versity, writing in the Jan. 31 NATURE, suggests that a simple diffusion mechanism may provide the necessary information about time and geographical location. During the initial stages of development, cells form embryonic fields, generally involving distances of less than 100 cells.

Dr. Crick's basic assumption is not new. As early as the 1930's, scientists suggested that a chemical diffuses through cells in a field, transmitting information as it goes.

Dr. Crick, by working the diffusion process out by what colleagues call "elegant mathematics," has revived the idea. An initial cell produces constant levels of an unidentified chemical called morphogen. It enters a line of cells at one end. As it diffuses through each cell in the line, it establishes a gradient of varying concentrations, which constitute positional information for the cells.

Dr. Crick's presentation may be too simplistic. "It is not his finest hour," says one English biologist. However, the simplicity may have been deliberate. According to Dr. Anthony Robertson of the University of Chicago, "Crick rightly holds that one should first look for the simplest explanation and discount it if necessary before concentrating on more complex phenomena. In a sense he's playing devil's advocate."

The second postulate, somewhat more complicated than Dr. Crick's but supported by preliminary evidence from experiments with the cellular slime mold and other extremely simple organisms, holds that time and place information is conveyed to cells by periodic pulses of chemical activity, initiated by a pacemaker cell. The pulses spread through an embryonic field to constitute an ephemeral map. This postulate is put forth by Dr. Goodwin, of the University of Sussex, and Dr. Cohen, of the University of Chicago. In papers soon to be published in SCIENCE, NATURE and the JOURNAL OF THEORETICAL BIOLOGY, Dr. Cohen, with Dr. Robertson, will present data from slime mold studies and other work.

The Goodwin-Cohen model, like Dr. Crick's, states that positional information is conveyed by a gradient, but in this case it is a gradient of frequencies established by periodic events rather than one set up by concentrations of a specific chemical. "Its action is analogous," says Dr. Robertson, "to the nervous system that operates according to electrical pulses."

Time lapse photography, which Dr. Robertson calls "the basic new tool of embryology," was used to study the development of a slime mold, an organism that is an aggregation of single-celled amoebas encased in a slime sheath. An initiator cell puts out pulses of a signaling agent—in this case, cyclic–3′5′–adenosine monophosphate (AMP), a hormone involved in most types of cellular metabolism. In response to the signal, neighboring amoebas begin to move toward the source in long streams, while putting out their own cyclic AMP signals in a chain reaction.

Streams of amoebas continue to migrate toward the source, piling up and pushing through a cone of slime until the developing mass falls over. The fallen mass is a slug with a body and a distinct tip or pacemaker region. That region, as in the aggregation process, continues to emit pulses from periodic cyclic AMP activity. These pulses move through the slug in waves causing bulges, followed by a phase of relaxation; in this way the organism moves.

If the pacemaker tip is removed experimentally, no movement occurs until a new region, somehow sensitive to the fact that its position in relation to the whole has changed, takes over to form a new tip and emit pulses.

Thus, the amoeba cells, once in the body of the slug, respond to their new position.

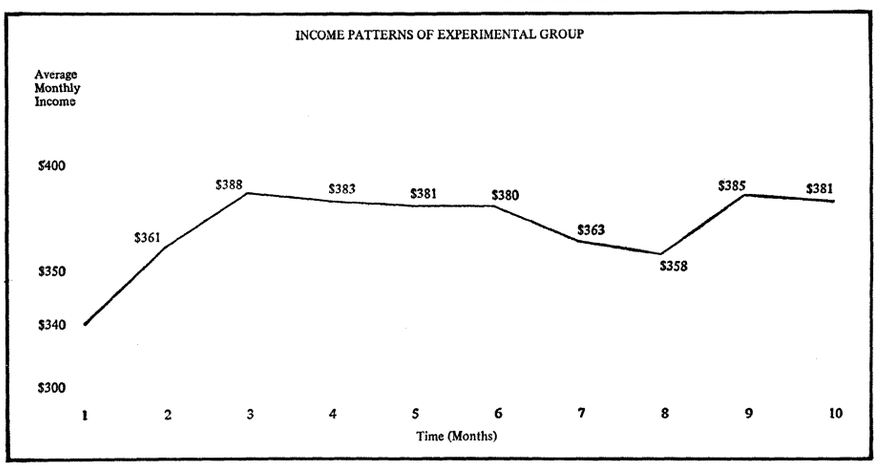
The essence of this theory of embryological development rests on the idea that biochemical events in cells and throughout tissues occur in rhythmic and periodic cycles that, in themselves, convey information.

It demands a complete reorientation for researchers steeped in molecular biology, which focuses primarily on events occurring within single cells more than on interactions among them. As Dr. Waddington points out, molecular biology has had its breakthrough. A similar breakthrough in the theory of embryology could lead to the same shifting of gears and an emphasis on cell behavior in time and space.

"Molecular biology and biochemistry," say Drs. Goodwin and Cohen, "tend to reinforce the deep-seated prejudice that differences of cell state are due to differences in the permanent, as distinct from the transient, biochemical composition of cells. . . . Our model makes clear the fact that, whereas at some stage of differentiation it is necessary for cell-specific substances to be synthesized, it is perfectly possible that the initial stage of the differentiation process involves differences of cell state which are strictly temporal." □

INCOME MAINTENANCE

Trying out the new plan



OEO

On the new welfare plan, families increased their average work earnings.

Although reforming the current welfare system is a project high on President Nixon's list of domestic priorities, the Administration's reform proposals have been in the House Ways and Means Committee since summer.

The committee is promising now to report out a welfare reform bill by April 1. And last week the President's proposals were given a boost when the Office of Economic Opportunity released the results of a study of a model income maintenance project that has been in operation—with input from several teams of university-based social scientists—since 1968.

The OEO project has been tried by researchers from the University of Wisconsin and Mathematica, a Princeton, N. J., research corporation, in Scranton, Pa., and in four New Jersey cities. It resembles Mr. Nixon's proposed welfare system in that the recipient families are guaranteed a set annual income. The 1,359 families involved in the OEO experiment were selected as representative welfare families: The average family contained five or six members.

The income-guarantee payment these families have been receiving has been set as a percentage of the poverty-line income of $3,300 per year. On the

average they have received $1,100 per family in annual income-guarantee payments. The question the OEO study attempts to answer is whether guaranteed payments have a deleterious effect on the recipients' work behavior.

Theoretically, the welfare families in the model program could have let their work income slide in proportion to their guaranteed income without being any worse off. That such a trend did not develop is demonstrated, OEO officials believe, by the study.

On the basis of the Mathematica-Wisconsin project, OEO officials conclude: "Apparently guaranteed income payments do not reduce work effort."

Although the work earnings of 29 percent of the model families declined after they began benefitting from the new welfare plan, 53 percent of the families have increased their work earnings in the course of the experiment. For the rest, there was no change in income. In a control group that received the ordinary welfare support, 31 percent earned less, 43 percent earned more and 26 percent earned the same.

The OEO study makes another point that should count as a plus for the Administration's welfare proposal: Administrative costs for a welfare system like the experimental one amount to $72 to $96 annually per family, compared to an estimated $200 to $300 annually for a family under the existing welfare system.

A question not answered by the OEO experiment is effectiveness of a work-training program, which the Administration wishes to incorporate into the proposed welfare scheme. According to Jody Allen, a programs analysis officer for the Department of Health, Education and Welfare, HEW is planning to begin an experimental income-maintenance project in Seattle, Wash., this summer that will test the costs and consequences of work-training schemes.

The Administration seems, on the whole, satisfied with the results of the OEO project, and is not encouraging more adventuresome experiments. Dr. John O. Wilson, assistant director for OEO and head of an interagency committee to coordinate the income-maintenance experiments, says the new HEW projects will be "quite similar" to the OEO projects. In the fall, the President placed a ban on experimenting with welfare reforms other than the ones he has proposed. Several spokesmen for a social research team who applied for a contract to operate the HEW projects say they were turned down because their proposals were "too experimental" and might produce results "difficult to manage." That contract ended up in the Stanford Research Institute.

So far, Congressional opposition to the President's welfare reform package has been surfacing from liberals who consider the program too limited, rather than from conservatives worried about the effects of an income-maintenance scheme on work behavior. A number of Senators are developing plans to increase the annual guaranteed benefit level above the $1,600 limit for a family of four recommended by the Administration. One, Sen. George McGovern (D-S.D.), is working on a reform welfare plan that would link welfare benefits not to a family's income level, but to the number of children in the family. McGovern estimates his proposal would cost up to $35 billion a year to operate, compared to an estimated $4 billion for the President's.

The OEO study does not say what, if anything, might happen to a welfare recipient's interest in working if his guaranteed benefits were raised considerably above the level that the Administration proposes. "We've experimented with a number of different guarantee rates," says Dr. Wilson, "but we haven't yet broken down our data enough to tell whether amounts have different effects on work income." But, he adds, "the preliminary indications are that it doesn't make much difference."

In any case, whether the final welfare reform bill is an expanded or a contracted version of the President's proposals, the Administration is convinced that the time is right to pass some kind of bill this year. Already, in fact, the Administration has earmarked some $500 million to begin financing a new welfare program in fiscal 1971. □

FOOD IRRADIATION

Strawberries, papayas, finfish

Using nuclear technology imported from the United States, Israel is producing irradiated potatoes and onions. The Dutch soon will be munching irradiated mushrooms.

And yet, ironically, the 18-year-old food irradiation program—aimed at increasing the usefulness of perishable foods by killing decay-causing organisms—is stalled in the United States (SN: 3/22, p. 287). Last year, in fact, things got so bad that the President's budget contained no funds for the Atomic Energy Commission's 1970 program, and the program was saved only by a recommendation of the Joint Committee on Atomic Energy that funds be diverted to it from other AEC programs (SN: 7/5, p. 69).

This year, the Army decided to terminate its program, but recanted because of the objections of Rep. Melvin Price (D–Ill.), chairman of the Joint Committee's Subcommittee on Research, Development and Radiation.

The Army's cancellation decision was prompted by the Food and Drug Administration's rejection, in 1968, of its petition to feed troops irradiated ham. Because the Army failed to prove to the FDA that irradiated ham was safe for human consumption, the FDA not only rejected the petition but rescinded its approval of irradiated bacon (SN: 8/3/68, p. 107).

Now it is the AEC's turn at bat. Last week at authorization hearings before the joint committee on the program's $280,000 budget request, officials revealed that the AEC would petition the FDA for approval of three irradiated foods. If approved, these will join irradiated white potatoes and wheat as candidates for the first irradiated foods the American consumer will eat. The three newcomers are strawberries, papayas and finfish (haddock and cod fillets). They were selected because, technically and economically, they offer the best chance of success.

The crucial factor that gives the AEC a better chance of acceptance than the Army is low dosage. The Army was bent on sterilization, wiping out all undesirable organisms, and so it used doses as high as 5.6 million rads. The AEC is aiming for pasteurization, a less extreme attack on decay-producing organisms. Pasteurization requires doses in the 50,000 to 250,000 rads range.

Of the three petitions, the one for strawberries will be submitted first. The results of a two-year animal feeding study will provide the basis for the AEC petition to the FDA around midsummer. A report will be ready in March.

The AEC is optimistic about the outcome. "Progress reports submitted during the study revealed no major problems, and the principal investigators believe that the data obtained will support a petition to FDA for clearance of this product for consumption," says Dr. John R. Totter, director of the AEC's division of biology and medicine.

Similar papaya and finfish studies are farther down the road. Two-year animal feeding studies on irradiated papayas are about eight months old, "and to date are proceeding without problems," observes Eugene E. Fowler, director of the AEC's division of isotopes development. "It is anticipated that a petition will be submitted to FDA during fiscal year 1972," he predicts.

The two-year animal feeding studies on haddock and cod have been postponed however, pending the outcome of microbiological studies. The problem here is *Clostridium botulinum*, the bacterium that causes the deadly food poisoning botulism. Before submitting a petition for haddock and cod, the AEC wants to ascertain that irradiation will not kill off all benign microorganisms that keep the botulinum microbe in check. If all goes well, two-year animal feeding studies on the finfish are expected to begin in 1972. □