PATTERNS OF DISEASE

on a basis of

Physiologic Pathology

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Preface

There are, at the present time, so many excellent textbooks of pathology that there is certainly no room for another. These books are essential to those whose duty it is to identify, on morphologic grounds, the diseases affecting tissues removed at operation or autopsy. Morbid anatomy is also the essential basis from which the man of research "works backward" in order to elucidate the beginnings of disease.

To the overburdened medical student and the young doctor in practice, however, these textbooks, to our mind, present too much and too little. On the one hand, the student must master infinite structural detail, which only too often explains nothing. Structure without function is meaningless. Therefore, where possible, structure without function has been omitted from these pages. On the other hand, the standard texts have omitted or not made clear two major phenomena: (1) the presentation of the disease process, beginning at the beginning (instead of beginning with the end result) and tracing its progression, step by step, first the biochemical changes, the altered function, the altered anatomy and the final cure or death, and (2) the compensatory mechanisms adopted by the body—probably the most important general principle in the practical application of pathology to medicine, because, in general, the treatment of disease depends largely on the ability of the body to compensate for the underactivity of its diseased organs by the overactivity of certain other tissues or organs capable of assuming similar functions. In addition, these overactivities of the relatively unaffected tissues or organs enable us to understand the principles of symptomatology. Without an understanding of these principles, morbid anatomy has no significance.

Although it has been our endeavor to emphasize these two principles, unfortunately we are grossly deficient in our knowledge of them and their mechanisms. If in many places we have exhibited a shocking dogmatism concerning these phenomena, it is not for the purpose of hiding our ignorance but to avoid lengthy and tortuous arguments which can be of interest only to the investigator and the more advanced physician.

These pages are based upon our lectures on pathology in the Medical College of Virginia, which are, of course, supplemented by gross and microscopic study of preserved and fresh specimens of diseased tissues and by numerous blackboard drawings. The latter form the basis of our illustrations, for which we thank Miss Helen Lorraine.

We owe our thanks to those of our colleagues who have helped us with valuable advice and suggestions and to Drs. E. G. Huf, E. C. Hoff and R. H. Hoge we are especially indebted.

THE AUTHOR

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Life and Disease

Before attempting to discuss modern ideas concerning the nature of disease, we must examine some of the fundamental conceptions concerning the nature of living organisms, because these conceptions apply also to the processes of disease. What is life? Unfortunately, nobody can answer this question satisfactorily. There are, however, certain attributes of all living forms, attributes which play a fundamental part in all disease processes, which we can describe sufficiently for our present purposes.

In the living body there is a harmonious co-operation among the many cells and tissues of such a nature that if any part is disturbed in its function by some outside influence, then the other parts immediately act in such a way as to restore or to compensate, as far as possible, for the disturbed function. Equilibrium among the parts is re-established.

All cells of the body are bathed by intercellular or body fluids, from which the cells not only receive nourishment, but into which they also pour their waste products. The health of the cell depends on the state of this fluid environment, and, for the maintenance of good health of the cells, this fluid must be kept fairly constant as regards its temperature, osmotic pressure and chemical composition. Brought into contact with the changing conditions of the outside world (conditions which might alter the constancy of the intercellular fluids), the healthy body always reacts in such a way as to maintain or restore that constancy and thus maintain healthy function of the cells.

The mechanism by which this constancy is maintained can be illustrated by a few brief examples.

1. When a nonliving object is put outside on a freezing day, it soon loses heat until it acquires the temperature of its environment. If that happened to our bodies, life would become impossible. Instead, we find that certain body mechanisms are immediately thrown into gear which steadily maintain body temperature. For example, the blood vessels of the skin contract, driving the warm blood away from the cold skin and back into the deeper parts of the body, thus diminishing loss of heat; this results in cold skin, and

we shiver; shivering is merely the rapid contraction of the body muscles, maintained long enough to produce more heat; with diminished heat loss and increased heat production, body temperature is maintained. In a hot environment these phenomena are reversed.

2. When a man is engaged in hard physical exertion, as in running or fighting, a number of changes occur in the body of such a nature as to facilitate his efforts and, at the same time, to maintain the constancy of his intercellular fluids. For instance, the bronchial tubes dilate, facilitating the intake of oxygen and the output of CO_2; the spleen (a reservoir for red blood cells) contracts, driving more red cells into the blood stream, facilitating the carriage of increased oxygen to the muscles; the liver (a reservoir of stored sugar, a muscle-energy food) spills more sugar into the blood for the use of the muscles; the arterioles of the abdominal organs contract, driving a larger proportion of the total blood into the muscles; and the heart handles larger volumes of blood. Thus, the muscles automatically receive a larger volume of blood, oxygen, sugar and other substances at their time of greatest need.

3. The chemical reaction, or the balance of acids and bases in the blood, is one of the most exactly controlled equilibria in the body. A comparatively small deviation of the blood to the acid side or to the alkaline side may soon result in death. The chief acid and alkali in the blood are carbonic acid (H_2CO_3) and sodium bicarbonate ($NaHCO_3$), respectively, so balanced that the ratio $\frac{H_2CO_3}{NaHCO_3}$ equals a constant, or very nearly so. If a man breathes an atmosphere containing too much CO_2, the body promptly forms as much more $NaHCO_3$ as is necessary to restore the ratio or the balance. If he swallows sufficient acid to destroy some $NaHCO_3$, then the momentarily increased acidity of the blood stimulates respiration to such an extent that CO_2 is blown off from the blood by the lungs until the balance is restored. Similarly, in conditions increasing the $NaHCO_3$ or diminishing the CO_2 in the blood, the body adopts appropriate measures to restore the ratio.

These three examples illustrate the fact that, when any of the various constants of the body fluids (temperature, osmotic pressure and chemical composition) are altered, the body immediately reacts by measures designed to restore that constant.

Nothing is so typical of living organisms as this. For this reason, Herbert Spencer defined life as "the continuous and automatic adjustment of internal conditions to external environment." A

thorough understanding of this cardinal principle is the key to an understanding of the principles of physiology and pathology. If we describe these changes as if nature were acting teleologically, it is merely for convenience of description. Actually, there is no evidence of such purposive activities.

DEFINITIONS

When the disturbances of equilibrium and their compensatory restoration result from everyday functions and experience, involving no harm to the body, but rather ministering to our ease, we call it *health.* The science of these phenomena is *physiology.*

When the disturbances are such that the compensatory mechanisms restoring equilibrium are delayed, fail or cause discomfort or dis-ease (whether or not actual injury is done to the body) we call the whole process *disease.* The science of these phenomena is *pathology.*

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Pathology, the Science of Disease

The study of pathology includes:

1. The nature of the injurious agents that may disturb the body
   (a) physical or chemical
   (b) living (bacteriology and parasitology)
2. The passive changes in the affected tissues
   (a) physical injuries, degenerations and necroses
   (b) hypofunction of the tissues affected
3. The reactive changes
   (a) local—inflammation and repair
   (b) general—hyperfunction of other (healthy or less affected) organs or tissues, in an effort to restore equilibrium (pathologic physiology)
   (c) psychic—the mental reaction of the patient's personality to his illness and its accompanying problems (morbid psychology).

The altered functions considered under pathologic physiology and morbid psychology constitute the *symptoms* of disease. The anatomic changes produced, when elicited on examination, constitute the *physical signs* of disease.

Without going too much into details, let us now illustrate the general principles of pathology, of life under stress, by examples similar to those in Chapter 1, using the above outline of the processes of pathology.

EXAMPLES

Chronic Nephritis

The injurious agent is a toxin or toxins from certain streptococci.

Passive Changes. These toxins or poisons injure and destroy a number of the secreting units of the kidney (glomeruli and tubules). If sufficient numbers are destroyed there is a functional insufficiency of the kidneys, resulting in a failure to excrete urea and other waste products and a failure to reabsorb water, thus concentrating urine. These effects are shown by a rise in the concentration of urea and

other waste substances in the blood and by the excretion of an increased volume of dilute urine of low specific gravity.

Reactive Changes. LOCAL. The injury to glomeruli and other structures results in inflammation, even long-continued (chronic) inflammation, resulting in a small scarred kidney.

GENERAL. The remainder of the body, flooded with waste products which should have been excreted, now reacts in such a way that (1) there is a rise of blood pressure in the glomeruli, and hence of filtration pressure, thus increasing the volume of excretion per kidney unit, and (2) the potential excretory powers of other organs are utilized, e.g. the skin, lungs, intestine, peritoneal and other serous surfaces, and even the tear glands. These phenomena account for the high blood pressure, the urea crystals sometimes found on the skin together with skin irritation, the uriniferous breath, the intestinal upsets (diarrhea or constipation), the accumulation of fluid sometimes found in the peritoneal, pleural and pericardial cavities, and the red watery eye of the patient with chronic nephritis.

Thus, we see that the body's efforts to re-establish equilibrium result in a series of positive activities of which the patient becomes aware. These are the symptoms of this disease.

POSTHEMORRHAGIC ANEMIA

Causes. Accidents, wounds, uterine hemorrhage from childbirth, etc.

Passive Changes. Hypofunction of the blood, i.e., the fall of blood volume, blood pressure and the numbers of red corpuscles, results in an inability of the blood to carry sufficient oxygen, food, etc., to the tissues, or to remove carbon dioxide and other waste products. This adversely affects the nutrition of the various organs. If it is sudden and severe, there is unconsciousness. If less severe but long continued, there may be fatty degeneration and other changes in such organs as the heart muscle, the liver, the kidney, the brain and blood capillaries, with some loss of function.

Reactive Changes. IN THE EARLY ACUTE STAGES the dangerous fall of blood volume and pressure in the body and brain brings about, through the nervous system, a series of changes—constriction of the small arterioles throughout the body (restores blood pressure), contraction of spleen (blood emptied from spleen reservoir helps to maintain blood volume and cells in vessels), rapid pulse (keeps arteries full), the passage of fluid from the tissues, through the capillary walls back into the blood stream (restores blood volume),