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Cell Secrets

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CELL SECRETS

In the good old days when the older generation could do their courting without having to keep one hand on the steering wheel they would finally unwind the lines from the whip stalk and use that trusty instrument of torture, the whip, to flick the little mare on the flank. That tap was sufficient to start her on a lively trot which often lasted for several miles, especially if she was headed toward home. Now we have a more or less close parallel to that whip in a good many life processes. And what are the points of resemblance? The action was speeded up; it required mere contact to accomplish it; the whip wasn't used up in the process; and a little went a long ways. This is a true picture of one class of cell products, the enzymes; and it represents with considerable accuracy two other products of the cell, the vitamines and the hormones. These three wonderful agencies challenge our interest and provoke a tremendous amount of research at present because they are so far-reaching in their effects and because they largely baffle any attempt to isolate or identify them. Fortunes are yearly being spent to learn their secrets and other fortunes are being amassed in the commercial exploitation of the half-truths which we have so far learned. In this paper I wish to sketch some of the high points of our present knowledge of these three (shall we call them substances), hormones, vitamines, and enzymes, as observed in the animal organism.

Certain organs and glands of the body secrete substances which are absorbed directly through their walls into the blood stream. These materials, called hormones or chemical messengers, are carried to different parts of the body and either bring about or speed up definite changes. The bodies which secrete them are called the endocrine or ductless glands. The uppermost one, situated at the base of the brain, is the pituitary gland. Its anterior lobe secretes an unknown substance, called pituitrin. If, early in life, this gland, by removal or disease, no longer produces pituitrin, the sex organs of the victim fail to mature, he accumulates fat, and strangest of all, he is apt to remain a dwarf. If on the other hand they oversecrete, the person may develop gigantism and grow to tremendous proportions. The posterior lobe probably produces a secretion but its nature and function are unknown. The thyroid gland, located in the neck, has yielded the secret of its secretion. It was isolated and analyzed by Dr. E. C. Kendall of the Mayo clinic at Rochester and was named thyroxin. Iodine is necessary to its formation and in localities where iodine is deficient, the gland must overwork, resulting in simple or endemic goiter. It is closely connected with sex activities and hence the disease is most often noticed in girls preceding and during the adolescent period. Iodized salt has been exploited in this connection. If the gland does not function in the young, cretinism or Mongolian idiocy may develop. For similar causes in the adult, we observe myxedema. These diseases, which produce heavy, dull features, coarse

skin and hair, and other symptoms, may often be relieved if taken in time by administration of thyroxin. Oversecretion of the gland produces extreme nervousness, partly due to an extremely high metabolic rate. Kendall states that the injection of .0003 oz. increases the carbon dioxide output by 400,000 mg. Situated behind this gland are four little kernels called parathyroids. They probably control the lime in the body and their removal produces tetany and death.

The thymus gland, situated lower in the neck, is called the gland of childhood. As in the case of the other endocrine glands, the possibilities and scientific speculations concerning this gland are astounding and almost unbelievable. Embedded in the pancreas are patches of tissue called the Islands of Langerhans. The secretion of these glands, though of unknown composition, has offered untold relief to suffering humanity due to the wonderful researches of Banting at the University of Toronto. It is called insulin (from island). In its absence the body cannot utilize sugar and in such cases administration of insulin extends the life and relieves the ailments of the sufferer from diabetes in a remarkable way. An overdose may produce convulsions but these can be prevented or dispelled by administration of sugar. The adrenals or suprarenal capsules, located over each kidney, are veritably miracle glands. They secrete adrenaline, also called epiniphrine, the only hormone, other than thyroxin, whose composition is known. It should be noted that, if the composition of such a substance is known, it can be manufactured and join the group of pure medicines, and need no longer be extracted from animal organs when needed. Among other important properties, it constricts blood vessels, reducing bleeding, and relieves surgical shock. It also apparently makes possible great feats of endurance and strength which are often exhibited when a person is under great nervous stress. One part to 300 million parts of body weight appreciably increases blood pressure, and administration of .002 oz. will kill a human by so contracting the blood vessels that no blood can flow.

The hormone of the ovaries will induce the estrus cycle and that from the organs of both sexes is responsible for the secondary sex traits. If the organs producing these hormons are removed before puberty, it is common knowledge that a sexless individual results.

Certain food manufacturers would have us change our American salutation of "how do you do" to "have you had your vitamins". When Casimir Funk in 1912 coined this word he little dreamed that it would become a household term. We can also imagine that he erred in another regard, viz. that within twenty years some of these substances would have been captured, analyzed, and built in the laboratory. And yet, in this year 1931 no one has yet gained the distinction of isolating or synthesizing even one. Their history is a thrilling romance. The first ones to be discovered were named according to their solubility, as fat soluble or water soluble; but through recommendation of the American Association of Biological Chemists they are now designated by letters: A, B, C, D, E, and G. A, D, and E are fat soluble, the other three water soluble. It is not only possible but probable that many others exist, as evidenced by the work of a number of present day investigators. Their similarity to enzymes as catalysts is seen in the tremendous effects which mere traces can bring about.

Vitamin A is found in cod liver oil, milk, eggs, spinach, etc. It is the growth-promoting factor of the young, and is also essential for adults. Textbooks as late as 1927 subscribe to a widely accepted theory that its deficiency produces a distressing eye mal-

ady called xerophthalmia but this idea is now being questioned in some quarters. It resists destruction relatively well. Since its chemical nature is unknown, the only way to identify it or measure its potency is by socalled biological assay, using as a laboratory agency, for example, the long-suffering white rat. If one of the rat twins grows and the other one, on a different diet, does not, the first rat may be said to have had his daily vitamins.

Vitamin B was the first to be discovered. Its absence produces polyneuritis or beri beri. A pigeon so affected loses the power of locomotion, and surprisingly regains this power when this dietary deficiency is corrected. It may be a double vitamin because one fraction of it also affects growth. For the latter property white rats are the subjects. It is abundant in yeast and fairly plentiful in all animal products found in man's dietary.

The deficiency of vitamin C has produced untold misery among groups on a restricted diet, such as explorers and sailors on long voyages. It is the antiscorbutic or scurvy preventing vitamin. This disease affects the joints, gums, weight and appetite, and is confined to man, monkeys, and guinea pigs. Fresh fruit and vegetables, orange and tomato juice are rich in this principle, and modern explorers, including Commander Byrd, include vitamin C on their shopping list.

Hopkins, Funk, Mellanby and McCollum, 1906 to 1922—that is the chronology in the capture of vitamin D. But its list of victims probably dates back to some of the bow legged, weak boned grand children of Adam and Eve. It is the antirachitic substance whose absence may produce rickets. I use "may" advisedly because ultraviolet light and other factors, by their absence, seem to function as accessories to the crime. It can be formed at will from ergosterol, a known chemical compound, but, having been formed it baffles all efforts to domesticate it in test tube or incubator. It is quite widely distributed, but cod liver oil, that delightful food product, is its favorite haunt. The significance of modern irradiated foods for the young of animals is here evident.

Vitamin E is the antisterility vitamin. A study of the effects of its absence upon the female shows that ovulation will occur and the fetus will grow for a time, then it dies and is resorbed. This condition is usually temporary if the dietary deficiency is corrected. For the male, sterility does not occur so easily, but once accomplished, it is likely to be permanent.

Vitamin G is of too recent discovery to warrant any extended discussion. Its deficiency in man is associated with pellagra. In general it is found with B.

The tremendous field of true enzymes has been left to the last because if presented first it would have usurped the time of the entire paper. Enzymes are catalysts (remember the whip analogy) which are produced in the living cell and which are necessary to almost every chemical action that goes on in plants and animals. These substances, none of which have been obtained pure and whose preparation in the impure state is enough to bring the gray hairs, are quite specific in nature. That is, they belong to the union and will work only when assigned to a certain job, or rather a certain food or substrate. In the process of digestion in the alimentary tract, several sets of them are furnished by the saliva to act on certain classes of foods; other groups are provided by the stomach, others by the pancreas and by the intestine. Still other enzymes bring about the oxidation of foods in the body to produce heat, and by a marvelously complicated process. To say that sugars are oxidized to carbon dioxide and water in the body is a statement as condensed in form as a transcontinental motor route

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FROM TEACHERS IN THE FIELD

The Project in High School Science

The use of the project in teaching the high school sciences is one of the major means of holding the interest of those who are taking the course chiefly because of requirements for graduation or college entrance. No doubt it would be an excellent means of presenting an entire year's work but would require a good deal of the teacher's time to develop such a course of study. This obstacle might well be overcome by gradually introducing the project year by year until the complete field was covered.

I have employed the project in my science classes as a means of earning extra credit, usually giving a maximum of 5% added to the final grade for a satisfactorily completed project. In the field of chemistry we have used a number of things that resulted in the stimulation of the entire class and in many cases a complete change of opinion about the subject. One year we allowed the students to work in pairs and develop displays illustrating some chemical process such as the manufacture of ink, matches, glass, bakelite, perfumes, dyes, paints, baking soda, etc. I suggested several things, showing how they might be developed, but required that they make their own choice of topic, and work out the way in which they thought it might be developed. After we had talked these over individually, all were required to make a thorough study of the process chosen before they were allowed to start work on their display.

When all had completed their study and had collected the materials for their display, they were allowed the laboratory hour to arrange and mount them. In addition to the interest developed, all learned a good deal about their own particular process and in addition learned to do library research. Each group made a report to the class about their project and explained the display, so that in a way the whole class benefitted from the individual work.

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Cell Secrets

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on a three inch map. One enzyme in yeast hitches water to cane sugar and makes simpler ones. Then another changes the simpler sugars to carbon dioxide and alcohol. To attempt to discuss the important enzymes would more than fill this Bulletin. Let me conclude with a few illustrations.

If barley is soaked and then allowed to sprout, it forms these little workers in tremendous amounts. Now dry and grind the sprouted grain and you have malt. I do not need to tell you why malt has such a big sale.

Cheese is very largely a product of enzymes. One of them, rennin, clots the milk. At least seven others change the curd into cheese.

An enzyme called invertase can change cane sugar into a mixture of the sugars which make up honey. And so efficient is this enzyme that if you were to furnish one ounce of it with all the sugar it could act upon you would be obliged to supply it with thirty-one tons—nearly two carloads—of sugar.

Enzymes, vitamins, hormones, small as they are, how they mock man in his efforts to reveal their secrets, in his efforts to equal their efficiency, or to create them in his laboratories.

R. W. Getchell.

THE STATE HIGH SCHOOL COURSE IN GENERAL SCIENCE

The course of study in general science for high schools issued by the State Department of Public Instruction has recently come from the press. The course is divided into fifteen units. Of these, eight are devoted primarily to physical and chemical facts; five are of a biological nature; and two deal with facts of astronomy and meteorology. The authors, however, have succeeded well in constructing a course in general science and have not merely put together unrelated parts of physics, chemistry, biology, and astronomy. The course seems to be fairly well balanced. Too often so-called courses in general science have been overdeveloped in one line according to the training of the author. If he were trained primarily in physics, it would be largely physics; if a chemist, he would over-emphasize the chemistry. The writer of this review being a biologist is gratified to see so much biological material included. The science of living things certainly is very important and belongs in a general science course. The biological material has been too meager in most of the general science textbooks. The writer states this, knowing that he will be accused of expressing the viewpoint of a specialist.

There are a few errors that occur in the biological material which should be corrected. Some of them are minor errors and others are more serious. On page 21, one of the differences noted between plants and animals is that plants are "independent for food." This, of course, is true only for green plants and a few bacteria. Non-chlorophyll plants, of which there are about 80,000 species, cannot make their own food. However, the most significant thing about plants is their ability to make the food for the world, but it should be made clear that this is not true for all plants. What evidently is a typographical error occurs on page 23. The wasp mentioned in connection with Smyrna fig culture is Blastophaga and not Plasto Phaga. Also the term pollination is preferable to pollenization.

One of the most serious errors is the statement that budding and grafting are means "used in the production of new and improved varieties of plants." (Page 23). This is not correct. No new varieties are produced by this method. Budding and grafting are used as methods of propagation to **prevent** new varieties from arising. The horticulturist wishes to propagate his plants and keep his variety true to type, so he uses grafting and budding where other means of vegetative propagation are not effective. The incorrect statement above violates seriously the fundamental biological principle of reproduction. Evidently this error is commonly made in our high schools, because the majority of the students who enter our college botany classes believe that grafting is the means by which new fruits are secured.

On page 28, under j in "teacher procedure" on how the body uses food, one would be led to believe that digestion is the process by which the body secures energy from the food. This is a serious error since digestion merely prepares the food for absorption and is not an energy releasing process. The process that should be taken up here is the much misunderstood process of respiration. It is by respiration that energy is secured through the physiological oxidation of foods. It is this process, rather than digestion, which should be compared with the combustion of fuel in an engine. No mention