Chapter 15 Outline and Notes

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THE MIND AND THE BODY INTERACT

WHAT IS PSYCHONEUROIMMUNOLOGY?

Psychoneuroimmunology combines the scientific study of the mind (psycho-), the nervous system (neuro-), and the immune system (immuno-) into a single discipline.

Psychoneuroimmunology represents a new paradigm.

A central theory of this new paradigm is that the mind and brain are one and the same, particularly in the ways that they interact with the endocrine organs and the immune system to affect health.

HISTORICAL ANTECEDENTS

Theories linking personalities to health are ancient.

Many ancient traditions linked illness to a disturbance of harmony among life forces.

An example of this was the Hippocratic theory of four humors, in which good health was attributed to “good humor”, an internal balance of four fluids (blood, yellow bile, black bile, and phlegm). Other examples included the Chinese concept of qi, the Greek pneuma, and the Indian prana.

The separation of the body from the mind (and the restriction of scientific investigation to the body only) began with the work of Ren, Descartes and the religious acceptance of Cartesian dualism in Europe.

THE IMMUNE SYSTEM MAINTAINS HEALTH

The immune system is responsible for detecting and maintaining a dynamic harmony or equilibrium called immunological homeostasis. It senses whether all the cells of the body are in harmony.

One important task of the immune system is distinguishing “self” from “nonself”.

CELLS OF THE IMMUNE SYSTEM AND THE LYMPHATIC CIRCULATION

The lymphatic circulation consists of a system of branched vessels that drain body tissues. The lymph in these vessels contains a liquid plasma and certain white blood cells only.

Cells of the immune system include white blood cells only, mostly lymphocytes. These cells travel through the lymph vessels and sometimes accumulate in lymph nodes.

Cells of the immune system include various types of white blood cells: macrophages (phagocytic cells), B lymphocytes (capable of producing antibodies), T lymphocytes, and others

Immune cells secrete and respond to chemical signals called cytokines.

Immune cells begin their development as stem cells in the bone marrow. They may complete their development in the bone marrow, the spleen, or in other more scattered locations such as the gut lining or the skin.

The DNA that codes for antigen receptors rearranges readily to generate many billions of receptors for different possible antigens.

Through a process of population selection, lymphocytes containing antigen receptors that bind to “self” antigens (those present in the body) are destroyed, leaving only those cells with receptors to “nonself” antigens.

INNATE IMMUNITY

Any chemical to which the immune system responds is called an antigen.

Even before a young animal's first exposure to antigen, it has certain natural or innate immunity. Innate immunity is an antigen-nonspecific response to certain possible threats:

Blood proteins called complement can inactivate certain bacteria and viruses.

Some lymphocytes can secrete interferon, a molecule that inhibits viruses from reproducing.

Natural killer lymphocytes can kill tumor cells without prior exposure.

Certain immune cells, called macrophages and neutrophils, can engulf bacterial and other cells by phagocytosis.

Innate immunity allows us to reject nonself cells and tissues, but it works no more strongly upon repeated encounters than on the first encounter with an antigen.

INFLAMMATION AND HEALING are functions of innate immunity:

Cells of the immune system promote the growth and repair of injured tissue.

An initial step in this process is inflammation, classically recognized by four signs: redness, swelling, pain, and increased temperature.

Some immune cells secrete cytokines called growth factors, which stimulate cell division and thus tissue repair and healing.

Increased temperature, as in fever, inhibits bacterial growth, enhances immune responses, and speeds up tissue repair.

SPECIFIC IMMUNITY

A lymphocyte that binds to an antigen is stimulated to divide repeatedly, producing a clone of identical cells that all bind to the same antigen.

IMMUNOLOGICAL MEMORY gives an individual specific immunity to antigens previously encountered. Antigen-specific immunity requires immunological memory.

Even after an illness has subsided, immunological memory consists of a higher number of lymphocytes with receptors for an antigen that an individual has encountered.

Vaccination is the practice of exposing individuals to small amounts of an antigen in a form which will not cause illness, but which will trigger an immunological memory which gives that individual specific immunity to that antigen, protecting the individual from diseases associated with that antigen. It is also called immunization.

MECHANISMS FOR REMOVAL OF ANTIGENS:

Cytotoxic T lymphocytes kill diseased “self” cells (cancer cells or virus-infected cells) whose antigens they recognize. This is called a cell-mediated response. B lymphocytes release proteins called antibodies, with various effects:

Antibody can combine with blood proteins called complement.

Together, antibody and complement can break apart bacterial cell membranes and can inactivate viruses.

Antibody and complement can also coat bacterial cells with molecules that attract neutrophils, a type of white blood cells that then engulf and destroy the bacteria.

Antibody can prevent bacterial adherence to host cells, thus preventing disease.

Antibody can inactivate many bacterial toxins.

Helper T lymphocytes secrete a cytokine called interleukin-2, which boosts the strength of both B cell and cytotoxic T cell responses.

TURNING OFF AN IMMUNE RESPONSE:

Antibodies and other immune cell products induce a feedback which suppresses further immune activity.

An equilibrium is reached when the number of cells being activated equals the number of cells being suppressed.

When an immune response tapers off, an equilibrium is reached at a level which is elevated above the original baseline, but well below that of the response itself.

Feedback is antigen-specific; it occurs independently for different antigens.

PASSIVE IMMUNITY

A baby receives temporary, antigen-specific immunity from the antibodies present in its mother's milk.

HARMFUL IMMUNE RESPONSES:

Autoimmune diseases cause damage to the body's own tissues when the immune system mistakenly attacks those tissues. Multiple sclerosis and juvenile diabetes can both arise this way.

Allergens are antigens from which no protection is needed. Allergies occur when the immune system reacts against these allergens by releasing histamine from mast cells, causing an unnecessary inflammation response.

PLASTICITY OF THE IMMUNE SYSTEM:

Immunological tolerance can sometimes be built up to an allergen by a desensitization process.

Immunosuppression: certain drugs (including alcohol, cocaine, heroin) and environmental toxins can suppress the entire immune system and allow more illnesses to occur. Stress and malnutrition can also lead to immunosuppression.

Immune potentiation: some cytokines enhance immune functions and cause tumors to shrink.

THE NEUROENDOCRINE SYSTEM CONSISTS OF NEURONS & ENDOCRINE GLANDS

Endocrine glands are those which secrete hormones, communication chemicals secreted into the blood and carried around the body by the circulatory system.

THE AUTONOMIC NERVOUS SYSTEM includes those “self-regulating” parts of the nervous system that are usually not consciously controlled. It contains two major components:

THE SYMPATHETIC NERVOUS SYSTEM stimulates a “fight or flight” response by secreting norepinephrine. This stimulates increased heart contractions, increased breathing, increased readiness of voluntary muscles, and decreased digestive activity.

THE PARASYMPATHETIC NERVOUS SYSTEM stimulates a “rest and ruminate” response by secreting acetylcholine. This stimulates digestive activity, slows both breathing and heart rate, and inhibits voluntary muscle activity.

THE STRESS RESPONSE

A stressor is any stimulus that causes the body to deviate from its normal state of balance (homeostasis).

The body's response to a stressor is called the stress response, part of a “general adaptation syndrome” that has three stages:

1. Alarm. This is the “fight or flight” response described above. In this reaction, lymphocytes are released from lymph nodes into the blood stream. Several hormones are also secreted, including epinephrine (adrenalin), norepinephrine, adrenocorticotrophic hormone (ACTH), and adrenal steroid hormones such as cortisol.

2. Resistance. The body releases more steroid hormones, epinephrine, and norepinephrine, causing increased heart rate, increased blood flow, increased phagocytic activity, and increased inflammation.

3. Exhaustion. If the stressor persists, the body reaches a condition in which steroids are used up, temperature drops, and immune resistance declines.

Chronic or repeated stress suppresses the immune system and lowers resistance to cancer and many other diseases.

THE RELAXATION RESPONSE

Relaxation can be mentally induced and practiced, as in many Eastern religions.

A related technique, called imaging, invokes specific mental images of a desired outcome.

Relaxation and imaging can relieve stress, boost athletic performance, and help fight cancers.

Contact with pets can bring about a greater degree of relaxation, which in turn can reduce the risks of heart attacks and can increase longevity more generally.

THE NEUROENDOCRINE SYSTEM INTERACTS WITH THE IMMUNE SYSTEM

EVIDENCE FOR ONE INTERCONNECTING NETWORK

Various lines of evidence show that the neuroendocrine system and the immune system are connected with and influence one another:

1. SHARED CYTOKINES:

Many immune cells (e.g. lymphocytes) have receptors for neurotransmitters & hormones.

Some types of brain cells and endocrine cells have receptors for cytokines like interleukin-1 and interleukin-2 secreted by immune cells.

2. NERVE ENDINGS IN IMMUNE ORGANS:

Nerve endings of the sympathetic nervous system can be found in organs of the immune system. These nerve endings can be demonstrated to secrete neurotransmitters such as norepinephrine.

3. STUDIES OF CYTOKINE FUNCTIONS

Cytokines of the immune system can be shown in vivo to increase secretion of certain endocrine system hornomes.

Low doses of enkephalins (produced by the brain) can increase several immune system functions, while higher doses of the same enkephalins can reduce immune function.

Several steroid hormones, including those produced under stress, can inhibit immune system functions.

THE PLACEBO EFFECT

Expectation or belief in the effects of a particular drug, treatment, or ritual can bring about physiological responses in the absence of a pharmacological agent. This is known as the placebo effect because it was first noticed in clinical trials of new drugs. The new drug is compared to a placebo, a similar formulation that does not contain the drug being tested, and the drug is not approved unless its effects are greater than the placebo. In these experiments, people are randomly assigned to receive either the drug or the placebo and do not know which they have actually received. People receiving the placebo will often experience physiological changes. This placebo effect provides evidence that beliefs and other mental states can affect bodily functions.

EFFECTS OF STRESS ON HEALTH:

STRESS AND THE IMMUNE SYSTEM

Low levels of certain steroid hormones (as in Addison's disease) results in overactive immune functions, while chronic high levels of these same hormones (as in Cushing's disease) results in immunosuppression.

Various studies have demonstrated that acute stress (up to a certain point) can be immunostimulatory, while people subjected to chronic stress have weaker immune responses and have more frequent and more severe illnesses as a result.

Depressed people have weaker immune responses and are more likely to develop cancers.

INDIVIDUAL VARIATION IN THE STRESS RESPONSE

People exposed to more stressful events in their lives have higher rates of subsequent illnesses including cancers.

Psychological tests can identify people with better “coping skills” in dealing with everyday stressors.

People identified as having better coping skills and more optimistic outlooks have a reduced risk for cancers and a higher survival rate if they get cancer, compared to other people with similar cancers and similar amounts of stress.

CONDITIONED LEARNING IN THE IMMUNE SYSTEM

The immune response, like other physiological functions, can be classically conditioned.

If a drug which alters the immune response (in either direction) is paired with a second stimulus, a conditioned reponse can be learned in which the immune system will subsequently respond to the second stimulus alone.

VOLUNTARY CONTROL OF THE IMMUNE SYSTEM

The immune system can be subjected to voluntary control by various means: relaxation and mental imaging, biofeedback (by viewing monitoring devices which show one's physiological functions, people can learn to control these normally involuntary functions), belonging to support groups (and receiving emotional support), anticipating and looking forward to important holidays and celebrations, belief in (and acceptance of) the inevitability of diseases predicted by astrology, but only among believers in the astrological system

The psychoneuroimmunology paradigm highlights the theory that diseases have internal as well as external causes. The body's internal state can determine many health outcomes.
