



1. BIODYNAMICS (THE “LIFE FORCE”)

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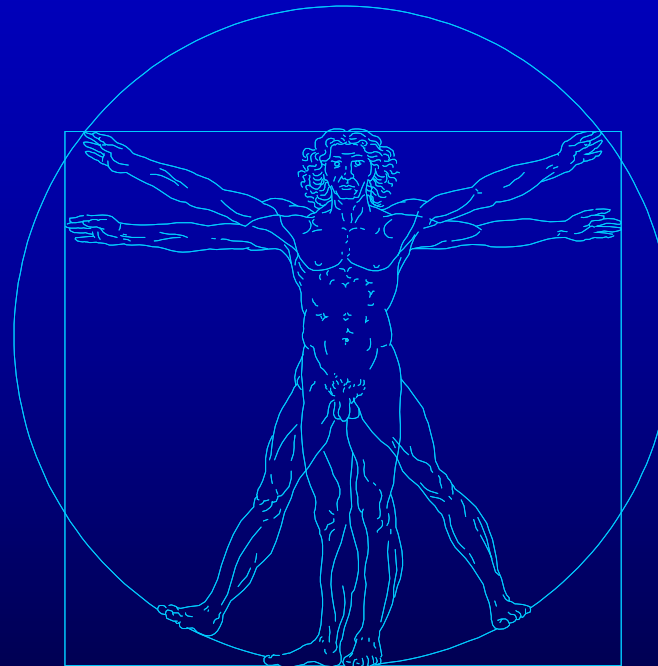
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1.1. Homeodynamics



in living systems





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Homeodynamics means the preservation, maintenance, and reintegration of the structural integrity and of the functional steady-state of living systems





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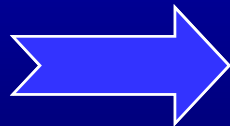
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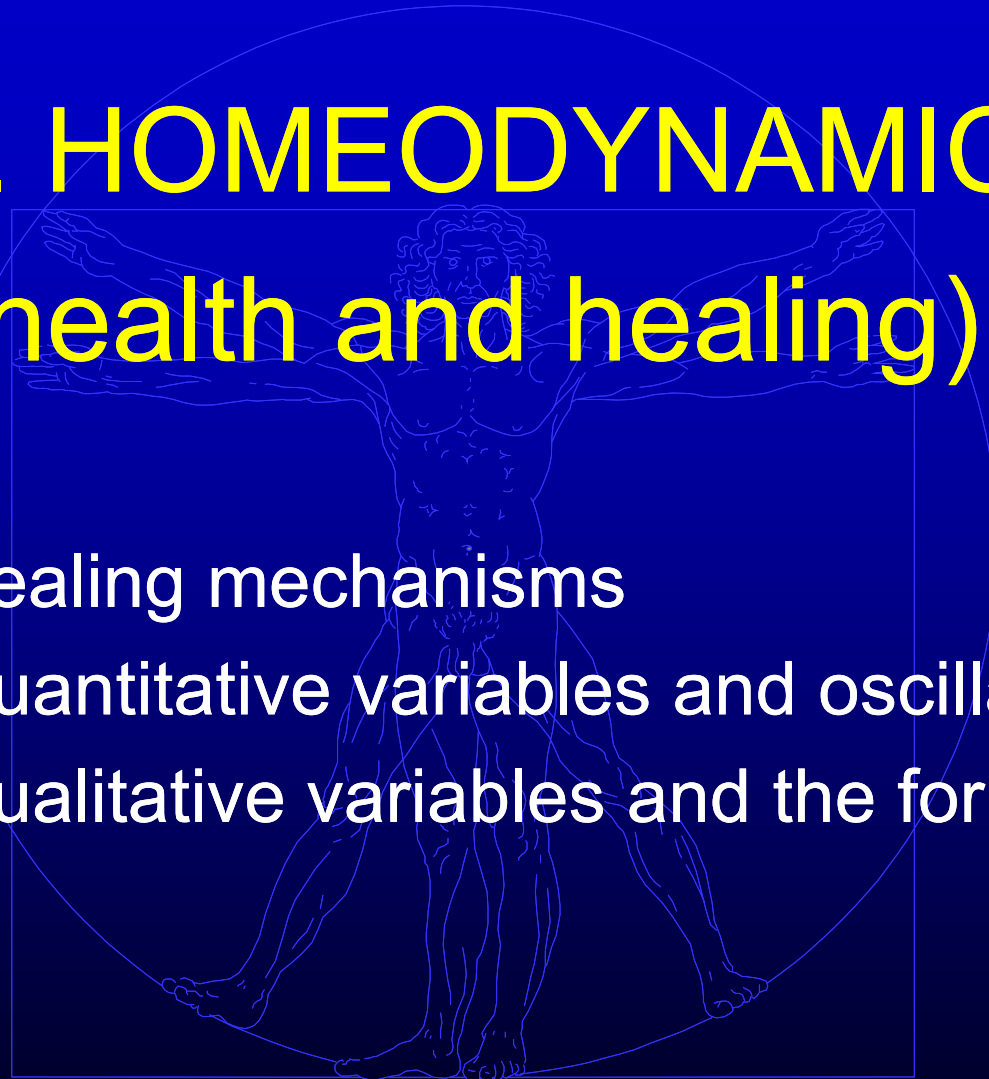
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1.1. HOMEODYNAMICS (health and healing)



- Healing mechanisms
- Quantitative variables and oscillations
- Qualitative variables and the form





A SYNTHETICAL VIEW OF HEALING MECHANISMS

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- The phenomena and the mechanisms involved in healing processes can be described according to two fundamental standpoints.
- The first one, that we may call *analytical*, considers all the single phenomena occurring in cells, tissues and blood during the healing from a damage. For example, we may investigate the molecular changes by which the integrity of the bone tissue is restored in the place where trauma broke a bone in two pieces; we may describe how an infarct heals with formation of a small connective tissue scar; how white cells, attracted by bacterial products, leave the bloodstream and migrate in the tissues where they phagocytose and kill invader microbes; or how liver cells regenerate after severe intoxication or viral infection.
- The second perspective, that we may call *synthetical*, is to try to design working models by which the *fundamental principles* and the *logic* of a complex phenomenon such as the healing process can be studied and understood. For example, we may observe that healing from trauma or from infection is due not only to local factors, like coagulation, cell chemotaxis, angiogenesis, but also to the participation of general factors, like activation of hypothalamus-hypophysis-adrenal axis, production of cytokines that reach all the body through the bloodstream, changes of liver protein metabolism, and so on. It is a crucial aspect of the healing process that billions of cells act in concert and in a finalized manner in order to destroy foreign invaders or tumor cells and to re-establish the healthy morphological and functional state.





BIOLOGICAL HEALING MECHANISMS

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MOLECULAR	CELLULAR	SYSTEMIC	PSYCHO-SOCIAL
DNA repair after mutation	Cell adhesion and movement	Inflammation and immune response	Changes in lifestyle, diet, exercise, hygiene meditation, prayer
Inactivation of toxins by antibodies	Free calcium homeostasis	Neuroendocrine response to stress	Patient-doctor relationship
Free radicals scavenging	Nerve fiber regeneration	Sympathic-parasympathic balance	Family help and social solidarity
Self-assembly of collagen and fibrin	Bacterial killing	Rest and relaxation	Healthy sexual relationships
Detoxication by cytochrome-P450	Tumor cell recognition and destruction	Control of blood fluidity/coagulation	Economic factors
Heat-shock proteins (chaperonins)	Bone resorption and deposition	Organ regeneration and remodeling	Cultural factors
Buffering capacity of fluids	Membrane exportation of toxins	Arterial pressure and blood circulation	Efficiency of healthcare systems





A SYNTHETICAL VIEW OF HEALING MECHANISMS

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- Both ways of knowledge of the healing process (“vital force”), the analytical and the synthetical, are important in order to describe and, possibly, to positively influence the healing process, but here we will give a greater emphasis to the second one essentially for two reasons:
- the first reason is that a thorough analysis of the biological events involved in a single healing process (e.g., wound healing, bacterial killing, immune defense development, and so on) is impossible in the available space for this review;
- the second and more important, is that while the analytical approach has been intensively pursued by molecular biology in the last three decades and represents the main body of teaching in medical schools, the synthetical perspective has been and is almost completely overlooked by modern, high-tech, medicine.
- The “*systemic thinking*” or “*integrative thinking*” is profoundly rooted in the history of physics and of mathematics of this century, representing a kind of reaction to the mechanicism of nineteenth century.





A SYNTHETICAL VIEW OF HEALING MECHANISMS

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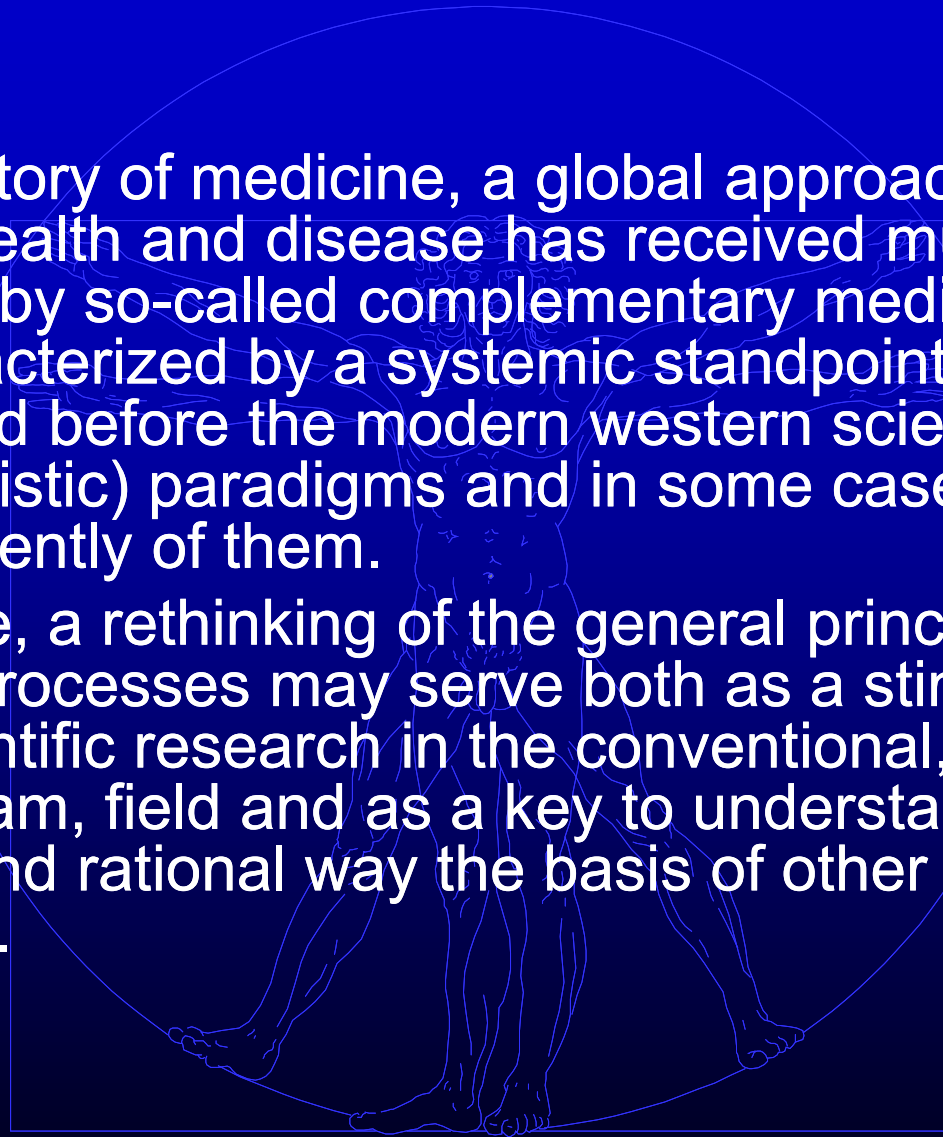
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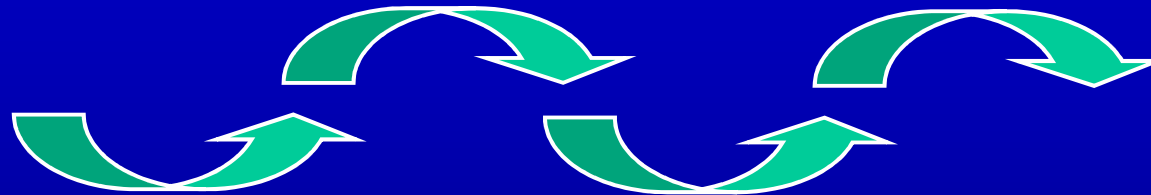
- In the history of medicine, a global approach to human health and disease has received much more attention by so-called complementary medicines, that are characterized by a systemic standpoint and developed before the modern western scientific (often reductionistic) paradigms and in some case independently of them.
- Therefore, a rethinking of the general principles of healing processes may serve both as a stimulus to new scientific research in the conventional, mainstream, field and as a key to understand in a deeper and rational way the basis of other medical traditions.





A HOMEODYNAMIC SYSTEM

consists in a set of anatomical, biochemical, and functional elements designed to maintain a physiological variable within minimum and maximum oscillation limits



➤ **at cell level**, (e.g. membrane transport systems, enzyme induction, heat-shock proteins, cyclic nucleotides)

➤ **at organ level** (e.g. regulation of blood flow, of numbers in cell populations, of structure and morphology)

➤ **at apparatus level** (e.g. regulation of blood pressure, thermoregulation, bowel function, sexual cycle, biological identity-HLA system, etc.)

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Relax

Music: *Fantastic-A* by Kevin MacLeod (incompetech.com)

NGC1232 galaxy



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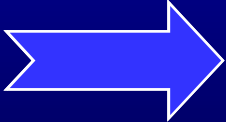
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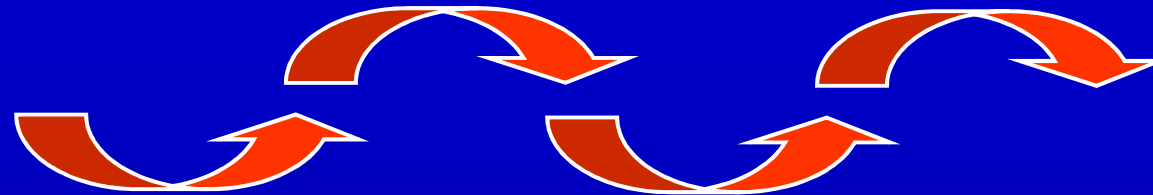
1.1. HOMEODYNAMICS (health and healing)

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HOMEOSTASIS (HOMEODYNAMICS)



Is the maintenance (and re-integration)
of normal **health state**

It has two dimensions:

- physiological **variables**
- cell/tissue/organ **integrity** (“structure”, form”) and **biological identity** (the original quality of **components**)

The concept of homeostasis, first introduced by the physiologist W.B. Cannon in 1929, refers to all those activities which cooperate in the INTEGRATION OF ALL THE MECHANISMS THAT ALLOW A PHYSIOLOGICAL VARIABLE TO BE MAINTAINED IN THE PROPER VARIATION INTERVAL. We speak about homeodynamics (instead of homeostasis) to emphasize the continuous changes of internal variables.

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EXAMPLES OF PHYSIOLOGICAL (HOMEODYNAMIC) VARIABLES

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- Body temperature
- Heart rate
- Body weight
- Blood pressure
- Glicaemia
- pH
- Urine volume and concentration
- Intracellular [Calcium]
- Red cell number
- Cell cycle duration
- Population dynamics





PLASMA CORTISOL HOMEODYNAMICS IN SEVEN HEALTHY SUBJECTS

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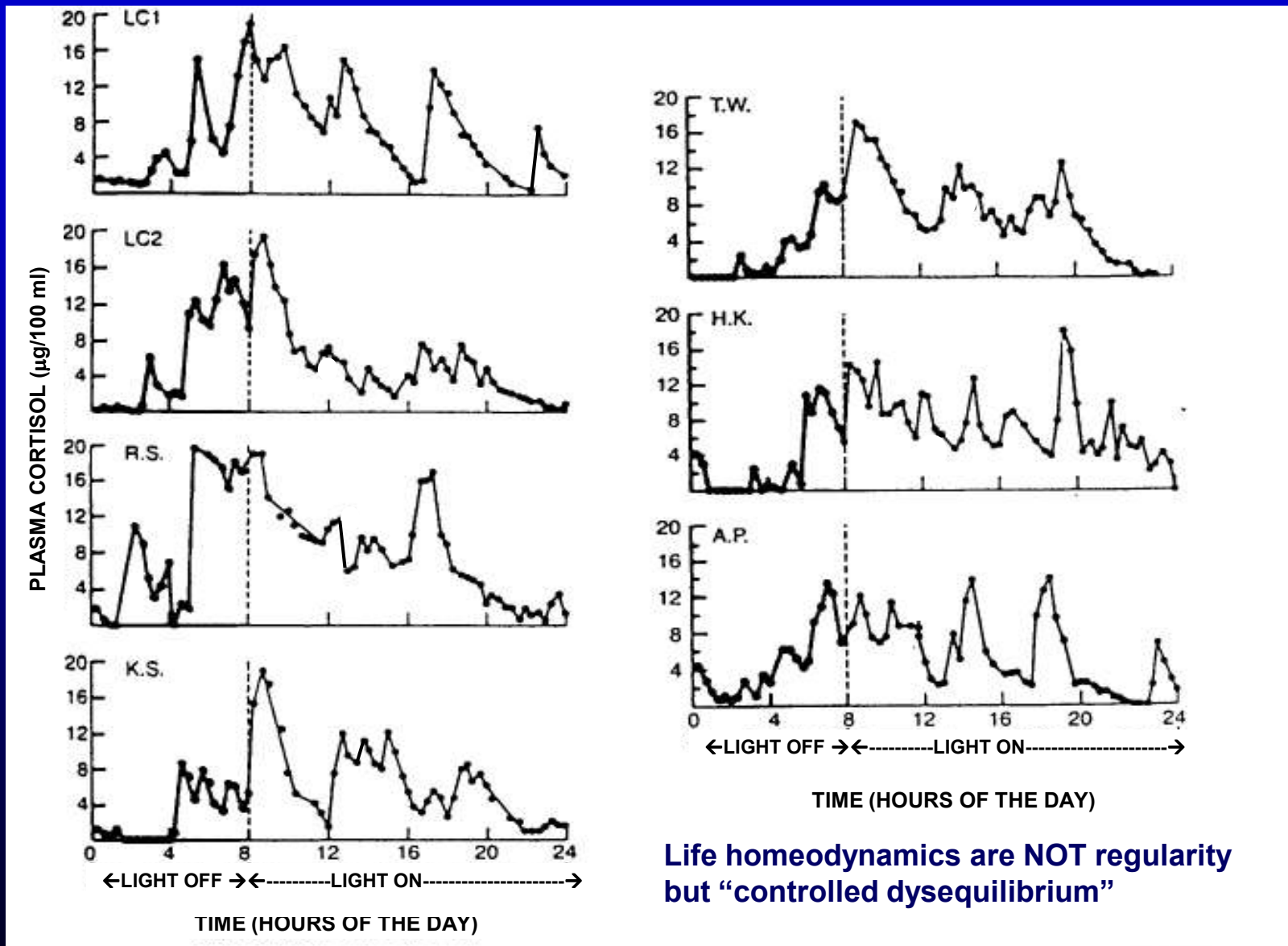
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CELL HOMEODYNAMICS AS “ CONTROLLED DYSEQUILIBRIUM”

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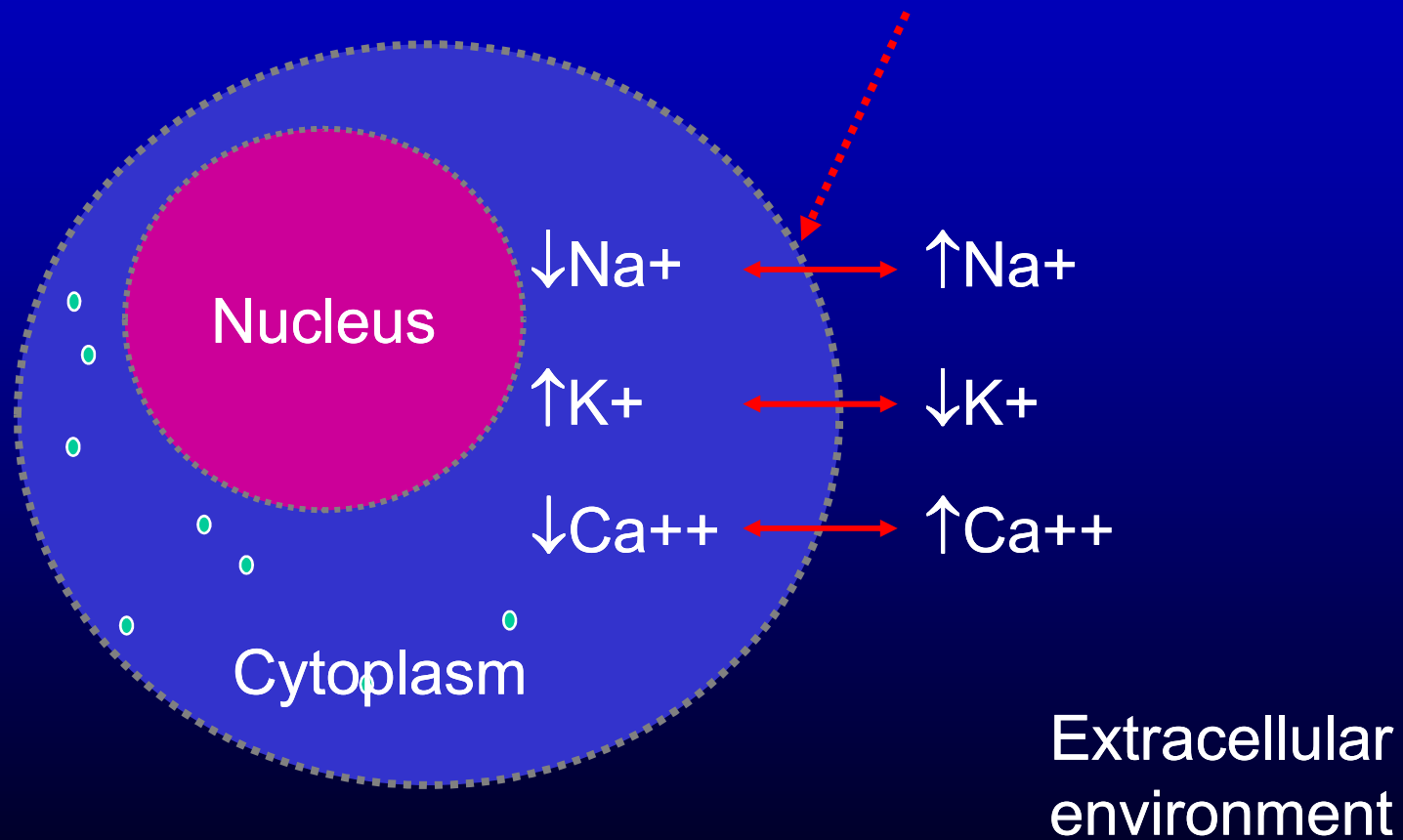
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Membrane enzymes, pumps and channels





OSCILLATIONS OF ANTIGEN-SPECIFIC B-LYMPHOCYTES

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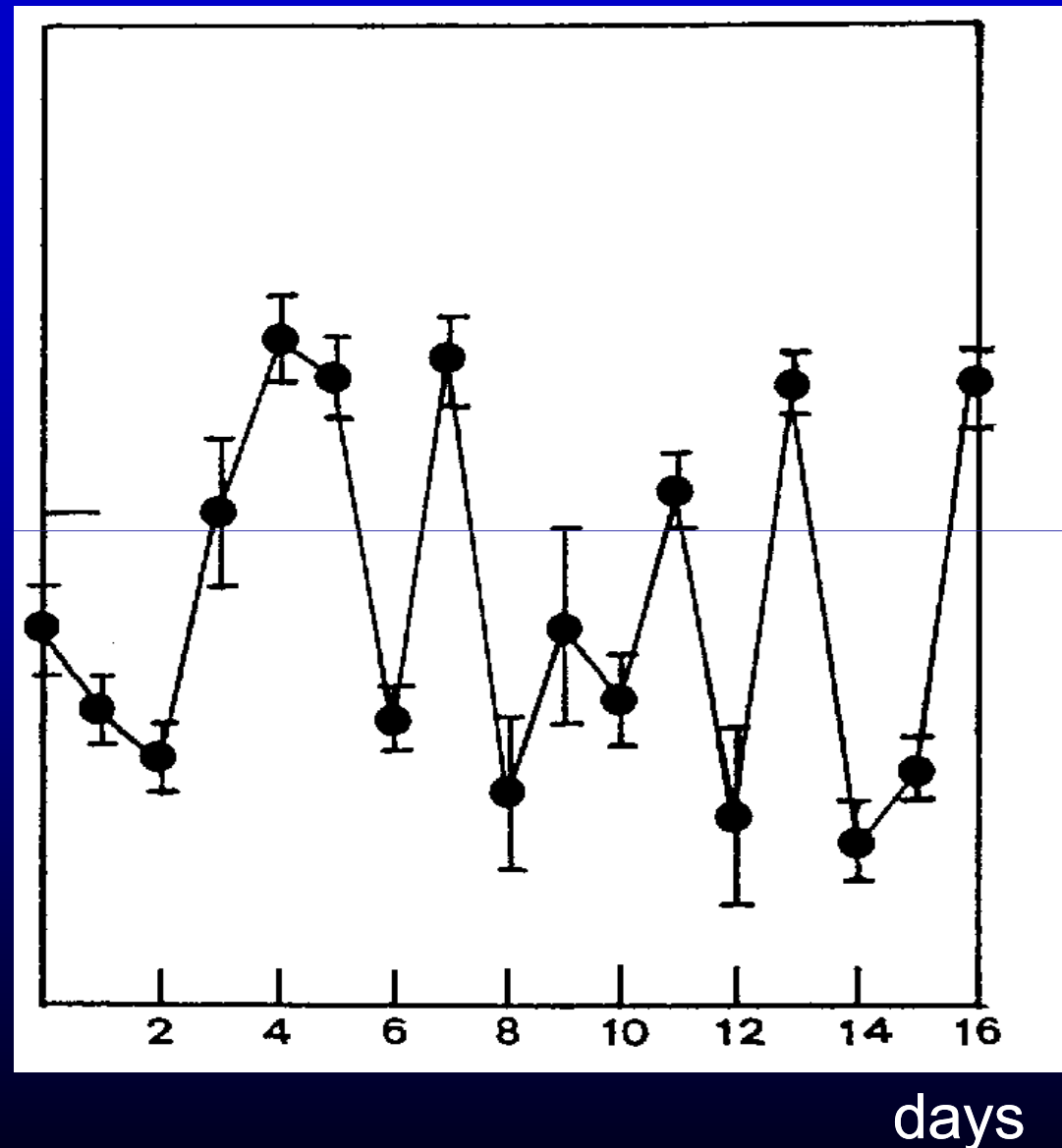
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Frequency of the antigen-specific cells in
the spleen after immunization





Complexity of energy metabolism (e.g.: citric acid cycle)

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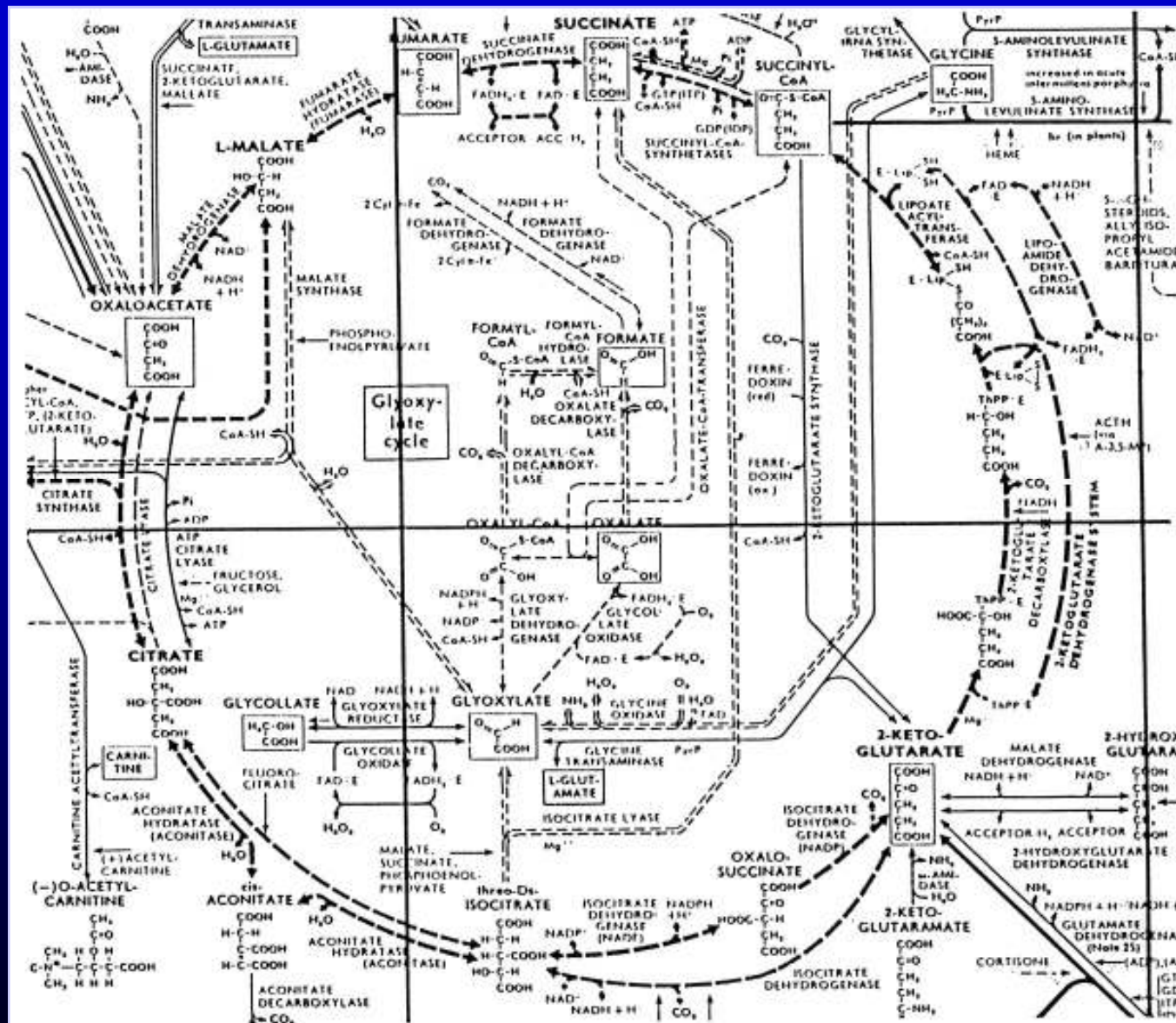
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CYTOKINE HOMEODYNAMICS AND MACROPHAGE FUNCTIONS

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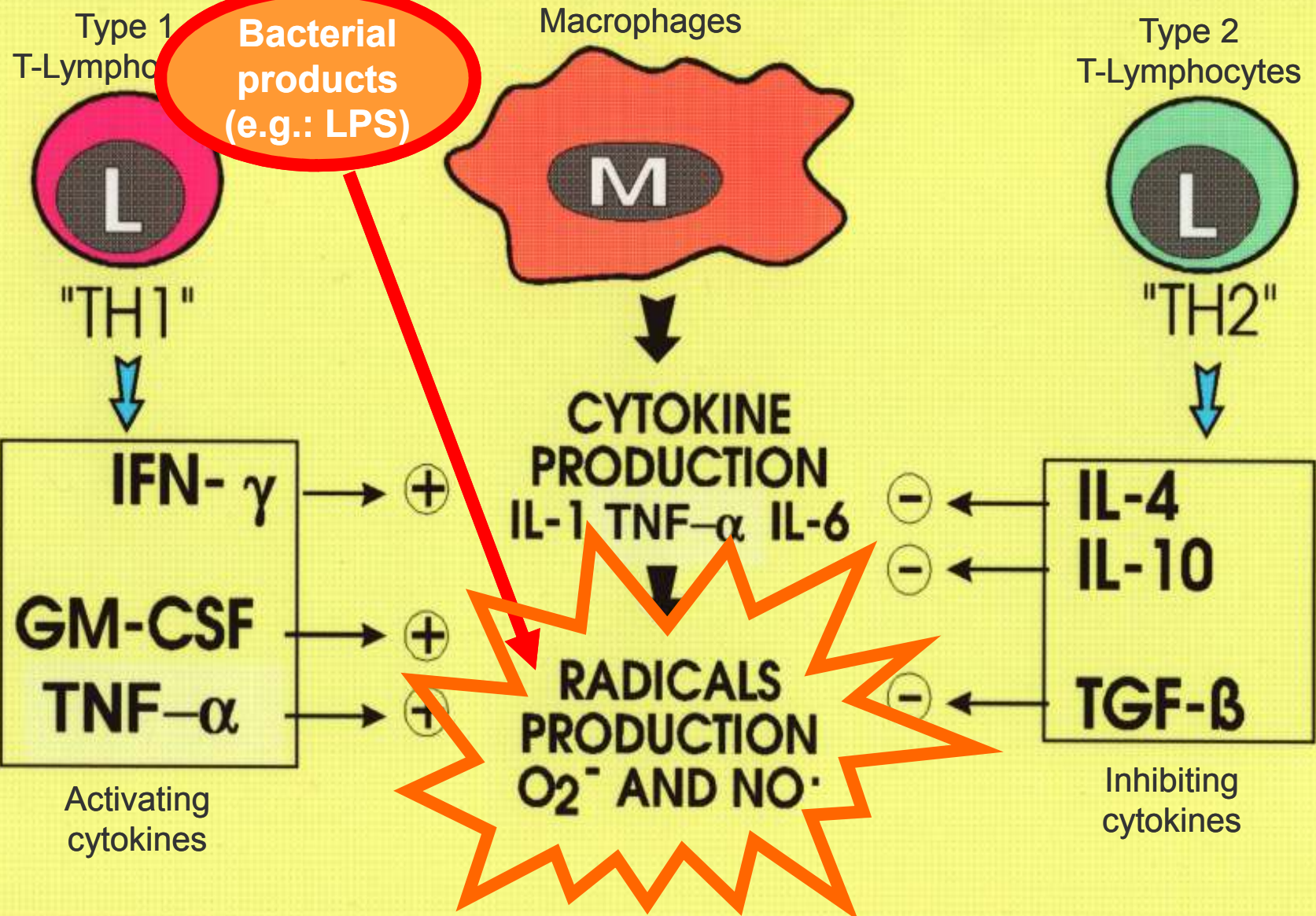
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Relax

Music: *Stoic morning* by Kevin MacLeod (incompetech.com)



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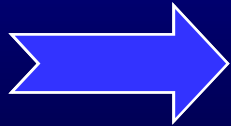
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EXAMPLES OF REGULATION OF INTEGRITY AND IDENTITY

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- Wound healing
- Lymphocyte homing
- Nerve fiber regeneration
- Bone remodeling
- HLA-based immune surveillance
- DNA repair
- Apoptose ("programmed cell death")
- Free radicals scavenging
- Genic recombination
- Heat-shock proteins system
- Idiotype auto-regulation





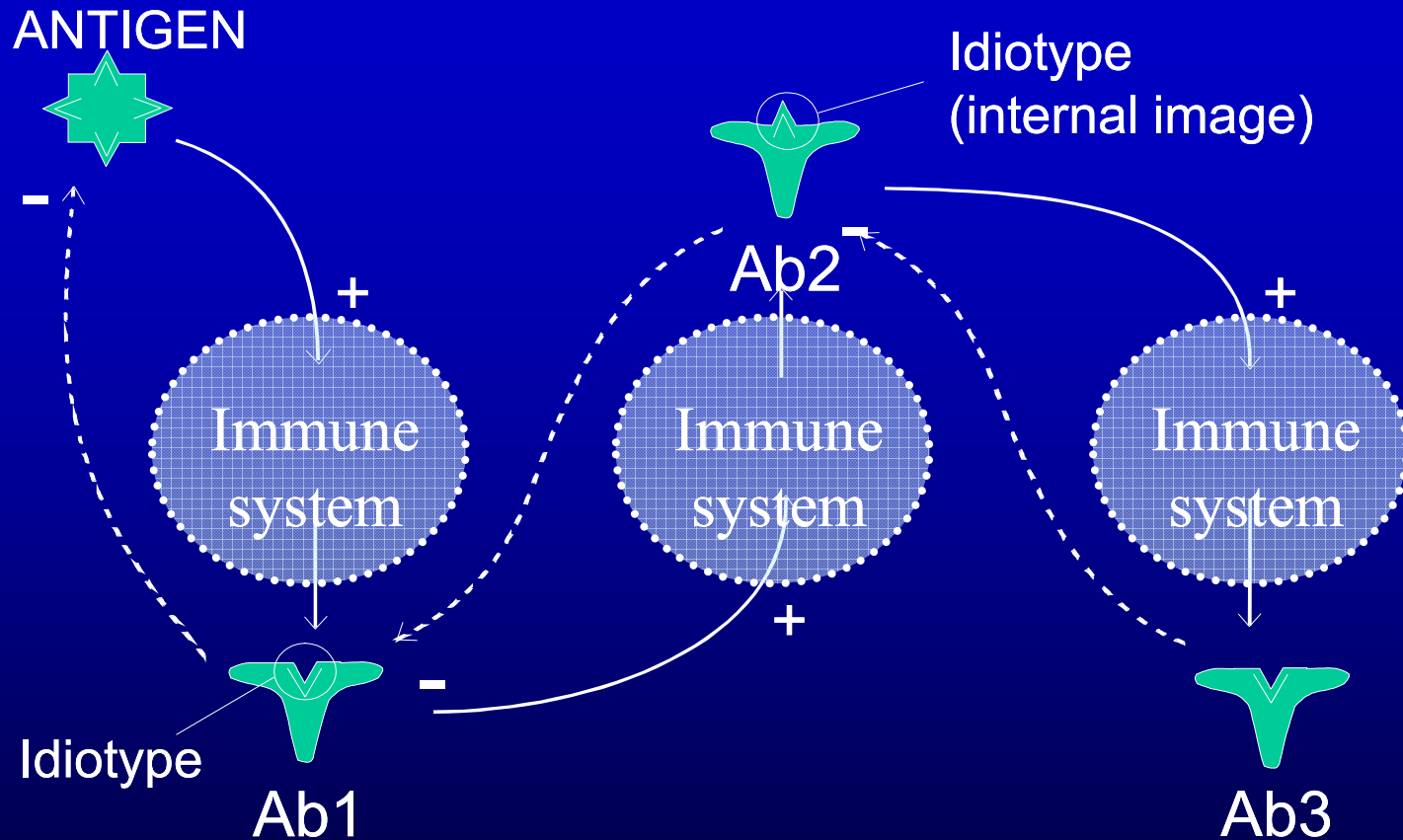
DYNAMIC IDIOTYPE SELF-REGULATION (the form of immune receptors)

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Credit is due above all to N. K. Jerne, the 1984 Nobel Prize-winner for Medicine, for constructing a model (the idiotype network) to explain these interactions. According to this theory, which is universally accepted today, the antibodies, as proteins, are themselves antigens and thus an antibody (antibody-1, or "Ab1"), directed specifically against a certain foreign antigen (in our case, for instance, an allergen) presents a particular structure (idiotype) in its variable part called Fab (Fragment antigen binding), and this idiotype may evoke the formation of specific antibodies (antiidiotype, or "Ab2"). These antiidiotype antibodies in turn evoke the formation of anti-antiidiotype antibodies, or "Ab3." Ab1, Ab2, and Ab3 are produced in different (decreasing) amounts in the course of a normal immune response. We do not know what the effective degree of "ramification" of the system is, but it would not appear to go beyond Ab3 or Ab4.





CELLULAR MAINTENANCE OF QUALITY OF PROTEINS

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To this damage caused to its proteins, the cells, all the cells, react by utilizing the so called heat-shock proteins. These proteins capture the denatured proteins and neutralize them before they can threaten the functioning of the overall cell metabolism. Therefore, HSP are regarded as the main system protecting the cell from the changes of protein constituents.

In the cytoplasm, HSP exist in a complex with heat shock factor (HSF). When the protein is utilized for the recovery process, the heat shock factor is detached and migrates to the nucleus, where binds to a heat shock element which in turn activates the transcription of the gene for heat shock proteins. We have, in a few words, a homeodynamic system at the cellular level: the more is the requirement of heat shock proteins, the more should be their production by the cell.

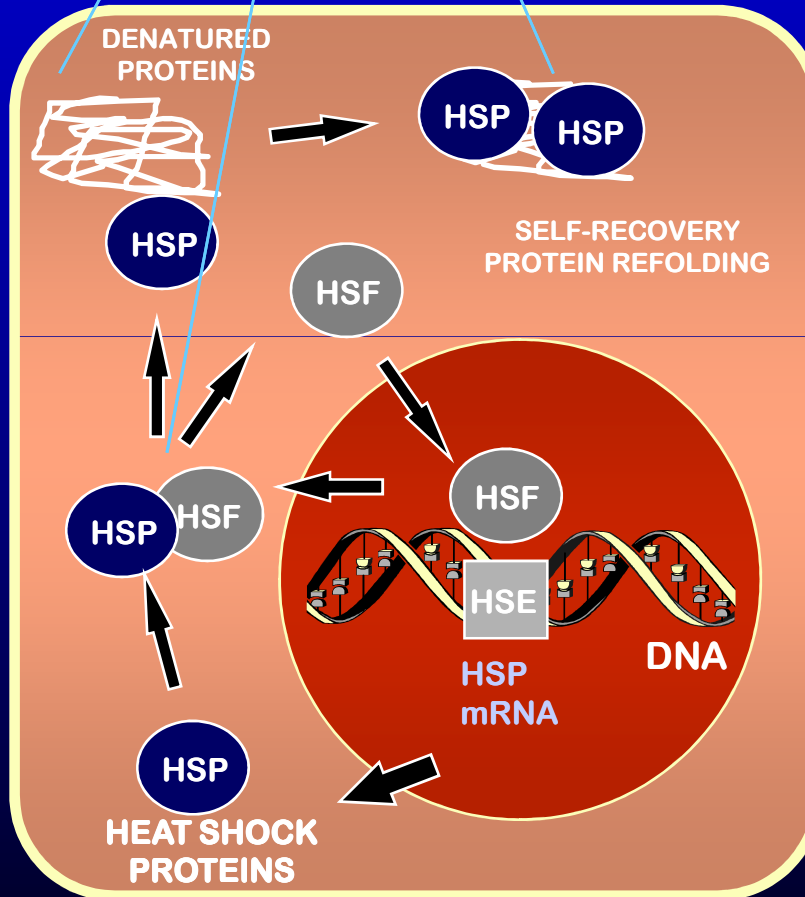
ENVIRONMENTAL STRESS

HEAT SHOCK

HEAVY METALS

METABOLIC INHIBITORS

E.M. FIELDS



PATHOLOGICAL CONDITIONS

FEVER

INFLAMMATION

OXIDANTS

ISCHEMIA

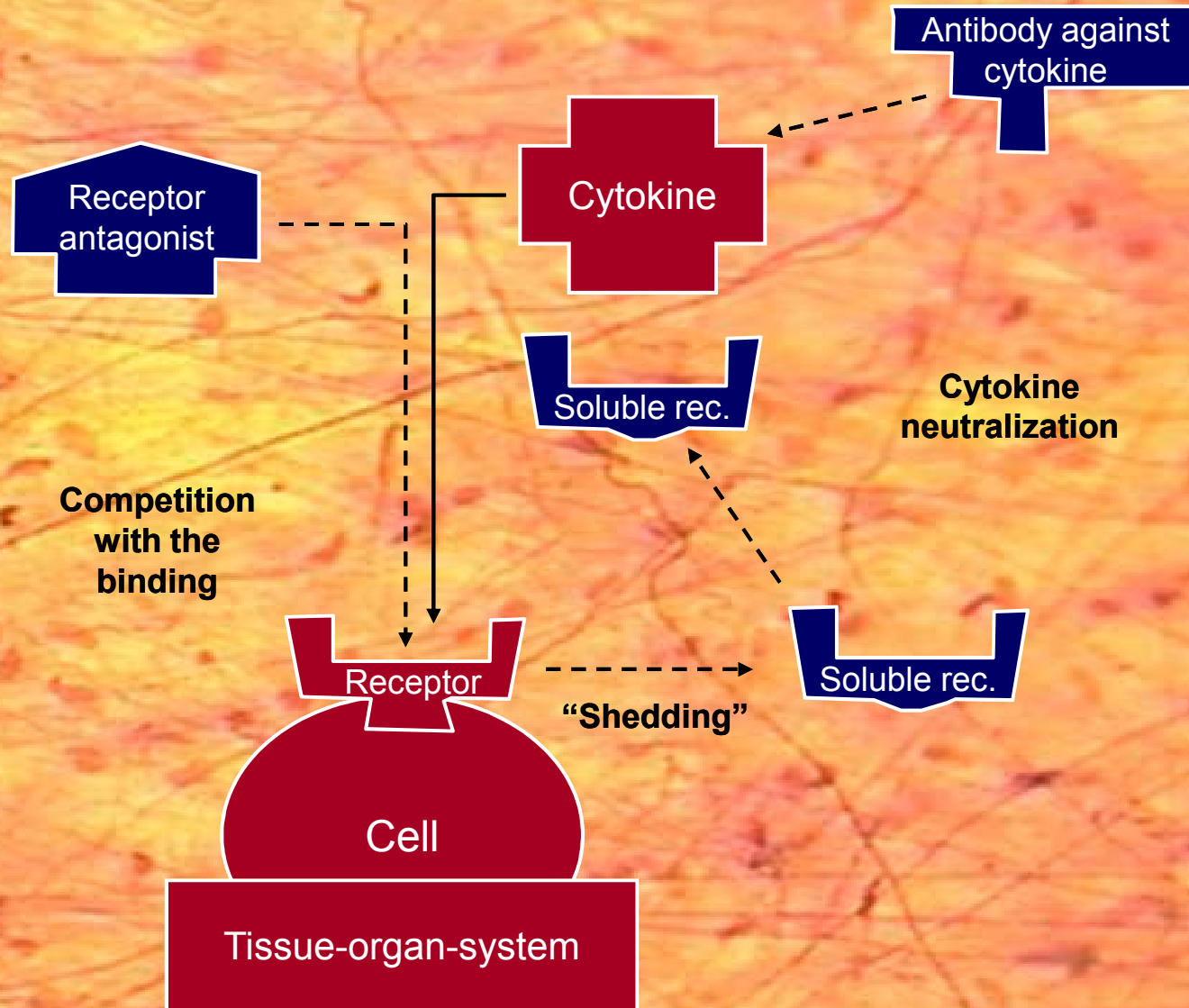
VIRUS

AGING





CYTOKINE HOMEODYNAMICS AND SELF-REGULATION





COMPLEXITY OF ADAPTIVE SYSTEMS

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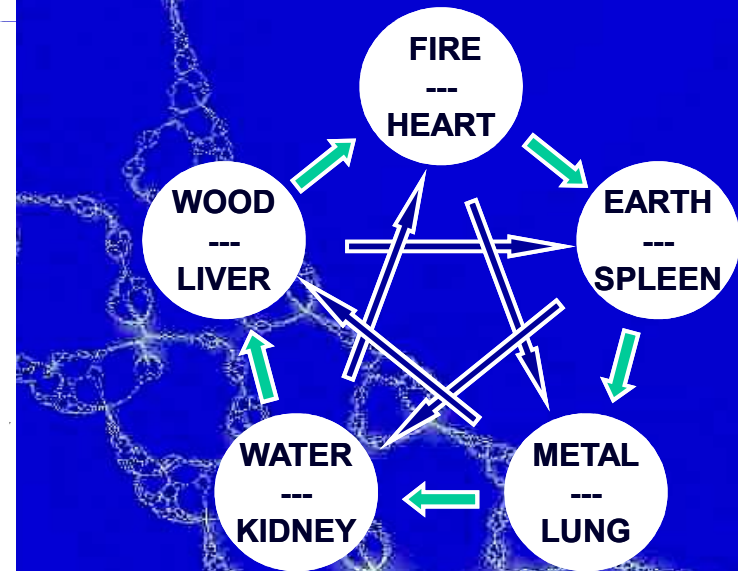
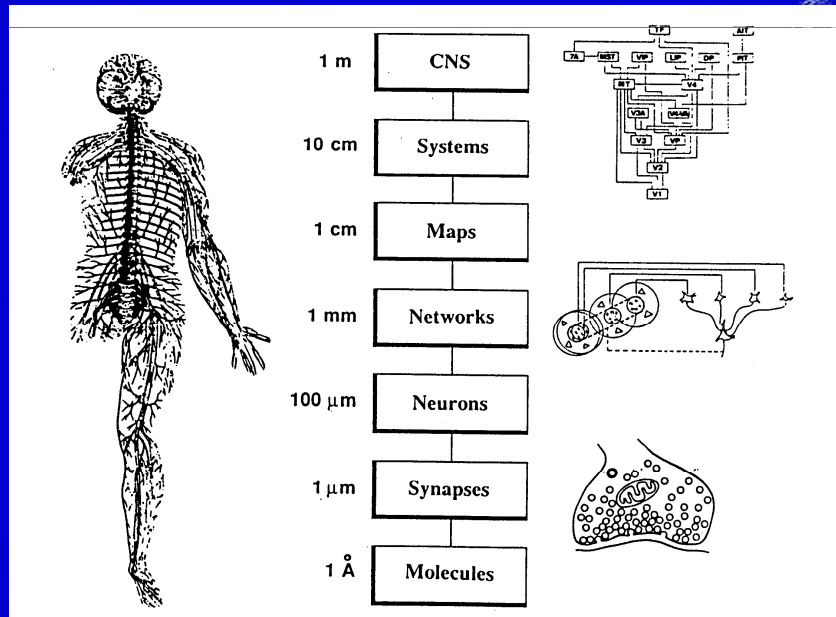
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A complex adaptive system is a collection of individual agents with freedom to act in ways that are not always totally predictable, and whose actions are interconnected so that one agent's actions changes the context for other agents

P.E. Plsek and T.Greenhalgh, Complexity science, *BMJ* 323, 625-628, 2001





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