cause many amino acids can be represented by any of several three-nucleotide sequences, amino acid order does not reveal the exact sequence of messenger RNA or DNA. Second, much of the DNA in a cell does not contain direct information about the structure of protein. For example, the stretches of DNA between genes for proteins may encode important instructions for protein production.

The path is now open to study "just about any gene you want," according to Baxter. A technique he and his colleagues recently developed can help determine the sequence of genes that make at least 2 percent of the messenger RNA in a cell. Moreover, the new technique does not require initial separation of messenger RNA molecules. Instead, all the messenger RNA is copied back to DNA, and that DNA is analyzed by sensitive methods (SN: 4/2/77, p. 216). Baxter identifies the resulting sequences by comparing them to known amino acid sequences.

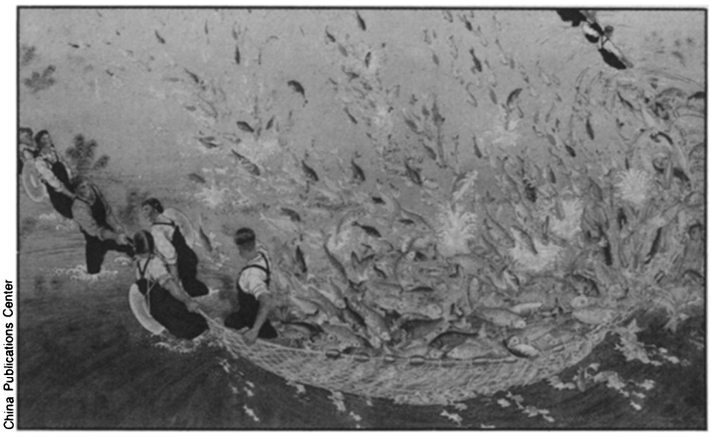
Interesting features of the human gene have already emerged. The region of messenger RNA coding for HCS ends with a stop signal, but only nine nucleotides past it is a second stop, as if a fail-safe device. The messenger RNA of the alpha globin chain also has a second stop signal, 90 nucleotides away from the first. The beta globin messenger RNA is the safest of all, with second and third stop signals backing up its termination, 60 and 87 nucleotides after the first.

Another surprising feature is found in the region of the HCS gene just after the second stop signal. A 24-nucleotide stretch reads identically (with one flaw) in opposite directions beginning at its center. The researchers suggest that this segment could bind a protein important for messenger RNA function. Mirror-image sequences, called palindromes, of a different type are known in bacteria, but such an arrangement of nucleotides has not been described in globin or other mammalian genes.

The work on human genes also demonstrates that nucleotide triplets, or codons, are used selectively to specify amino acids. For example, although there are six triplets that code for the amino acid leucine, one triplet (CUG) specifies more than 80 percent of the leucines in beta globin. The gene for alpha globin shows a slightly different selectivity, but in the parts sequenced so far there is again a striking bias toward using CUG for leucine.

This selectivity seems to reflect the specialized roles of cells, rather than species differences, Forget points out. The distribution of codons in the human globin genes is more similar to that in rabbit beta globin genes (as determined by Argiris Efstratiadis and co-workers at Harvard) than to the distribution Baxter and colleagues find in the HCS gene. The role of selectivity remains unclear, but the researchers agree that more cells and more genes must be analyzed. □

Science in China: Quakes, crops, lasers



China Publications Center

Painting of a commune fish pond by peasant artist of Husien. The carp are fed refuse, including sugar cane leaves and silkworm debris.

Having sponsored 19 delegations of American scientists on visits to the People's Republic of China and hosted 25 Chinese scientific delegations visiting the United States, the National Academy of Sciences has developed its own new breed of "Old China Hands." Three of them summarized their overall impressions about the state of science in China during the Academy's annual meeting last week in Washington.

Using a large manpower base of youthful volunteers, Carl Kisslinger, a University of Colorado geologist, says, the Chinese have a unique opportunity to collect data concerning earthquake precursors, since the country experiences five or six quakes a year with Richter magnitude greater than 6. "China certainly holds the evidence needed for the explication of some of the big questions of earth dynamics."

However, Kisslinger warns that little synthesis of knowledge and few theoretical breakthroughs can be expected from China as long as research there remains narrowly focused on immediate precursors, and the educational system excludes graduate study. Chinese seismologists, he says, now rely almost exclusively on theoretical interpretations of data published in foreign journals. This de-emphasis of theory and the absence of advanced training, he concludes, "will tend to diminish the quality of the work that might otherwise be accomplished."

Meanwhile, some direct exchange of seismic data may help scientists in the two countries make the most of each other's strengths. Kisslinger says the United States has also invited some young Chinese seismologists to take graduate courses here, but so far the offer has not been accepted.

The state of agriculture in China was reviewed by Arthur Kelman, chairman of the University of Wisconsin's Department of Plant Pathology. Since only about 11 percent of China's land is viable for raising crops, he says, the Chinese have become pioneers in intensive agriculture: "The countryside is a garden."

As an illustration of the intensity and efficiency of this effort, Kelman described in some detail what he calls the "ecologically closed system" of a silkworm commune. Leaves from cultivated mulberry trees are picked and fed to the growing silkworms in four-hour shifts. The excrement and debris left by the worms is then placed in fish ponds where improved strains of 3-foot-long carp are raised. These are periodically harvested and the silt from the pond is used to fertilize the mulberry trees. Debris from other crops raised on the commune is fed to pigs, whose droppings are in turn used to support a lucrative mushroom industry.

Many "midlevel" scientists are used to sustain and improve this system, Kelman says. He shares the concern about higher education expressed by the other speakers, but concludes, "I am not sure that the Chinese ought to invest in basic research in biology at a level equivalent to the U.S."

As an example of Chinese work in high technology, University of Illinois physicist Charles P. Slichter described applications of solid-state research in China. Beginning in the late 1950s, he says the Chinese began to develop semiconductor electronic devices, almost skipping the vacuum tube altogether. Now such technology has reached the stage of integrated circuitry like that in the United States in the late 1960s. He concludes, "I think that's truly remarkable."

Laser facilities and applied work on superconductors are also well advanced, he says, but again, the Chinese are apparently having to rely on theoretical breakthroughs abroad. By adopting what he calls a "following mode," scientists in China will probably be unable to catch up to the rest of the world with a lag time of better than three to five years, and then only in a few selected fields. Should policy on advanced study and basic research change, however, he says, China would quickly have a generation of young scientists "as good as any in the world." □