BOTANY

Plants Grow Whiskers

Hormones and Drugs Have Strange Effect on Growth, Rooting, Flowering, and Seed Production of Plants

By DR. FRANK THONE

A ROMANCE was once written by H. G. Wells about a "Food of the Gods," that caused enormous growth in record-breaking time in human beings and all kinds of animals. Even before that, of course, we had the classic fairy tale about Jack's beanstalk, that remarkable vegetable that climbed to the clouds in a single night.

Jack's beanstalk was a pure figment of the imagination. The story Wells wrote was based on the then new and sensational discoveries about hormones, or gland secretions, in animals. These are chemicals of amazing properties. Minute quantities of hormones make us tall or squatty, thin or fat, angry or affectionate, depending on what glands they come from and what parts of us they affect.

Now it is being rapidly discovered that plants have hormones, too—though no sharply marked-off glands for making them have yet been discovered in plants. Their effects are just as sensational as those of animal hormones, and their eventual practical applications may become as far-reaching.

Already one of these plant hormones is in widespread use among gardeners and nurserymen, to make roots form on cuttings of such valued woody plants as holly, yew, lemon, etc., which ordinarily are very stubborn about throwing out roots and must be propagated much more expensively by grafting, or grown from seed without certainty as to quantity or quality of the product.

Seedless Fruits

Another possible use, demonstrated thus far only in a scientist's greenhouse, is spraying hormones into unpollinated flowers of tomatoes and other plants, which then produce fruits completely without seeds. Commercial application of this very recent discovery will depend on finding ways of treating large numbers of flowers rapidly and cheaply.

Some of the experimental results are simply fantastic: making roots grow from leaves, and even from petals of flowers. One botanist, surveying a plant with a mass of artifically induced roots growing among the leaves on its stem, said, "We can make plants with whiskers now!"

The single piece of research that made possible this production of roots wherever you want them was deemed worthy of a $1000 prize at a recent meeting of the American Association for the Advancement of Science. The experimenters mixed a very small quantity of the hormone with lanolin, an animal fat, to make a kind of paste or salve. This they spread on the stems and other plant parts where they wanted roots to grow. And the roots grew.

On the Market

Anybody can do it now. Several chemical manufacturing concerns have the material on the market. It is offered under a variety of patented trade names, but its true chemical name is indole-3-acetic acid. Under that name its retail price is about $3 a gram. That makes it rather expensive, for a gram is only approximately a thirtieth of an avoirdupois ounce. But a little of the hormone goes a long way: plants react to dilutions as thin as one part in several millions.

If there is a child in your neighborhood who mysteriously refuses to get taller, the doctor may say something more or less unintelligible about glandular deficiency, administer a remedy made from the glands of slaughtered animals —a hormone. Whereupon, if all goes well, the youngster resumes normal growth.

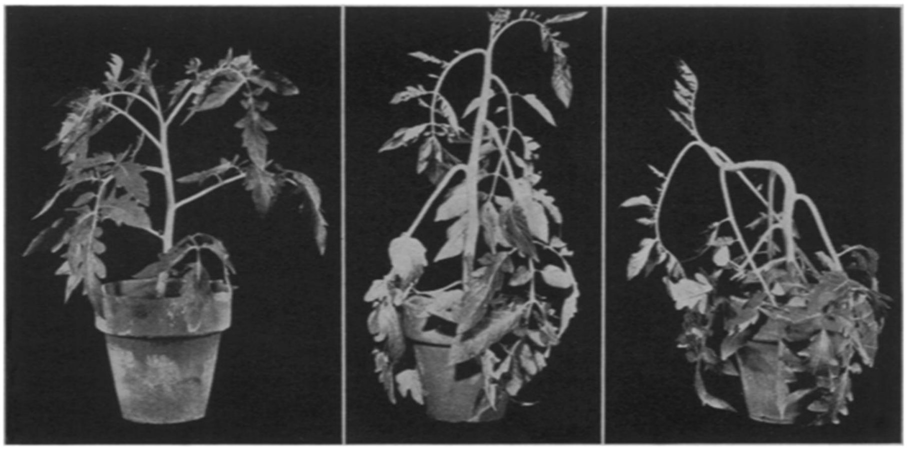
Hormones are necessary for growth in length by plants no less than they are for growth by children. Indeed, of the relatively few plant hormones we know, the best known ones are those of plant growth. They are called the auxins, from the Greek word meaning growth.

Formed at Stem Tips

Auxins are formed at the very tips of growing stems and other actively growing parts of the plant. Their effects, however, are not in the same regions where they are formed, but a little back of or below them, where cells are elongating rapidly. The auxins are what cause the cells to elongate.

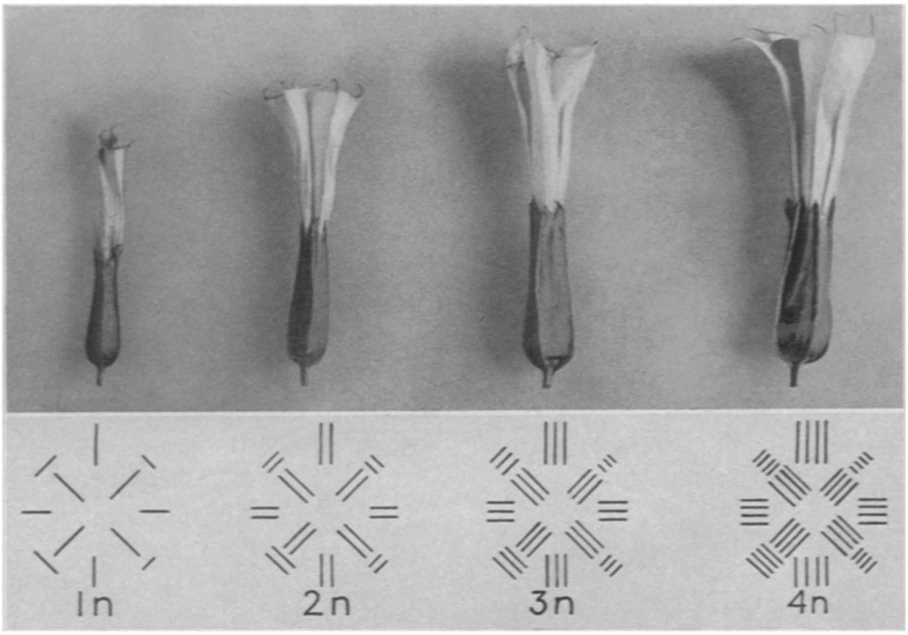
The picture is further complicated by the fact that the stem-tips apparently do not make auxins out of raw material on the spot, but receive some half-finished product, known provisionally as "auxin precursor" from below, turn it into the active hormones, and then send it back to the zone of elongating cells.

Thus, although plants do not have definite glands as animals do, these fast-growing tip-ends appear to serve in much the same way as glands.



QUICK EFFECTS

Chemical duplications of auxins have strange effects on plant growth within an hour after application. On the left is a normal tomato plant, untreated; in the center one treated with the gas ethylene; on the right one treated with indole propionic acid. Bending is toward the treated side when the application is large; away from it if small.



MORE CHROMOSOMES: BIGGER FLOWERS

Above, flower sizes in strains of Datura, arranged in order of the number of chromosomes, as shown in the diagrams below. These range from haploid (half-normal) on left, through diploid (normal) and triploid to tetraploid (twice normal). Changes in chromosome numbers were induced by application of colchicine solution. The photograph is used through the courtesy of the Journal of Heredity.

There are three kinds of auxins thus far known, called respectively auxin a, auxin b, and hetero-auxin. (That "hetero" comes from the Greek, too; it means merely "other.") Hetero-auxin is the one that has been identified as the chemical indole-3-acetic acid and is now sold to nurserymen and laboratory workers with plants.

Strangely enough, plant hormones are also made by animals, and animal hormones are formed by plants. Auxin is found in a number of familiar animal gland secretions such as saliva, pepsin, and urine. It is also found in glandular organs themselves, like the liver and the kidneys. It is abundant in incubating eggs during certain stages of the embryo's development.

Animal Hormones in Plants

Among the animal hormones formed by plants is one of the most powerful and most useful: theelin, the female sex hormone. Strangely enough, too, theelin and certain other animal hormones have strongly stimulating effects on plant growth, when strong doses of them are added to the soil in which the plants are growing. This, of course, is still too expensive a way to speed up crop growth; but some day something may come of it.

Some of the lower plants, particularly fungi, are known to have auxins of their own. Yeast, which may be regarded as a special type of fungus, has an auxin-like stuff that has been named bios. Where bios comes from is still uncertain; it seems sure that the yeast does not make all the bios it needs for its own growth.

Whole Subject is New

The whole subject of plant hormones is still shiny-new. "Growth substances" were vaguely talked about for a couple of centuries, but it was not until well into the present one that plant hormones became definitely known things. As an index: a recent list of technical articles on the subject published in scientific magazines contained nearly 300 titles. Very few of them were more than twenty years old, and the vast majority were published less than five years ago.

A new world in plant knowledge and plant control is opening to us. It would be rash to prophesy what may happen. It would be even more rash to declare anything impossible.

Science sometimes accomplishes its revolutions with the oddest of weapons. Who for example would have thought that the sovereign remedy for the once-dreaded pernicious anemia would be found in liver, a "giblet" that butchers once could hardly give away? Or that common garden peas would crack open the sealed secrets of heredity?

Science has once more wrought a wonder with an obscure and unpromising means. This time it is a somewhat old-fashioned remedy for rheumatism, gout, and similar ailments. The stuff is known as colchicine, and it is made from the bulbs of the common autumn-flowering crocus, named *Colchicum autumnale* by botanists.

If a solution of colchicine is injected into a plant, or merely sprayed on it, or applied in any of a half-dozen other ways, the leaves presently begin to act strangely. Patches of their tissue grow faster than neighboring parts, so that the leaves come to have a wrinkled, crumpled appearance.

Offspring Are Giants

Flowers that grow from some of the colchicine-washed places on the stem are apt to be freakish also. But what is more important, the seeds they bear are apt to produce giants—plants that look like their parents but are much bigger, and breed true to their new big size.

If the colchicine treatment is applied to this giant generation, the process may be repeated, bringing on a second and even larger race of giants. The plants have been doubled and redoubled.

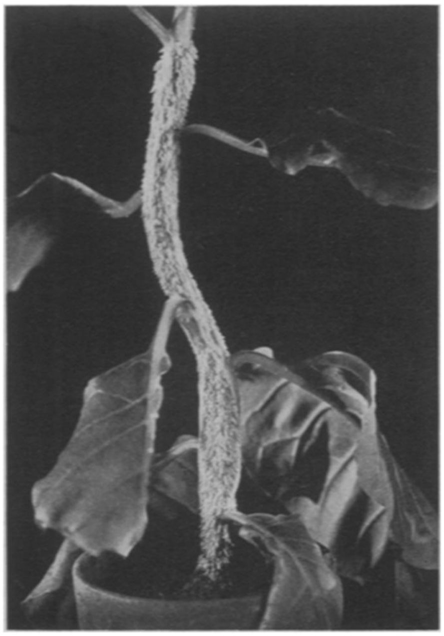
At the Cold Spring Harbor station for experimental evolution of the Carnegie Institution of Washington, where this hitherto unsuspected power of colchicine was discovered, results have been obtained with such field and garden crops as clover, alfalfa, tobacco, onion, and radish, and flowers like cosmos, nasturtium, foxglove, and phlox.

The prospect of producing bigger (and inferentially better), true-breeding plant varieties is exciting enough, but that is only the beginning of the story.

What goes on inside the plant tissues when they begin to show such strange external behavior apparently is a doubling of the chromosome numbers. Chromosomes are the structures within the cell that carry the genes, or units of heredity.

It has been known for a long time that when chromosome numbers double by spontaneous or accidental action in cell division, the offspring are likely to be giants. But this is the first time that such doublings have been made possible whenever man wants them. Scientists therefore have a new springboard from which they can dive even deeper into the secrets of life.

One of the most thrilling possibilities opened up by this new way of making



"WITH WHISKERS"

The stem of this plant grew a perfect beard of short roots when the soil in the pot was treated with a hundredth of a gram of indole butyric acid, one of the synthetic growth-promoting substances.

chromosomes double up is the chance of getting hitherto impossible hybrids that will produce offspring. As a rule, one can get only sterile hybrids between two plants or animals that are not closely related, like horse and donkey, or cabbage and radish. This is because the chromosomes of the alien cells have a hard time finding proper mates when crossing takes place.

But if you can bring into the picture these giant germ cells with double or quadruple chromosome numbers, it is much more easily possible for these difficult crossings to be made. Once made, it is again more easily possible for them to continue true to seed.

This does not mean that completely unrelated plants can now be crossed. We are not going to see such fanciful hybrids as strawberry with watermelon or endive with cucumber. But scientific Cupids may try to arrange such cousin-matings as tomato with eggplant, or wheat with a wild grass, or lettuce with endive. Results are apt to be interesting, and some of them may be highly valuable.

The botanical building at the University of Chicago has its top floor built as a greenhouse, but no plants are ever grown there. When it was built it seemed a fine idea, but the plants just acted queer and then died. So they had to give it up.

But members of the botany department were determined to find out what ailed the place. They traced the trouble very quickly to illuminating gas used in the laboratories on floors below. Then they took the gas to pieces chemically, to see what made it so poisonous.

They discovered that the poisonous part of the gas was a compound known as ethylene, found in almost all natural and artificial gas. A number of other compounds, some of them related closely to ethylene, others not, were found to have similar effects. Many of these worked also when they were dissolved in water reaching the plants.

But finding out that ethylene and other compounds were plant poisons did not close the case at all. The plant physiologists knew, from medical experience, that very small doses of poison can be useful as tonics or stimulants.

Continued experimentation showed that these poisonous gases could be put to work in much the same way. And now they do work, in hundreds and thousands of places, affecting large quantities of fruits, vegetables, flowers, and other marketable plant products.

Gas treatments have been found valuable, for example, in bringing the bright hue of ripeness to oranges and other citrus fruits, which are green-skinned when they are picked. Bananas, also shipped green, are made beautiful for their market debut with a touch of the same magic gas. Celery is blanched. Dormant cuttings of many species of flowers are made to awaken, like Sleeping Beauty in the story, by the invisible stimulus.

It develops that ethylene is a normal product of the life-processes of plants themselves, particularly during the process we call ripening. This explains the "mysterious" power of apples in a cellar to prevent sprouts on potatoes stored in the same bin. The apples give off enough ethylene to discourage the sprouts. Experiments in Germany have even shown that apples will stunt the growth of seedlings, cause leaves to fall off sensitive plants, etc., all through the power of their internally-generated ethylene.

The late G. K. Chesterton once wrote a book of essays which he titled "Tremendous Trifles." He could have found plenty of material in the plant world to write about. Every day we are finding some new thing, trifling in size or quantity, but tremendous in its effects on the green life round about us, and therefore in the end on us also, who are dependent on plant life for the maintenance of our own lives.

Science News Letter, January 22, 1938

ECONOMICS—SOCIOLOGY

Millions of Americans Fail To Affect National Economy

ONE out of six people in the United States could disappear tomorrow without affecting the income of the nation, it was revealed before the American Association for the Advancement of Science in an inquiry that provides preliminary blue-prints for more effective use of human resources and man-power.

Some 15,000,000 to 20,000,000 people live at a subsistence level and take a very meager part in economic life, a paper communicated by Frederick Osborn of New York City declared.

These people, representing probably some of our finest stocks, are located in the Appalachian Highlands, the Ozarks, the cut-over regions of northern Michigan, Minnesota and Wisconsin and they include marginal farmers and share-croppers in the South and the western wheat areas. The unemployed in our cities are also in the class of our population that neither produce nor consume in the sense of any broad exchange of goods.

One of the major tasks of society is to make these people into effective producers and consumers.

"If all our people could be brought to the level of the 25 per cent. who are at present our largest consumers, our total economic activity could be increased manyfold," Mr. Osborn declared.

Scientists were called upon to assume social responsibility for the consequences of their inventiveness, lest they find themselves in the subservient position of German scientists. Dr. Eduard C. Lindeman of the New York School of Social Work warned that "a technological age cannot afford to have its