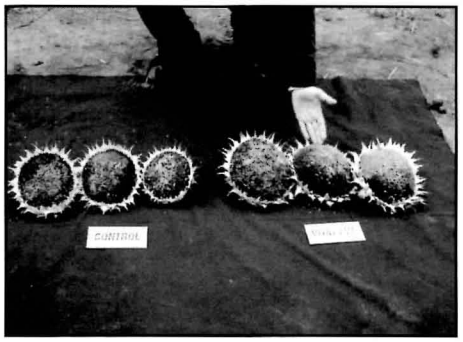
Vitazyme in Ukraine for 2009 proved again its consistency for all crops. A 24% increase in yield for sunflowers is self-evident in these remarkable photos! Similar yield increases were obtained for corn, sugar beets, wheat, barley, canola, and forage.



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