LIGHT, PIGMENTATION, AND NEW GROWTH.*

BY

WILFRED WATKINS-PITCHFORD, M.D., F.R.C.S.,

GOVERNMENT PATHOLOGIST, NATAL.

A CELL, or cells, of an otherwise healthy body may give rise, by fission, to "cancerous" progeny.

Cancer appears as an unregulated process of growth, the possibility of which has probably existed from the times of man's earliest ancestors. The process will be most fruitfully investigated when it is considered as one to which the whole community of metazoan life is liable.

Microscopically examined, the initiation of carcinoma proves to be a multiplication of epithelial cells in the *wrong direction*, of sarcoma, an *uncontrolled frequency* in the multiplication of connective tissue cells in all directions. Cancer, therefore, is a misbehaviour of the body cells in their function of multiplication: from the cytological standpoint it may be looked upon as a psychic phenomenon.

From the very dawn of life the cells of the body have been subjected to the discipline of a relatively fixed environment; the suggestion therefore arises that the cytodal misbehaviour indicated by cancer may be the result of some fundamental change in the long accustomed environment of the cells.

Cells from which a malignant new growth may arise have certain common characteristics: (1) Comparatively little morphological differentiation; (2) slight, if any, anatomical connexions with other cells; and (3) the performance of functions associated with frequent multiplication by fission.

Carcinoma and sarcoma appear to be due to one and the same cause. Primary carcinomatous stroma is probably sarcomatous in nature. Although sarcoma may exist independently of carcinoma, yet when it originates in the subcutaneous tissue, it seems to be frequently accompanied by some carcinomatous changes in the adjacent epidermis.

Every normal cell has, from the beginning, inherited certain fundamental physiological peculiarities, and its growth and multiplication by fission are instigated and influenced now as of yore. The activities of the cells of the higher animals are controlled more by the "habits" inherited from former times than by their present environment. These "habits" were originally acquired, and subsequently ingrained, under the compulsion of an environment which has now become so modified as to serve but as a "reminder" of former conditions.

My inference as to the causation of cancer has been drawn from a survey of the phenomena associated with the relations of the animal body to light. No living matter is indifferent to light. Many unicellular organisms, both animal and vegetable, are phototactic. The growing seedlings of the higher plants exhibit a phenomenon (heliotropism) akin to phototaxis, for they bend over towards a source of light in such a manner that their cells multiply towards it. Not only do green—that is, pigmented—plants grow towards the light, but their least differentiated cells—those of the mesophyll—are stimulated to fissional activity by a moderate illumination. If it be admitted that the individual cells which compose the spherical colonies of certain aquatic protozoans are similarly responsive to light—that they divide more freely when illuminated and possess the capacity for phototaxis—then the whole colony, so long as all the members are uniform in their response, will remain symmetrical and will not be heliotropic. If, however, the cells in one region of the surface of such a colony became more pigmented and less phototactic than the remainder, then a "heliotropic axis" would become developed, and the colony would set itself in such a direction as to present the less pigmented, more phototactic, cells towards the light. The result of this change would be that the less pigmented cells would divide more rapidly than, and tend to envelop, their darker and more sheltered neighbours. Such a colony would speedily become unsymmetrical, and would resemble the spheroidal larvae of Sycon and other primitive metazoans, for we find that these consist of a mass of small, colourless cells superimposed upon a few large pigmented cells.

These primitive anatomical peculiarities are found, I believe, in the morula stage of all animals and are even foreshadowed in their germ cells. The mature, impregnated ovum is darker (more pigmented) on one side than the other, and its subsequent segmentation, therefore, results in the appearance of two varieties of cell—light and dark. In all animals above amphibians the lighter cells multiply with relative rapidity and become the ectoderm, the darker cells form the endoderm. I am led to infer from these considerations that the primary cause of the differentiation of the embryonic layers may be an inheritance of those peculiarities of cell-fission which were the result of stimulation by light under the control of pigmentation. I suggest that the original function of pigment in early animal forms was to direct and restrain the fission of the cells; to produce, by originating a heliotropic axis, a more rapid multiplication—in a direction away from their pigmented neighbours—of the cells which become the enveloping ectoderm, whilst affording shelter to those which become the endoderm. A vitally important result of this pigmentary differentiation would be that the cells of the different embryonic layers would respect one another's domains, and thus the "integrity" of the tissues would be secured at the outset. The cells of the higher animals doubtless inherit the habits of orderly growth which were thus acquired by their ancestors.

The phenomena of the internal pigmentation of animals appear hitherto to have escaped inquiry, and may prove to be of deep significance.

The entrance of light into the bodies of the higher animals is very sedulously regulated. I believe that an inverse ratio may be shown to exist between the degree of external protection from light and that of internal pigmentation. Internal pigmentation is evidenced in the endoderm of the more primitive metazoans, and in the mesoderm (an offspring of the endoderm) of all animals, from the mollusca upwards. The blood of the higher vertebrates is a pigmented tissue of mesodermic origin. Among the lower vertebrates (fishes, amphibians, and reptiles) the mesodermic lining of the body cavity is commonly pigmented. This peritoneal pigmentation is almost invariably more marked upon the dorsal side of the sac (that is, towards the direction from which the light usually falls), and varies (inversely) in intensity with the degree of external protection from illumination.

Those regions of the body surface which are not liable to direct illumination do not need to be protected from it, and are therefore comparatively unprotected by pigment or other agency. A difference in the degree of pigmentation of the dorsal and ventral surfaces of the body is usually observed in the higher animals; the exceptions to this rule are in those animals the ventral surface of which is more freely exposed to light than in others.

I contend that the external pigmentation of animals is, primarily, but one of several agencies serving to protect the enclosed tissues from excess of illumination, that the pigmentation of certain internal tissues assists in controlling and directing the multiplication of those cells which habitually undergo fission, and that the "intention" of the particular colour selected for the blood of the higher vertebrates is similar to that with which we make use of ruby glass in the window of a photographic dark room.

The favourite colour scheme of the animal kingdom comprises that which will best arrest the more actinic rays of the sunlight, and is represented by the series black, brown, red, orange and yellow. This scheme is reproduced, in miniature, in the races of mankind—with the striking exception of the white man.

The production of pigment in response to increase of illumination is a vital and not a physical process, and is probably an inherent reaction to provide against some consequence dangerous to the organism.

Reflecting and dispersing surfaces, pigment, scales, feathers, hair, posture of body, and light-avoiding habits are among the agencies which protect the tissues of the animal body from excess of illumination. The protecting agencies in man are limited to the pigmentation of his skin. His erect attitude causes him to present the ventral surface—which has for countless ages been directed downwards—to direct illumination. In the matter of protection from light man stands isolated in the domain of biology. The white man is the last link in a chain, almost interminable in length, of pigment-controlled and pigment-

* An abstract of "An Essay on Cancer" to be communicated to the South African Medical Congress, August, 1909.

protected creatures, and—without hairy coat and without colour—he is fitted only for a nocturnal existence. It seems probable that no other animal in its natural state exposes its body so constantly to bright daylight and direct sunlight as does civilized man.

The cells of the body possess peculiarities which, for want of a better term, must be called psychic. They possess the "instinct" for orderly multiplication, and behave "instinctively" as their ancestors behaved. The direction of multiplication of epithelial cells was originally and for many ages dictated by the presence of pigment; the habit of multiplying away from the site of pigment, or away from connective tissue cells, has now become a very stable characteristic of epithelium. The protection afforded in past times against actinic stimulation has established a very firm habit of leisurely and orderly multiplication in the connective tissue cells. The traces of pigment in the dermis and epidermis of the white man, and the basement membranes of epithelial structures, probably perform a mnemonic function and serve to "remind" the cells of former conditions. The "physiological resistance" of tissues hypothesized by Cohnheim is identical with this principle of cell instinct for direction of multiplication.

We may look to find a relative increase of liability to cancer associated with a relative decrease in pigmentation.

My main proposition is that cancer is the result of the loss by the cell of its "instinct" for orderliness in multiplication, and that this "psychosis" of the cell is usually consequent upon undue actinic stimulation.

The relative frequency of sarcoma, as compared with carcinoma, in early life is an ontogenetic reproduction of a phylogenetic peculiarity.

To the penetration and stimulation of the tissues by radiant energy we shall apply the term "irradiation." The liability of an organ or region to be affected by cancer is in proportion to its liability to irradiation. Organs and regions (such as the superficial portion of the parotid and the dorsum of the trunk) which have been, in past ages, continuously liable to irradiation have acquired a partial immunity to cancer. This partial immunity is usually signalized by "latent malignancy" and chronicity of the process. Those organs which are best protected from irradiation are the least liable to cancer; those which were formerly well-protected and are now exposed are the most liable.

Mammary cancer in the woman is usually due to deficient protection of the breasts from light.

The specially frequent localization of cancer in those median pelvic structures which lie immediately behind and below the base of the bladder may be due to the dioptric effect of this organ, when distended, upon actinic rays penetrating the anterior abdominal wall. The light which can so penetrate must be (1) small in amount, (2) in excess of that to which the abdominal contents have been accustomed in all former states, and (3) although invisible, must yet, like visible light, be amenable to concentration in certain localities by spherical refraction.

The selection of the pyloric region of the stomach may be due to the fact that, when the organ is distended with gas, a large portion of this region is in close contact with the abdominal wall in the subcostal angle.

The face, being the most continuously illuminated region of the body, is specially liable to be affected. The marked predilection shown by rodent ulcer for a certain locality may be accounted for by a "retro-illumination" of the skin of this region by light reflected from the globe of the eye, and also transmitted through subjacent sinuses by transillumination. The relative frequency with which the lower eyelid and the lower lip are affected may be associated with the relatively greater protection of the upper. The "kangra" cancer of the Kashmiri is due to direct irradiation from an artificial source of light and heat.

The cell's environment usually requires very prolonged illumination from natural sources before the stability of its "instinct" is threatened.

External cancer originates, by preference, at or near the junction of unpigmented with pigmented surfaces, or at the junction of less with more pigmented surfaces, the difference in the degree of pigmentation being evident either in the individual affected or in his near ancestors. "Cell-instinct" is probably least stable in such border zones.

The relative immunity of transparent epithelial structures, such as the cornea, lens, and mucous lining of the trachea, may be due to the fact that a transparent substance arrests no light, and is not, therefore, affected by illumination in the manner in which translucent and opaque substances are.

The occurrence of subcutaneous (melanotic) sarcoma near the finger-nail or toenail of the white man is explained by reference to the pigmentation of the digits of the negro—in the latter we find that this region is a border zone between pigmented and unpigmented regions. Subcutaneous sarcoma has been observed with marked frequency upon the heel and the borders of the foot of the uncivilized negro. These regions are unprotected by pigment and are border zones.

The liability of the kidneys to cancer during infancy is perhaps due to the relative thinness of the posterior parietes at this period of life, and also to the fact that the characteristic attitude of infancy is the crawling one.

The preference shown by sarcoma for the femur and the neighbourhood of the knee-joint is probably due to the fact that of all regions of the limbs this one has experienced the greatest increase in illumination by the assumption of the erect attitude.

Congenital cancer, sarcoma of the placenta, and deciduoma malignum appear to be consequent upon irradiation of the gravid uterus and its contents.

The increased liability to cancer with advancing years may be due to the final yielding of the cells to long-continued stress of environment, to general depreciation of psychic peculiarities (including cell instincts), and to reduction in the agencies of protection—pigment and hair.

The essence of racial liability appears to be degree of deprivation of pigment. If the races of mankind be graded upon a basis of colour, the relative liability of any one race is represented by its position in the scale.

Cancer has been found to be slightly more prevalent among those who are the more exposed to actinic stimulation—seamen, dwellers beside lakes and rivers, agricultural labourers, masons, etc.

Cancer houses usually appear to be unwholesome dwellings, often affording special facilities in their immediate neighbourhood for the irradiation of their anaemic inhabitants.

The increase of cancer within the last seventy-five years is perhaps due to diminished protection from light and increased exposure to illumination. Woollen garments have been largely replaced by cotton, and black and brown clothes by those of a light colour. Narrow streets and dark houses are no longer tolerated, and suburban life has largely replaced that of the city. Artificial illumination has become greatly more actinic in its character. The habit of snuffing has yielded to the vastly more prevalent usage of smoking tobacco by means of a pipe.

A manifest deduction from the principles we have advanced is that cancer may be prevented by efficient protection of the body from light. Natural protections, such as hair upon face, to be encouraged. The clothing to be absolutely light-proof. The ventral surface of the thorax and abdomen to be specially protected. The tobacco pipe to be discarded at 35.

The essential difference between a simple (pathological) hyperplasia and a malignant hyperplasia is perhaps a psychic one—a question of inheritance or non-inheritance of orderly instincts by the principal actors. The sites of selection by cancer are also common sites for simple hyperplastic lesions. Prevention of irradiation may possibly obviate both disorders.

THE *Liverpool Daily Post* calls attention to the fact that at the recent assizes in that city, in one of the cases heard in which medical evidence was required, three medical men in succession requested to have the oath administered in the Scottish way. Our contemporary calls attention to the fact that, on the motion of Mr. Frederick Lowndes, the Liverpool Medical Institution some time ago passed a resolution condemning the insanitary, and in many cases dangerous, custom of kissing the book, and adds: "The change is a very desirable one, and if the medical men themselves practise what they preach, the thinking portion of the community will not be long in following their example."