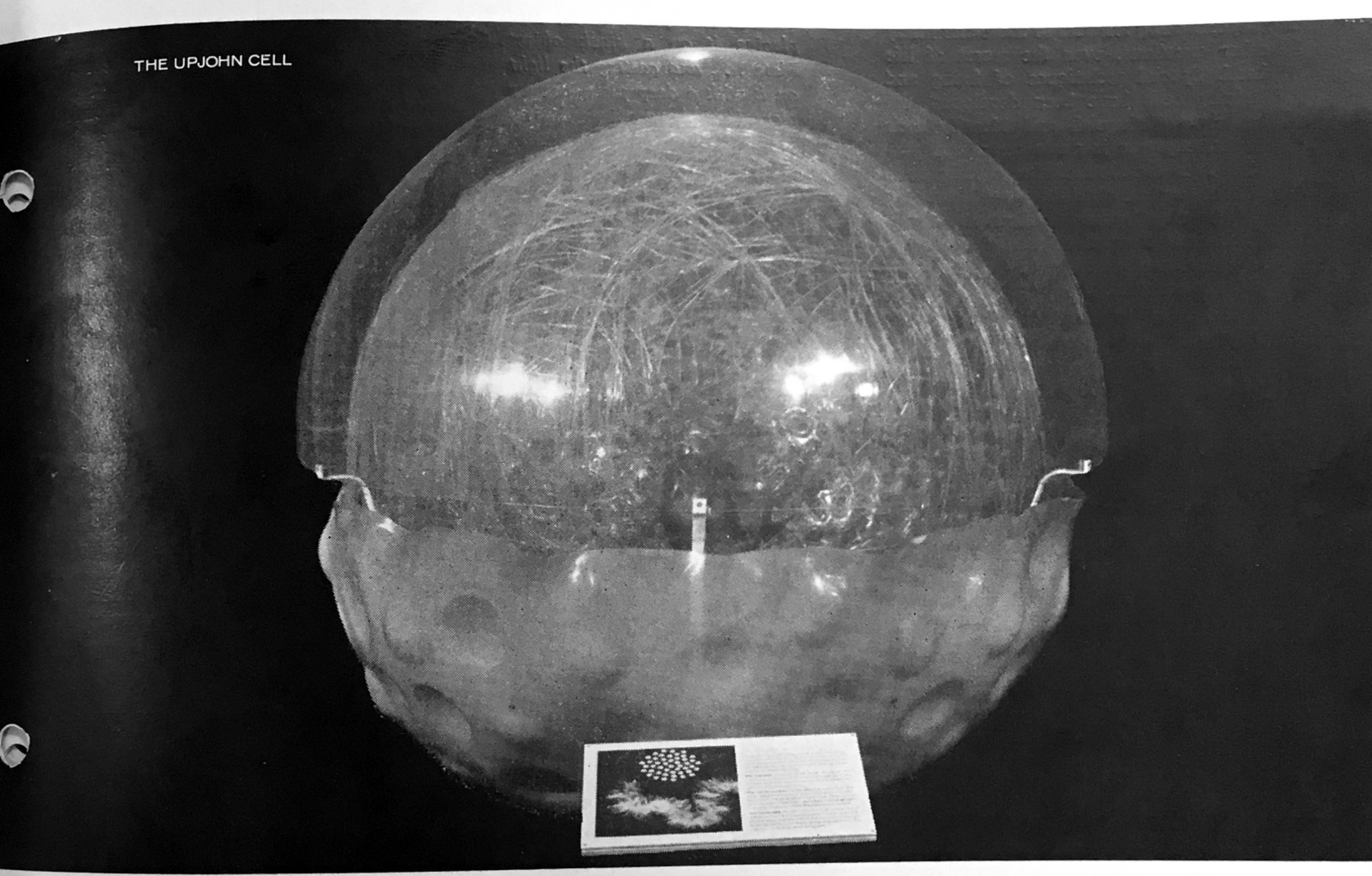
Victorian Cancer News

Registered in Australia for transmission by post as a periodical.

A Quarterly News Letter issued by the Public Education Sub-Committee of the Anti-Cancer Council of Victoria

No. 16 • APRIL-JUNE, 1963



The plastic model of a basic cell shown above is an attempt to interpret discoveries brought about by recently developed physical and chemical techniques. The model, designed for The Upjohn Company, was included in the American Cancer Society exhibit at the "Century 21" World Fair in Seattle, 1962.

SPECIAL FEATURE — THE CELL

"It is to the cell that the study of every bodily function sooner or later drives us. In the muscle cell lies the problem of the heartbeat and that of muscular contraction; in the gland cell reside the causes of secretion; in the epithelial cell, in the white blood cell, lies the problem of the absorption of food; and the secrets of the mind are hidden in the ganglion cell". (Verworn, 1895.)

THE CELL AND ITS MYSTERIES

by A. J. Brown

What is it that determines the difference between man, the ant and the elephant, between the towering mountain ash and the humble vegetable? How do the different tissues of the animal body develop from the embryonic cell? Why do certain cells in certain circumstances disregard the principles governing normal cell growth, set up their own rules of behaviour, and proceed on an abnormal and uncontrolled course of disorderly multiplication?

Scientists in many laboratories in many countries have long probed the mysteries of the cell under the microscope, seeking answers to these and many other questions, even the secret of life itself. Special techniques of fixing and staining cells have been developed, the better to distinguish and identify their structure. By an intricate centrifugal process, even the most elusive cellular components can be obtained from a solution of carefully "ground" cells; once separated, each component can be tested for its functional activity or analysed for chemical content.

The desire to learn more about these tiny particles of life, and the way they work together to build and maintain the vastly complicated machine that is the living body, has spurred the development of ever more powerful instruments of magnification. With the aid of the electron microscope, research workers are able to study the intricate structure of normal and malignant cells magnified up to 100,000 times. The technique of phase-contrast microscopy permits them to witness one of the most dramatic of all biological phenomena—mitosis or cell division: "the great act of 'self-copying and self-renewing', when what was one becomes two and there is no residue."

HISTORICAL BACKGROUND

But what is the cell and why is it so important to understand it? It is the fundamental structural unit, or basic common denominator, of all forms of life, whether human, animal or vegetable. All living things, from the most primitive one-celled organism to the trillion-celled human being, are made up of cells. We can in fact understand life itself only in so far as we apprehend the structure and function of cells.

The existence of cells as physical entities has been known since 1665, when the English physicist, Robert Hooke, first observed them in a piece of cork under his primitive microscope, and coined the word "cell" to denote these minute structures in the microscopic world he had discovered. Describing his experiment, Hooke wrote:—

"I took a good clear piece of Cork, and with a Pen-knife sharpen'd as keen as a razor, I cut a piece of it off, and thereby left the surface of it exceeding smooth, then examining it very diligently with a Microscope, me thought I could perceive it to appear a little porous; but I could not so plainly distinguish them as to be sure that they were pores . . . I with the same sharp pen-knife cut off from the former smooth surface an exceeding thin piece of it, and placing it on a black object Plate . . . and casting the light on it with a deep plano-convex glass, I could exceedingly plainly perceive it to be all perforated and porous, much like a Honeycomb, but that the pores of it were not regular . . . these pores, or cells, *were not very deep, but consisted of a great many little Boxes, separated out of one continued long pore by certain Diaphragms . . . Nor is this kind of texture peculiar to Cork onely; for upon examination with my Microscope, I have found that the pith of an Elder, or almost any other Tree, the inner pulp or pith of the Cany hollow stalks of several other Vegetables . . . &c. have much such a kind of Schematisme, as I have lately shewn that of Cork."*

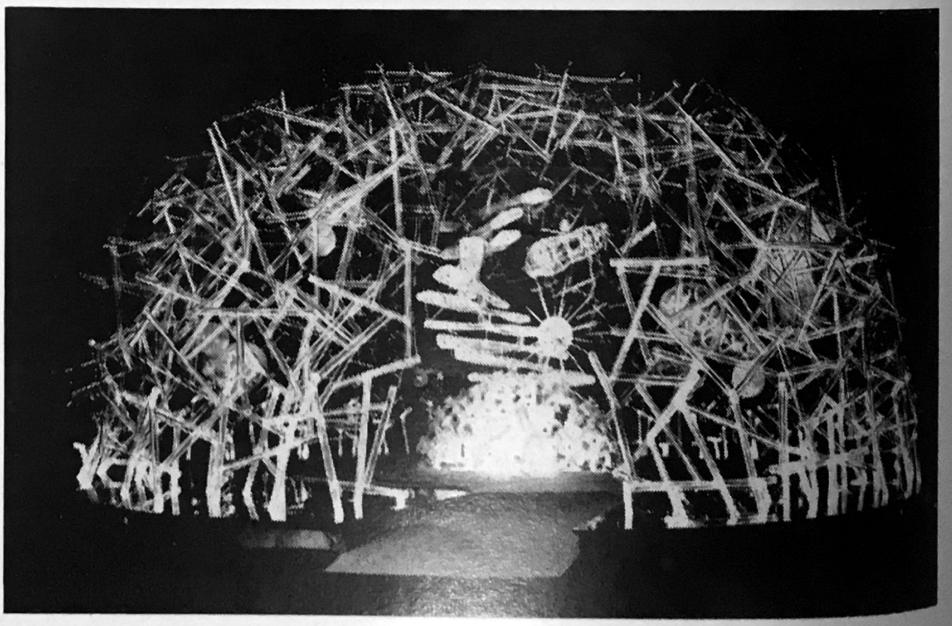
The realisation that all living organisms are composed of cells came slowly, however, and it was not until 1838-9 that the cell theory as we know it today was first formulated by two German scientists, M. J. Schleiden and Theodor Schwann. A zoologist, Schwann applied the concept to animal tissues and deduced that "cells are organisms, and entire animals and plants are aggregates of these organisms arranged according to definite laws."

The importance of the theory in the development of biological thought has been compared to that of Darwin's theory of evolution. Though its authors were not wholly correct in their conclusions about the origins of cells, and few of their ideas were original, they focussed attention on the essential structures that had to be investigated and understood if biological science was to progress. Twenty years later, another important advance was made, when the pathologist Rudolf Virchow established that no cell arises except from another. Thus it became clear that "life is an uninterrupted succession of cells. Growth, development, inheritance, evolution, disease, aging and death are but varied aspects of cellular behaviour."

BIOLOGY OF THE CELL

Most cells are so microscopic in size that they are invisible to the unaided human eye; some, for example, are so small that 250,000 could be placed on the head of a pin. They are of many different shapes; some are spherical, others are layered in flat sheets, still others are long

THE UPJOHN CO.



Another three-dimensional interpretation of cellular form and structure.

and hairlike. Cell shapes are determined partly by mechanical forces and partly by the function that each fulfils in the body of which it is a part. Thus muscle and bone cells are elongated and run parallel to the organ's long axis; the rounded shape of red blood cells, on the contrary, allows them to pass smoothly through the smallest capillaries.

Though cells with different functions have little in common so far as outward appearances are concerned, all share a common structure. Each is composed of a vital and mysterious substance called **protoplasm,** which in turn is subdivided into nucleus, cytoplasm and cell membrane. The limiting **membrane** surrounds the cell, holding together the mass of **cytoplasm**—a jelly-like material which fills the cell, distributing nourishment and oxygen, ridding the cell of its waste products and, depending on the function of the particular cell, manufacturing substances such as digestive enzymes, hormones, and so forth.

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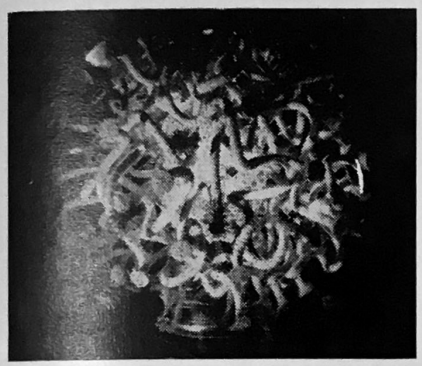


THE NUCLEUS OF THE CELL. The structure of the nucleus is particularly important to biological science because the chromosomes it contains transmit the cell's heredity.

Embedded within the cytoplasm is the **nucleus**, a dark, round, more or less centrally-situated body. Made up of nuclear material which forms chromosomes —thread-shaped bodies which transmit the heredity of the cell and the organism from one generation to the next—it is the most important part of the cell, regulating its growth and development, and determining its reproduction.

Protoplasm is a living material and makes the cell "alive". On analysis it is found to consist of representative amounts of the basic constituents of the body. A major part consists of water, but there are lesser amounts of protein, fat and carbohydrates and traces of salts, hormones, vitamins and minerals. Our diet is in fact determined by the requirements of the body cells for specific substances.

Just as discovery of the cell itself awaited development of the light microscope, so the incredible complexity of its internal composition is only now being revealed by the electron microscope. Optically empty parts of the cell are now seen to contain intricate and precisely organized structures unimagined before such magnifications became possible. Mitochondria, minute semi-solid bodies found in the cytoplasm of all cells, which appeared as simple rods under the light microscope, have emerged as complicated structures with a high degree of internal organisation. As finer and finer details come into focus, the relisation grows that here within the cell is a world of life in miniature —a whole universe waiting to be explored.

THE GROWTH OF MAN

"For Nature," wrote Lamarck in 1802, "Time is nothing . . . she always has it at her disposal; and it is for her the means by which she has accomplished the greatest as well as the least results. For all the evolution of the earth and of living beings, Nature needs but three elements — Space, Time and Matter."

What vast spans of time must have passed between the appearance of the first primitive one-celled creature on Earth, and the development of complex multi-cellular organisms, no-one can say. What is certain is that as soon as single cells began to join together to form communities, the ground was prepared for modification and specialisation of the function of the cells.

Whereas the single-celled animal exists independently of all others, the colony of cells, as H. E. L. Mellersh so aptly puts it in that excellent book **"The Story of Life"**, "knows how to combine and then how to acquiesce in specialisation and divisions of labour, so that a greater entity, a higher individual, is formed." Some of the cells assume responsibility for the function of absorbing food, others for that of reproduction, or for one of the many other roles required to form and maintain the composite entity.

This modification of cell function is characteristic of the development of all multi-cellular organisms and is accompanied by changes in the shape of the individual cells, fitting them for the specific task each must perform. Let us briefly consider, as an example, the case of man.

After fertilisation of the female ovum, or egg cell, has taken place, cell division and consequent growth proceeds at a rapid rate. In the nine months preceding birth, the human embryo grows from a nearly weightless single cell to a fully formed individual weighing about seven pounds and consisting of an estimated 2 trillion (2,000,000,000,000) cells. It is interesting to speculate what would happen if a baby were to grow at the same rate after birth as before. At eight months he would weigh approximately one hundred million pounds — 50,000 tons! Fortunately, Nature's controls operate to slow down cell division during infancy and childhood to a rate sufficient to maintain normal body development.

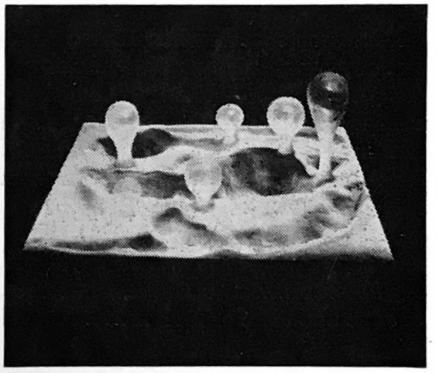
Very early in the life of the embryo the process of cell differentiation commences. In response to some unknown stimuli certain cells are changed in such a way that after subsequent divisions their descendants assume different and distinctive features, forming bone, muscle, skin, glands, and other special **tissues.** These in turn are organised to form **organs,** such as the heart, liver and lungs, which can undertake particular tasks essential to the life of the body as a whole. The organs themselves are organised into unified **systems** fulfilling various specialised functions—for example, the digestive and respiratory systems.

By the 20th year, cell division in many tissues has virtually ceased except to replace cells that have worn out or been damaged by injury or disease; when an injury occurs the healthy cells surrounding the damaged tissue reproduce to fill the wound. It has been estimated that some 2% of the 25-60 trillion cells comprising the full-grown human body are lost through death or injury every day. Thus billions of new cells must be manufactured daily to restore the loss.

The greatest rate of renewal is found in the skin, the male gonads, the intestines and the bone marrow. The liver cell, on the other hand, appears to have a life of about 18 months, while the highly differentiated nerve cells are present at birth in their full quota and are irreplaceable in the event of their destruction.

It is little wonder that the human body is often compared to a machine — one that is infinitely more complex, and performs infinitely more tasks, than any machine man has yet been able to construct.

THE UPJOHN CO.



THE CELL MEMBRANE, based on electron micrographs of membranes from rat tissues. The complicated contour, with its deep outpouchings and infoldings, is important in establishing a large area of contact between cells.

THE RIDDLE OF CANCER

Among the myriad questions concerning the cell that science has yet to answer, those relating to the problem of disordered cell growth are perhaps the most intriguing. From the very beginning, the normal growth process demonstrates a controlled and purposeful pattern of development. Throughout, it is subject to and responds to inherent limiting influences, so that when its purpose has been achieved and maturity reached, growth comes to a halt. A delicate balance is maintained between the various tissues and organs, enabling each to perform its preordained tasks efficiently and with due regard to the overall requirements of the organism of which it forms a part.

In some individuals, for reasons that are not yet clear, this biological balance and control no longer seems to function as it should. The pattern of normal growth is disrupted, cell division takes place erratically and without purpose, and the cells thus produced group together to form an abnormal mass or **tumour.**

Many tumours, such as warts and cysts, consist of cells which, although multiplying in excess, remain in a well-circumscribed community and do not spread beyond a limited area. Since they do not as a rule endanger life, they are said to be **benign.**

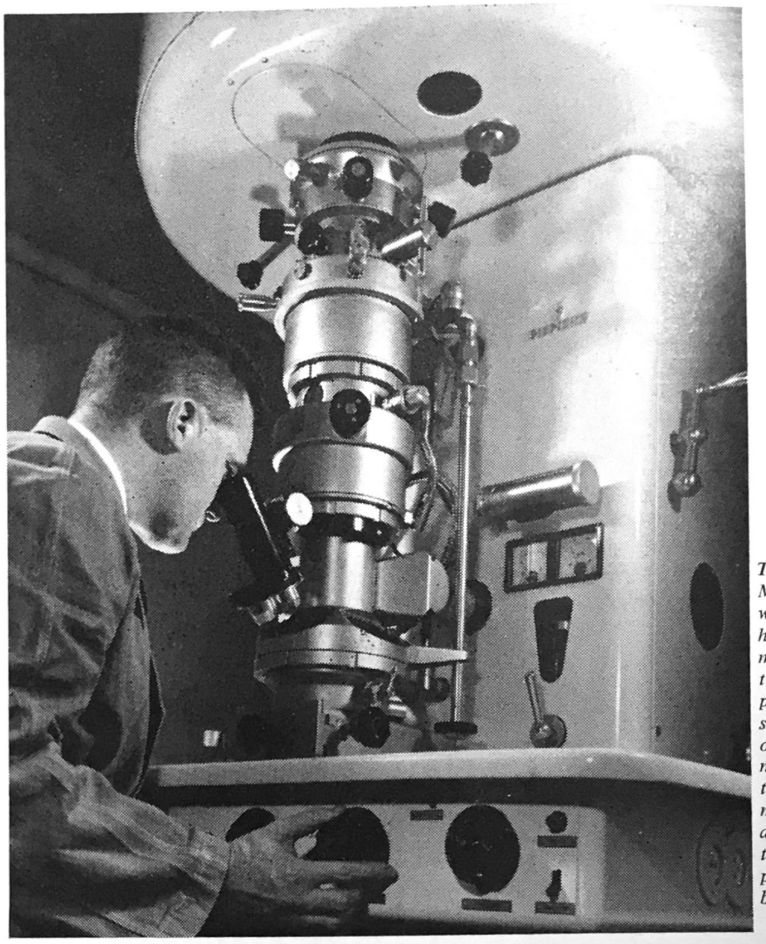
Other tumours, however, are not limited in their growth in this way. Their cells may infiltrate into surrounding tissues, robbing neighbouring cells of nourishment and bringing about their destruction. An even more dangerous characteristic is their ability to "metastasise", or spread. Invading the walls of lymph canals and blood vessels the migratory cells enter the circulatory system, through which they are borne to distant parts of the body where "secondary" colonies of growth are established. This type of tumour—because its cells, unless controlled by proper treatment, continue dividing indefinitely and will eventually destroy tissues or organs essential to the life of the organism—is called **malignant,** or cancer.

Microscopic comparison of the structure of normal and cancerous cells reveals many significant differences. The cells of a malignant tumour tend to be misshapen and irregular in size, and to lose the distinctive features characteristic of neighbouring normal cells in the same tissue. Further, they frequently reproduce in an apparently uncontrolled way, dividing not one into two and two into four, but one into three or four or five.

PROGRESS IN RESEARCH

Intensive study of these abnormal cells, which have caused mankind so much fear and suffering, goes on unceasingly—to discover how malignant cells derive from apparently normal cells, what causes them to act in this way, how to control their rapid and unruly growth, and so on. These and many other questions remain unanswered, but research has made some progress.

The known differences in the behaviour and structure of normal and cancer cells have enabled scientists to develop a number of chemical compounds which are temporarily effective in controlling some forms of malignant disease. The 20 or 30 substances now in standard use are of several types. Some are cell poisons intended to interfere with the process of cell division, and thus to inhibit the growth of cancer cells. Others, the metabolic antagonists, are intended to starve malignant cells by blocking vital metabolic processes. Certain hormones have been found to control for varying periods the growth of some hormone-dependent cancers, such as those of the breast and prostate, by modifying the hormonal environment.



THE ELECTRON MICROSCOPE, with magnifications as high as 100,000, has made it possible for the scientist to explore the ultra-fine structure of cells and organisms. Its immense power of detecting the most minute detail has enabled research workers to determine certain physical differences between normal and cancer cells.

But of all the secrets deciphered through the study of cells, perhaps none is more dramatic and has greater possibilities than a technique, developed by Dr. George N. Papanicolaou in the United States, that points the way to a new means of cancer detection. This procedure relies for its effectiveness on a natural process that takes place in the body cycle.

Worn-out and damaged cells, as we have seen, are continually being replenished through cell division. As the new cells push up from below in the process of growth, old cells are dislodged at the surface and are washed away in mucus. This happens both in normal and abnormal cell growth. Microscopic examination of a sample of this fluid thus provides a valuable guide to the type of cells being dislodged from nearby tissues. The presence of abnormal cells in the sample, even without other symptoms, suggests that cancer may be developing.

Cells studied in this way come from the lungs, bronchial tubes, stomach, bladder or other accessible sites. The majority, however, come from the neck of the uterus, one of the most common sites of cancer in women. Early detection of cancer of this organ through the cell or 'smear' test has been so successful that many doctors believe this form of the disease could virtually be eliminated as a cause of death if the examination could be given regularly to all women.

Despite years of painstaking research and some brilliant achievements our scientific knowledge of the cancer cell's origins and behaviour—or, for that matter, of the mechanism of normal cell division, and growth—is far from complete. But the accelerated pace of scientific investigation, aided by new techniques and instruments, is probing ever deeper into the mysteries of the cell, adding new facts to our stockpile of knowledge and providing a more rational basis for the fundamental study of disease and its alleviation. The day may not be too far distant when the untiring efforts of research workers throughout the world will provide the answer to that most perplexing phenomenon of cell growth—cancer.

DISSECTING THE GUILTY CIGARETTE

OF MICE AND MEN AND LUNG CANCER

Numerous research projects into all aspects of the relation of smoking to ill-health, particularly lung cancer, are now under way in many countries. They are being supported by national cancer societies, governmental authorities, medical research institutes and university departments, and by various tobacco companies. The following account of the work of the British Tobacco Research Council appeared in "The Herald" on April 20th, 1963. We reprint it with grateful acknowledgements to The Herald and Weekly Times Ltd.

Some of the world's strangest cigarettes have just been made in Britain—eight million of them. They have been given the brand name "T One", but they will never be sold to the public. They are for MICE.

Each represents the "average British cigarette", blended from all the tobaccos on the market. Each will be smoked in the "average British way", 11 puffs a minute, each puff lasting two seconds, with a thousandth of a litre of smoke dragged through the butt each time.

The actual smoking will be done not by mice, but by machines. The smoke will be condensed—turned into a liquid by trapping it in ice-boxes. And it is this which will be given to the mice—by painting it on to their flanks.

The Brand T One experiment is one of a host of new projects now being launched by the Tobacco Research Council to throw fresh light on the relationship between smoking and lung cancer.

(By the end of this year the Tobacco Research Council, formerly the Tobacco Manufacturers' Standing Committee, will have spent £1 million on research into smoking since 1956.)

If the concentrated liquid tobacco smoke sets going any tumours in the mice, scientists will then break it down into its different constituents and try these separately for any cancerous effect. A culprit chemical may thus be pinpointed.

Mr. Geoffrey Todd, the Tobacco Research Council's director, told me today: "Research to date suggests that if you paint mice with huge doses of the liquid concentrate several times a week over the whole of their life-span you can spark off tumours in a few. But the doses needed represent smoking thousands of cigarettes a year.

"At present, nobody can say what chemical in condensed smoke is able to cause tumours in mice. Nor do we know if what happens in the body of a mouse can be applied to the lungs of a man. But if all the research we are doing on animals points in the same direction, then we shall feel confident we are on to something of importance to humans."

The work has started in the Council's new £250,000 laboratories at Harrogate. Machines there are already puffing away at the Brand T One cigarettes. More than 8,000 mice will be used in the research. All are female and have been specially bred in completely sterile conditions so that they are free from disease.

Mr. Todd also told me about another important research project, to be started next year. The tobacco for it is growing now in Mexico. At the end of the season it will be harvested and divided into two. One batch will be cured slowly in the sun; this is how cigar tobacco is dried, and results in a dark leaf.

The other batch will be hung in barns over flue-pipes heated by an oil-burner. This is the curing process used for British cigarette tobacco, and the heat quickly turns the leaf a golden colour.

PUFFED SMOKE

Two brands of cigarette will then be made. Smoke from each will be condensed and painted on separate colonies of mice, but some of the smoke will be puffed directly at the animals so that they inhale it. The purpose of this test is to find out if there is anything in modern tobacco curing methods which might cause cancer.

The same brands of cigarettes will be used to explore another possibility—that smoking may trigger cancer in lungs which have been attacked by a virus.

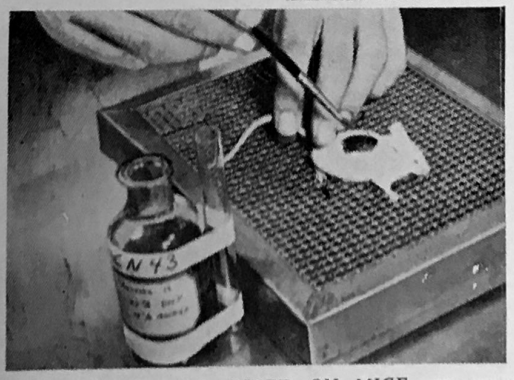
Two American scientists—Paul Kotin and Dean Wisely, of the University of Southern California—found a hint of this recently when they dosed 1,800 mice with flu virus and choking, Los Angeles-type smog. None of the animals inhaling smog alone developed tumours. Only 11 of those injected with flu virus did. But 33 of the mice which received both insults to their lungs went down with cancer.

These, incidentally, are the only known cases of lung cancer being artificially induced in an animal.

ARE GERMS TO BLAME?

Some rats whose skin has turned mahogany brown from nicotine in the 65 cigarette-a-day smogs in which they have spent the whole of their lives, are completely disease-free. This leads one to suspect that human smokers are attacked by germs, or have some additional factors in their make-up, which lay them open to lung cancer where animals are not. For this reason, the Tobacco Research Council is giving £500,000 towards a massive 10-year study by the London School of Hygiene with the aim of getting at the root causes of all respiratory disease.

AMERICAN CANCER SOCIETY



TOBACCO TARS PAINTED ON MICE can cause skin cancers. This is one link in the chain of evidence connecting lung cancer in humans with cigarette smoking.

Mr. Todd explained: "We want to find out why Mr. A gets lung cancer when Mr. B and Mr. C don't—is there something about him that is different from the rest?

"We may well end up with a list of 10 characteristics which add up to a lung cancer 'type'. It might be possible then for a man to go to his doctor and be told: 'You have all 10—you are in the high risk category—I advise you not to smoke'. Or for another man to be told: 'You have none of these characteristics—go ahead and smoke to your heart's content'."

Mr. Todd added: "We have tried to lay down a balanced research program—to put a whole host of popular ideas on a scientific footing. With a bit of luck we might obtain some important leads within four or five years, but it is becoming obvious that there are many other factors involved in lung cancer apart from just smoking."

There I left Mr. Todd. But from other inquiries I have made it is now possible to summarise the smoking-lung cancer story to date like this:

NOBODY can deny that there is a link between the two. But nobody has proved that smoking is the sole culprit.

ANIMALS have never been given cancer by inhaling cigarette smoke.

NOBODY is sure what constituents in cigarette smoke are harmful.

The result of the trend towards smoking "filter-tips" will not be apparent for 30 years. The cancer mortality figures of the 1990s will show their true value.

ELIMINATING FACTORS

It is most unlikely that the temperature at which a cigarette burns is an important factor.* By the time the smoke reaches the mouth it is cool.

It is most unlikely that cigarette paper is a factor. It forms only three per cent of a smoke. Cigarettes made entirely out of paper have failed to cause tumours.

Manufacturers' printing ink has been ruled out. So have petrol lighters.

The way in which tobacco is cured could be a factor.

There are grounds for suspicion that cancer may strike in already-diseased lungs, or lungs scarred by a virus.

There is reason to wonder if smoking may not prematurely age some lungs, so that the local mechanism for controlling growth of cells there fails.

The quest for truth goes on.

NOTE: Many research workers would disagree with the view expressed here that the burning temperature of cigarettes is unimportant. Some scientists have suggested that the high temperatures at which cigarettes burn while actually being smoked (700° to 850°C.) could account for the production of cancer-causing chemicals during combustion. If this is so, the lower burning temperatures of pipe and cigar tobacco would help to explain the lesser risk of developing lung cancer experienced by pipe and cigar smokers.* — **Editor, "V.C.N."

CELL EXAMINATION: NEW WEAPON IN CANCER DIAGNOSIS

by Carlotta Kellaway and A. J. Brown

The development of scientific methods of diagnosis in the present century can be counted a major advance in the fight against cancer. By revealing the presence of malignant growths while they are still "localized", or confined to the immediate body areas in which they originated, these techniques help to save thousands of lives each year.

Twenty-five years ago doctors cured only one case of cancer in every four they treated. Today, following notable advances in surgical techniques and in methods of radiation treatment, the figure is one in three. With the wider application of available methods of cancer detection, many authorities claim that half of all present cases, or one in two, are potentially curable.

DANGER OF DELAY

The problem is to detect the disease at the early or "localized" stage, so that all cancer cells in the body can be removed by surgery or destroyed by radiation. Delay in diagnosis and treatment may allow time for some of these outlaw cells to break away from the primary growth and to be carried by the lymph channels or blood vessels to other parts of the body.

This process, known as "metastasis", may be retarded temporarily by the body's own protective mechanism. Neighbouring lymph nodes may trap for a while the migrating cancer cells and thus delay their spread. At this, the "regional involvement" stage of the disease, cure is still possible in many cases, although the outlook is less hopeful than with localized cancer (See Table).

Once cancer cells have spread beyond the regional lymph nodes the disease is regarded as "advanced" and there is relatively little prospect for cure, although much can be done to prolong life and palliate the effects of the disease.

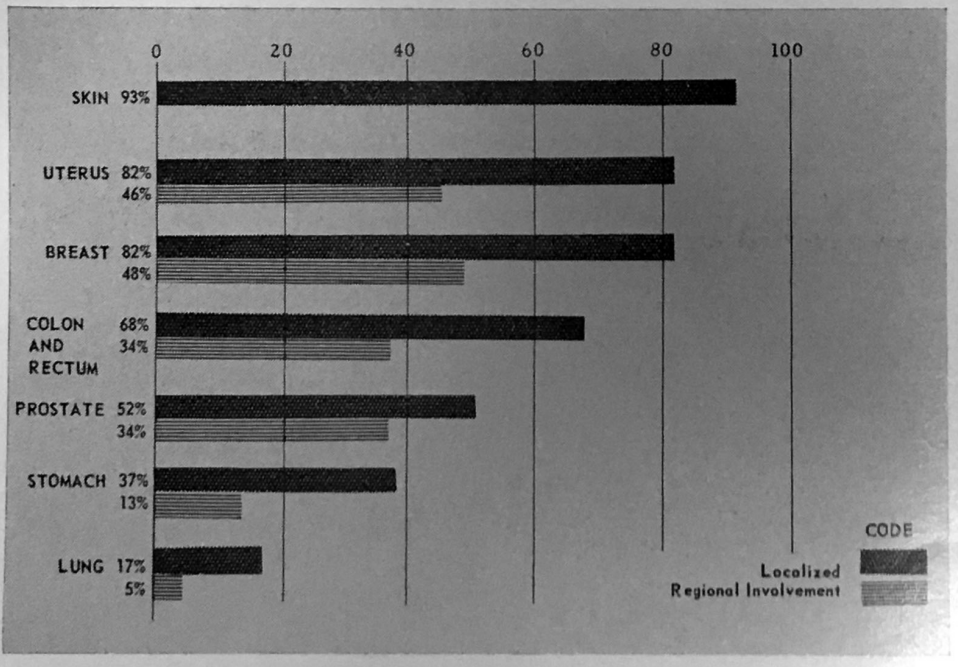
EARLY DETECTION

What steps then can be taken to ensure that diagnosis is made as early as possible? Much rests on the patient himself, whose promptness in reporting any possible cancer symptom to his doctor will materially improve his chance of cure.

At present the discovery of cancer is often delayed because many people feel that **their** symptoms are not serious enough to warrant medical attention. A continuing public education programme is therefore necessary to alert all adults to the warning signs of the disease, and to the need for prompt action when one is noticed.

Some authorities believe that the most effective safeguard against cancer is a routine annual check-up, so that the presence of any symptoms may be detected at the earliest possible stage.

FIVE-YEAR CANCER SURVIVAL RATES FOR SELECTED SITES



THE IMPORTANCE OF EARLY DIAGNOSIS AND TREATMENT OF CANCER is illustrated by the above table. It shows the five-year survival rates of cancer of several common sites when treated in the "localized" and "regional involvement" stages. The "advanced" stage is not included since prospects for cure are generally so unfavourable. The figures were reported at the 4th National Cancer Conference, U.S.A., 1960. (N.B.—Five-year survival without recurrence is generally regarded as a "cure," although the disease may subsequently recur in some cases.—Ed.)

CONFIRMING THE DIAGNOSIS

When cancer is suspected, the steps taken to confirm the diagnosis follow a carefully-planned routine, beginning in the general practitioner's surgery and ending in the pathologist's laboratory.

The family doctor, with his detailed knowledge of the patient's medical history, plays an important part in the discovery of early cancer. After listening to the patient's account of his symptoms, he performs a thorough physical examination to determine their cause. Most external cancers are readily diagnosed, but it is often difficult to detect internal growths in their earliest stages by examination alone. For this reason it is often necessary to arrange for a number of specialised investigations, which may include X-rays, laboratory tests of blood and urine, or visualisation of one or other of the internal organs by means of special viewing instruments.

THE BIOPSY

The presence of cancer can be identified with certainty by means of a "biopsy", that is, the microscopic examination of a minute piece of tissue removed from the growth. The pathologist who carries out the examination is able to tell from the appearance of the cells in the tissue sample whether the growth is actually cancerous, and if so, the type of cancer present.

If the tumour is readily accessible, the specimen may be obtained by the family doctor at the first examination, but as a rule the biopsy is performed during one of the special investigations or in the course of an exploratory operation. In the latter case the pathologist, after studying the tissue under the microscope, is generally able to make an on-the-spot diagnosis. This information is immediately relayed to the surgeon, who is then able to decide what operation, if any, is needed.

A further examination is often made of the total excised growth after the operation to determine the need for and nature of any future treatment, whether surgery or radio-therapy, that may help to protect the patient against any recurrence of the disease.

Until recently, the role of the pathologist in cancer diagnosis has been largely concerned with the laboratory examination of specimens from patients with symptoms of the disease. Despite the diagnostic aids at the doctor's disposal, the detection of early localized cancer, before it has given rise to any noticeable symptoms, remains a major problem.

THE CELL TEST

For years doctors and scientists searched for a simple and sure procedure that would reveal cancer at its earliest and most curable stage. Such a means for the early detection of some cancers is now available. Known as the "cell test", it is being applied on an increasing scale in Australia in connection with one of the most common forms of cancer in women—that affecting the uterus, or womb.

One British expert who visited Australia recently predicted that if every woman over thirty years of age was given an annual examination, including this test, the cure of cancer of the womb would become an achievable goal in virtually all women who develop the disease.

The man chiefly responsible for developing cell examination as a practical procedure was Dr. George N. Papanicolaou, a Greek scientist who had settled in the United States. During the 1920's Dr. Papanicolaou was investigating the various types of cells shed or "exfoliated" by the uterus and vaginal lining at different periods of the menstrual cycle.

These cast-off cells accumulate in the normal fluid secretions, and in the course of his research he noted in some samples of secretions a number of cells with abnormally large nuclei. He was able to determine that these abnormal cells were in fact malignant, and that their presence indicated the growth of cancer in the parent organ although no other symptoms were yet visible.

Dr. Papanicolaou perfected a method of withdrawing small samples of secretions, placing them on glass slides, and staining this "smear" with special dyes which made the cells clearly distinguishable. Since there are generally distinct structural differences between normal cells and their malignant counterparts, the nature of the cells present in the sample could then be accurately determined by microscopic examination.

Despite his success in detecting early cancer in this way, it was not until some 25 years later that Dr. Papanicolaou's revolutionary technique began to gain acceptance as a practical and reliable means of cancer detection. Subsequent field trials in the United States, the U.S.S.R., Canada and elsewhere have put beyond doubt that it can be usefully employed on a mass basis. In these trials about five women out of every thousand examined, proved on the average to have unsuspected uterine cancer. Detected at this symptomless stage, the cure rate for this form of the disease is close to 100% —one of the brightest prospects in cancer control today.

SKILLED TECHNICIANS AT THE ROYAL WOMEN'S HOSPITAL, MELBOURNE, study slides of cells in body fluids, looking for abnormalities suggestive of cancer.

HOPES FOR THE FUTURE

Cell examination, or cyto-pathology, is fast becoming a major diagnostic tool, and seems likely to become even more important in the future. It is not, however, a precise test that can determine with absolute certainty that cancer is present and its exact site. For this a biopsy is essential. But it can, and does, point to suspicious areas of tissue that warrant a biopsy—long before any other symptoms of disease make their appearance.

Its proven success in detecting localized cancer of the uterus now forms the basis for extensive research as to how the technique may be applied to other parts of the body from which cell samplings may be taken. Already some success has been achieved in evolving methods for detecting cancer of the stomach, lungs, rectum and kidney. For the immediate future, however, uterine cancer is the most promising target, because of its nature and adaptability to mass screenings, and the exceptionally good prospects it offers for complete and permanent cure.

The Anti-Cancer Council has encouraged the development of cell examination services in several Victorian hospitals by providing funds for the purchase of equipment, and for training pathologists and technicians in the specialised techniques. It has also assisted in setting up a pilot scheme for a Cancer Detection Centre at the Royal Women's Hospital. The Council is continuing its efforts to expand facilities for cytological diagnosis, which are neither as freely utilised nor as generally available in Victoria as is desirable if cancer is to be brought more fully under control.

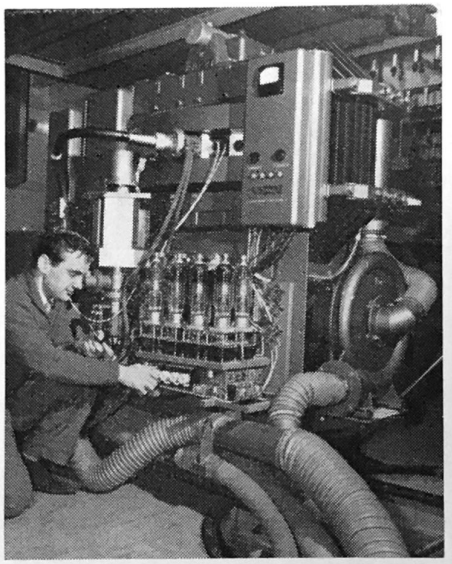
TREATMENT STUDIES UNDER WAY ON NEW MACHINE

Physicists from the Peter MacCallum Clinic are testing the cancer treatment applications of the most powerful electronic equipment in Australia — Melbourne University's atom-smashing Betatron, which has a maximum energy output of 35 million electron volts. By arrangement with the University, the Clinic staff have access to the machine for 10 hours each week to take physical measurements of the electron beam. Overseas experience has shown that the streams of minute electrical charges produced by the Betatron can be effectively used in treating some forms of cancer.

The results of the studies now under way may have an important bearing on future developments in the treatment of cancer in Victoria.

Apart from these investigations, the Betatron is being used for pure research by members of the Physics Department staff under the supervision of Dr. B. M. Spicer, associate director of nuclear research. Since its installation early in March, Dr. Spicer and his colleagues have completed an experiment to determine the photo-neutron cross-section of calcium-40. At least another 20 experiments involving the disintegration of atomic nuclei of other materials are presently under way or listed for study in the coming months.

The Anti-Cancer Council contributed towards the total cost of £100,000 required to purchase and instal the machine in radiation-proof premises at the University.



Mr. Peter Byrne, technical officer, engaged in maintenance of the Betatron at the Physics Department, University of Melbourne.

CO-OPERATIVE STUDY OF LEUKAEMIA

Children's hospitals throughout Australia are taking part in a group study of the effects of anti-cancer drugs in prolonging remissions of symptoms in acute leukaemia. The study, sponsored by the Australian Cancer Society, involves the use of drugs with proven effect against the disease in patients aged up to 14 years, and does not duplicate any project in progress elsewhere.

Chemotherapy for acute leukaemia in childhood has made significant progress during the past 15 years. Worthwhile remissions can now be produced in at least 80% of patients, and the average length of the period of survival is more than a year. The problem with each of the various drugs used in treatment, however, has been the development sooner or later of resistance to its anti-leukaemic action. Recent work suggests that the growth of drug resistance may be delayed by using the available drugs in rotation, discontinuing each drug and replacing it with the next before resistance has developed.

This is the first time that clinical workers in all States have joined together to pool their experience in leukaemia treatment. They will all keep to the same strict plan in studying their patients. This combined teamwork will produce the answer more promptly than if each doctor worked in isolation.

The stimulus for the study has come from the work of the group's chairman, Dr. John Colebatch, at the Royal Children's Hospital in Melbourne. Dr. Colebatch recently returned from a tour overseas as the Anti-Cancer Council's Robert Fowler Travelling Fellow for 1962, during which he investigated the latest developments in leukaemia treatment.

CONTINUING SUPPORT FOR EDUCATION CAMPAIGN

The development of a healthy public state of mind with regard to cancer is of vital importance in combating the disease. The growing public support for the Council's education programme is therefore encouraging evidence that ignorance, superstition and unreasoning fear of cancer are slowly being dispelled.

The Country Committees are continuing to play a vital part in this campaign. In the Loddon Region the Conference sponsored by the Bendigo Regional Committee in February has led to an intensification of cancer education activities. A vigorous two-day programme in Echuca included three public meetings, lectures on smoking and lung cancer to 800 schoolchildren, literature distribution and press and radio publicity. The Castlemaine and Kyneton Committees are planning similar programmes in association with local community groups.

The Hamilton Regional Committee has also been very active. The support of local service clubs and the C.W.A. was enlisted to plan an intensive "Education Week" in May. Featuring public and group meetings, film screenings, school talks, door-to-door distribution of folders and handbills, and a display in the Art Gallery foyer, the programme received excellent press and radio publicity. Over 1,000 secondary and technical school students were addressed on smoking risks.

For the second year running it is planned to have an anti-cancer exhibit at the Royal Melbourne Show, while the Mobile Unit will visit the Shows at Bendigo, Geelong, Hamilton, Shepparton and Wangaratta.

PLANNING "CANCER EDUCATION WEEK" AT HAMILTON. Left to right are: Mr. R. R. Whitelaw, Secretary of the Hamilton Committee; Mr. A. J. Brown, the Council's Education Officer; Mr. E. J. Gleeson, Chairman; and Mr. J. Ashworth, Director of the Hamilton Art Gallery. The display is in the Art Gallery foyer.