TELLING CELLS

by M. D. Bellomy

One of the most important jobs in cancer diagnosis today is that of the man or woman who is on "speaking" terms with human cells—the cytotechnologists, or screeners, who understand the messages formed by the cells in our bodies and who translate such messages into a language understandable to all. It is these men and women who, by microscopically studying our cells, can tell us whether or not we have cancer—while we still have no symptoms—at a time when there is little to fear from the disease.

Modern cancer cytology is a dynamic science. It utilizes some of the methods of many fields, applying the results to interpreting intracellular processes and determining the significance of cellular structure and functions.

Professor J. E. Harris of the University of Bristol says that cell physiology today is the common meeting-ground of the botanist and zoologist, of the biochemist and biophysicist, of the geneticist and the embryologist. To these should be added: of the cytologist and the cytotechnologist. The attention of all these specialists is focused on cell morphology—both normal and abnormal—since neither can be appreciated and their messages accurately interpreted without knowledge of the other.

One of the nation's largest and most modern Cytology Centers is located in the Cancer Institute at Miami, Florida. The aims and objectives of this nonprofit institute are a three-way attack on cancer. First, it is saving human lives by maintaining a diagnostic section (The Cytology Center), so effective in discovering cervical cancer in its early, curable stage that the incidence of this type cancer has dropped from 2.58 per cent in 1954 to 1.15 per cent in 1956.

Second, the research program of the Institute encompasses trace mineral and metabolic studies regarded so highly that the U. S. Public Health Service has made grants available for their continuation. The Institute's Live Cell Experimental Laboratory has contributed much to the better understanding of cellular growth and activity, and

its staff is presently concentrating on isolating and investigating a cancer immune factor found in many experimental animals.

Third, the Institute has established a cytology training center which is not surpassed in this country. In fact, the Miami Cancer Institute is one of a limited number qualified to turn out cytotechnologists. Many now employed by the Institute received their training there. One of these, Robert Scanlon, is chief cytotechnologist. Mr. Scanlon is a veteran of World War II and a University of Miami graduate. He studied cytology on a fellowship provided by the Institute's auxiliary woman's corps.

Mr. Scanlon says that his principal reason for studying cytology is the "newness" of the science and its great potential. He added that cells—of anything—always had fascinated him and he felt he could satisfy this innate curiosity at the same time he was helping rout a world-wide killer.

IN ADDITION to training cytotechnologists in the art of recognizing the health conditions of cells, the Institute also trains laboratory technicians, offers exchange courtesies to University of Miami students and holds an annual Seminar on Cytology for medical doctors. Physicians are offered a six-months cytology course and a one-year course; technologists a six-months course and a one-year course; a two-weeks course in laboratory technique in connection with cytotechnology also is given.

Physicians from many states and several foreign countries have enrolled for these courses. They have been anxious to learn so they could teach or apply the knowledge gained in their own communities, both in the U. S. and abroad.

But, in spite of expanded training programs, there are simply not enough cytotechnologists to supply the ever-increasing demand. Since more and more persons have already learned and many others are in process of learning, that today's best cancer protection is in early detection, cytology centers are literally "swamped" with tests. The prospective cytotechnologist will find no crowding in this field. In fact, he may see the day—and soon—when he will wish there were many more.

There is a great need for qualified screeners in many sections of the United States today, but in Central and South American countries the shortage is acute. The Institute receives many requests from Latin American countries to supply cytotechnologists for positions in the many cytology centers recently established and others nearing completion. Many of these positions will remain open for the reason that not enough men and women have learned to "tell" cells.

To comprehend the unique position of the cytotechnologist, it is

necessary for us to know something of cellular life and activity, and the great capacity for learning which the screener must have to understand the "language" of the cells.

In all animal and plant life, the basic unit is the cell. Man's organs are composed of microscopic cells, each one with the ability to function as an independent unit.

SIZES VARY. The human red blood cells average 7.5 microns in diameter. Other cells may be from 10 to 50 microns in diameter.

These cells, which differ greatly in shape as well as size, are classified according to their different functions; but all have certain structural attributes in common. There are hundreds of types, each one so complex that it challenges the efforts of many scientists. However, day by day, researchers are gaining a better understanding of how a cell functions and what changes occur under various conditions.

Of the billions of cells composing the human body, any one may be transformed into a cancer cell. This transformation appears to be gradual, sometimes taking days, months or even years.

All cells reproduce by dividing and differentiating into various forms. Every part of the body has its own type cells. In the adult, the multiplication of cells occurs only to replace those cells which have died, so that the organs are able to continue their normal functions.

Under abnormal conditions, the dividing cells may assume a bandit-like existence: instead of multiplying only in accord with body needs, they may divide at a greater than normal rate, resulting in abnormally proliferating tissue, until death is caused by their interference with the normal, vital functions of the body.

An interesting aspect of normal cell growth is that it is restricted by body controls. Cancer, to the contrary, grows without restraint until the organism dies. For any advance in the solution of the overall problem of cancer, emphasis must be placed on a study of the normal cell. It is only by this means that we may gain insight into the way in which a normal cell is transformed into a cancerous cell.

Normal cells that revert to the primitive, wildly-multiplying entity, may pass through four stages. The first is, of course, normal; second, inflammatory; third, precancer; and fourth, cancer. Then, to add complexity to complexity, each of these stages of growth may be divided into types. For example, among normal cells there is size variation of both the cell and nucleus. Young, immature (basal) cells are small and their cytoplasmic envelopes are uniformly round or slightly oval. Their nuclei are small and neat.

Slightly older or more mature (parabasal) cells also have round

or oval cytoplasmic envelopes but they are larger. Correspondingly, they have larger nuclei.

Next, we find the *Middle Type Cell.* These are still more mature, since they gradually replace the basal type. They tend at first to an ovoid or elongated shape which increases gradually in size and becomes ellipsoid or quadrilateral. When fully developed, the Middle Type Cell is two to three times the size of the basal cell and its cytoplasmic "raincoat" has become very thin, indeed.

Cells known as *precornified* are more mature and larger even than the intermediate type. They are wafer flat and have a hexagonal or octagonal shape. The nuclei of such cells, however, are not as large as those of the intermediate type.

Another cell type is the *cornified.* These are quite similar to the precornified in shape, size and small nuclei. J. Ernest Ayre's *Classification of Normal Cell Types* states: "The actual morphology of some of these cells is identical with that of the precornified cells, the only difference being that the staining reaction of the cytoplasm is orange-red."

And, finally here, we recognize the *hypercornified* or overmature cell. This is a truly strange type: it has entirely lost its nuclei (heart). This type cell is present in human beings only infrequently.

We could break down the other stages of cell development from normal through malignancy and we would find a great many grades, types, and classifications. However, one example is sufficient.

CELL SPECIMENS COME to the Cytology Center from physicians' offices in the community, from hospitals, and from physicians throughout the State of Florida, other states and foreign countries. With the exception of tests which are delivered by messenger from local hospitals or clinics, the cytologic specimens are sent through the mail, using the simple mailing technique described by Ayre and Dakin in 1946. Specimens may be mailed in a light envelope container, making airmail transportation possible, and thus speedier reporting of diagnoses.

In the receiving department, the tests are recorded and each patient's name is checked to determine whether a previous cytology test has been made. If it has, the slides and history are available for study along with the current test. The number assigned to the case and the name of the patient are stenciled into the glass specimen slide with a diamond pencil, to avoid any possible error. The slides are placed in 50-capacity racks. Material on the slides, when first received, is colorless. It is necessary to stain the slides in order to examine them more easily under the microscope. After staining, mounting and drying, slides are ready for microscopic examination, diagnosis and reporting.

What a colorful lot we would be if our body cells were all pale pink, with bright blue or purple nuclei shining like polka dots in each one. Unfortunately—at least for the cytotechnologists—this is not true. Normally, protoplasm—the stuff cells are made of—is transparent.

It is true that cell studies were undertaken long before a method for staining them was developed. However, the gap between normal cells and cancer cells is sometimes very slight and it may include many gradations, the exact differentiation of which is often an extremely difficult task.

THE DEVELOPMENT, by Papanicolaou, of a technique for staining cervical cell smears provided screeners with an effective and accurate way of "seeing" even slight differences in cells. Papanicolaou-stained slides reveal the form and size of individual cells, the concentration and distribution of chromatin in the nucleus, and many characteristics which are almost impossible to discern in unstained cells.

Although cytotechnologists seldom stain the slides they examine—except in emergencies—they must be thoroughly familiar with the operation.

The staining process is complex yet it is certainly worth the effort expended. The specimens to be stained are first immersed in a series of alcohol solutions, beginning with one containing 95 per cent alcohol, and continuing through successive changes from 70 per cent to 50 per cent alcohol, to distilled water. They must pass through such consecutive changes to water because the first dye has a water base.

Progressively then, the specimens are dipped in Haematoxylin, immersed in a 0.5 per cent aqueous solution of hydrochloric acid, rinsed under running water then dipped into a solution of lithium carbonate, back under the running water, then returned through alcohol solutions of 50 per cent, 70 per cent, 80 per cent, and 95 per cent, to remove water from the cells because the next staining solution has an alcohol base. The Haematoxylin solution provides the blue color of the nuclei seen in stained cells.

To prepare the slides to receive a second color, they are given one rinse in each of two 55 per cent alcohol solutions. They are then immersed in OG-6 which colors the red blood cells a bright orange-red.

For their third dye bath, the slides must be rinsed three more times in each of two 95 per cent alcohol solutions. They are then placed in a solution known as EA-36 which stains the cytoplasm either pink, blue or green depending upon the chemical make-up or maturity of each cell.

The process is completed by rinsing the slides three times in each of three 95 per cent alcohol solutions followed by two rinses in absolute alcohol to remove any water re-

maining in the cell. Two xylol rinses are then given the slides, to clear them for microscopic examination.

Finally, each slide is coated with mounting media and a thin glass coverslip is placed on top to seal in the stained specimen. Slides can then be retained for permanent record.

It requires about 35 minutes from the time the slides enter the first alcohol solutions to complete the staining process.

THE CYTOTECHNOLOGIST must, in addition to knowing how to stain the slides he or she may later study, be a skillful microscopist, have studied chemistry and biology, and must know something about photomicroscopy.

"By utilizing the microscope to form an image on a photographic plate or on a screen," says Dr. Clyde Walter Mason of Cornell University, "its advantages are greatly extended, and are made available to others besides the person manipulating the instrument . . .

"In a record or a report, properly prepared photomicrographs accompanied by a brief comment can take the place of pages of discussion of appearances which are impossible to represent by words alone. Similarly, a projected image of a microscopic object can save a great deal of more or less vague description, and insures that the same concrete idea is conveyed to the different observers. The photomicrograph has the advantages of convenience and permanency. . . . The photomicrograph print of the image on the screen may be seen by many persons simultaneously."

Women cytotechnologists far outnumber men. I discussed this trend with Dr. J. Ernest Ayre, Director of the Institute. He told me he knew of no reason why this should be true unless it was that, in the past, men, in general, seemed to think cytology was a science for and applied to women only. Certainly there is room for both men and women in this field.

He added, however, that women make excellent screeners. Their minds are quick, he said, and their eyes sharp—both of which are essential in the capable cytotechnologist. I asked him about qualifications. "The Institute prefers men and women with science degrees or those who have had some previous experience in microscopic techniques," he said, "but they must have completed two years of college or its equivalent and courses in biology and chemistry are prerequisites."

Some fellowships are available for qualified persons at the Institute and it is possible for trainees to combine part-time technical work with their training.

We hope the scientists discover that Mars is not inhabited. This country can't afford to stretch foreign aid any further—CLYDE MOORE

WHEN IT PAYS NOT TO WORK

by Joseph Arkin

Social and labor legislation can destroy the system that made America the industrial leader of the world...

A LUDICROUS situation has developed in the American economy whereby many workers find it more profitable not to work. Social and labor legislation have changed this country from a strict capitalistic state to a combination capitalist-welfare form of state. The Roosevelt and Truman administrations gave impetus to a movement for "welfare benefits" that far outstripped the countries of Europe, where the concept of providing protection for workers originated.

Opponents of such measures have constantly argued that the American worker is no longer thrifty, and that he has been robbed of his initiative while each day he becomes more dependent upon the government. The unemployed worker who finds it more profitable to draw unemployment insurance checks, and the farmer who puts his acreage into the soil bank, are the forerunners of the worker who will find that he can draw more from government and management pensions than by working.

Unusual? No. Take the situation of the employees of the New York City Transit Authority as an example. Recently they became eligible for social security benefits in addition to their city pensions. Since January 1, 1958, applications for retirement have poured into the offices of the Transit Authority, at a rate more than double that of the previous year. George Viger, senior accountant group chief of the Transit Authority cites these examples for the rush to retirement.

A motorman assigned to the IRT Division can at age 65 draw $108.00 per month from Social Security; a New York City pension of $145.00; and $89.00 from the pension fund of the old IRT when it was under private management. A total of $342.00 per month. Thus he has an estimated pension of $4,104.00 per year—practically all tax free—as opposed to his present net working income of $3,247.00.

Actually, he gains $857.00 by retiring, or in effect is paying over $70.00 per month for the privilege

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