

Mihai Nadin  
Anticipation and Medicine

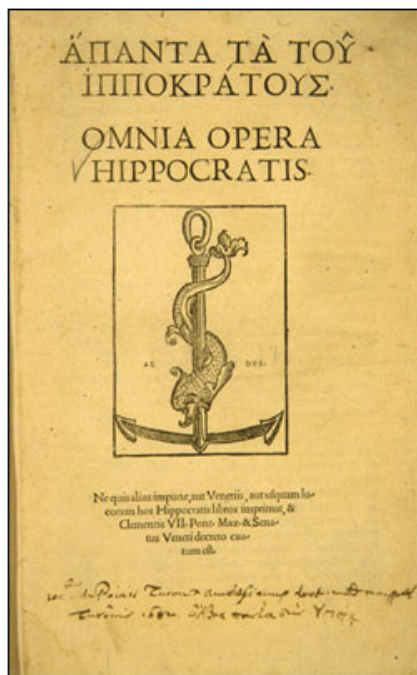
## A lost punch line



[illegible]

Most think of it as the human equivalent of a 15,000-mile checkup and fluid change, which can uncover hidden problems and ensure longer engine life.

# No longer under oath?



I swear by Apollo the physician, and Aesculapius the surgeon, likewise Hygeia and Panacea, and call all the gods and goddesses to witness, that I will observe and keep this underwritten oath, to the utmost of my power and judgment.

I will reverence my master who taught me the art. Equally with my parents, will I allow him things necessary for his support, and will consider his sons as brothers. I will teach them my art without reward or agreement; and I will impart all my acquirement, instructions, and whatever I know, to my master's children, as to my own; and likewise to all my pupils, who shall bind and tie themselves by a professional oath, but to none else.

With regard to healing the sick, I will devise and order for them the best diet, according to my judgment and means; and I will take care that they suffer no hurt or damage.

Nor shall any man's entreaty prevail upon me to administer poison to anyone; neither will I counsel any man to do so. Moreover, I will give no sort of medicine to any pregnant woman, with a view to destroy the child.

Further, I will comport myself and use my knowledge in a godly manner. I will not cut for the stone, but will commit that affair entirely to the surgeons.

Whatsoever house I may enter, my visit shall be for the convenience and advantage of the patient; and I will willingly refrain from doing any

## Editing the DNA – opportunities and challenges

If I faithfully observe this oath, may I thrive and prosper in my fortune and profession, and live in the estimation of posterity; or on breach thereof, may the reverse be my fate!

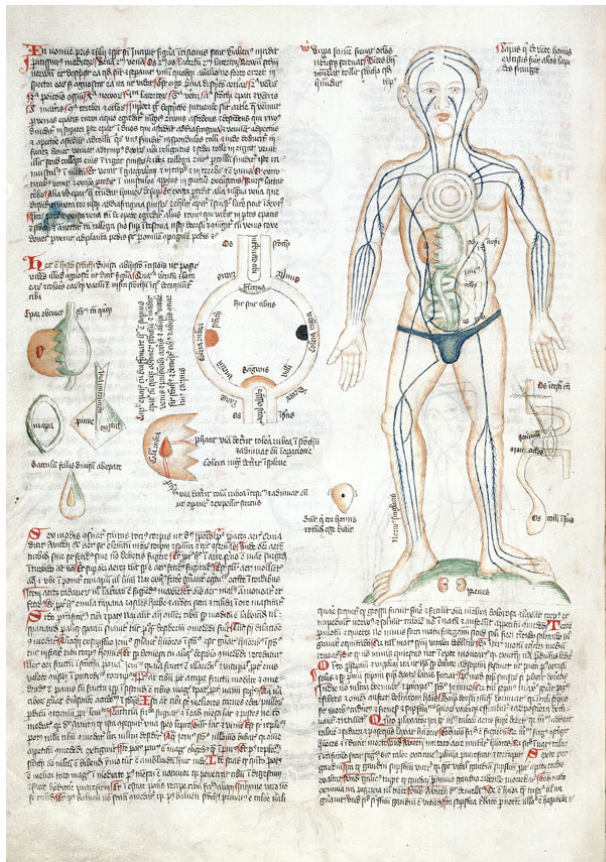
# Modern industrial medicine is based on the physics view of life and health

It treats disease with medication or surgery.

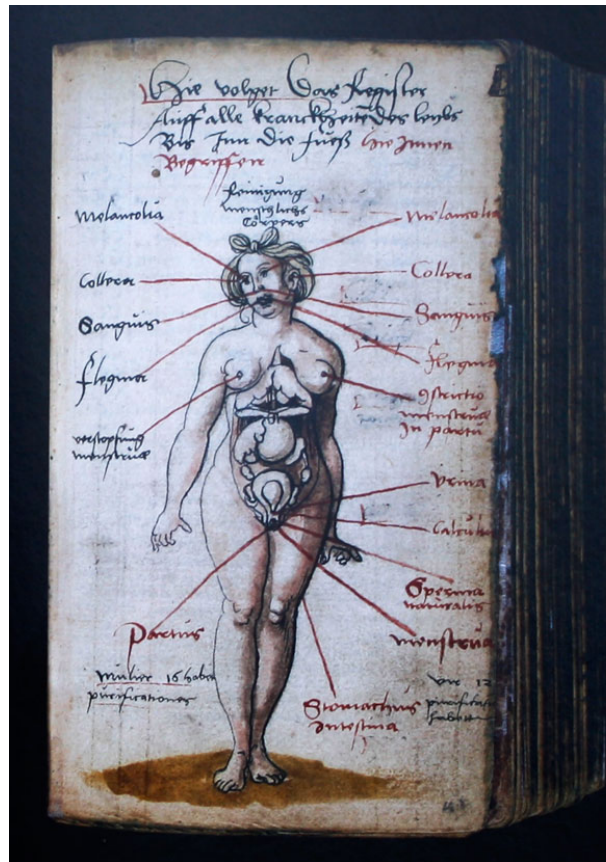
- appropriate for emergency interventions
- cannot distinguish between health and illness
- limited pro-active success



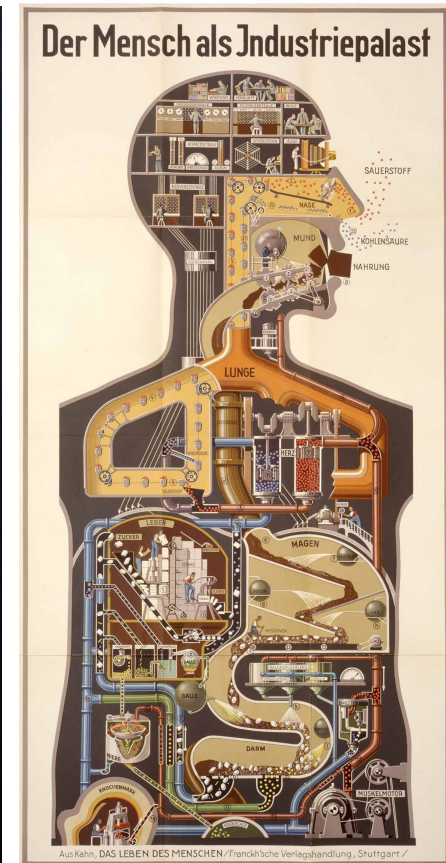
# Roots of medical reductionism



Organ Man, with Arteries, the Stomach and Internal Organs  
artist unknown, from The Apocalypse, c. 1420-1430



Nude Female Anatomical Figure, artist unknown from  
Arzneibuch, 1524-c. 1550



El hombre como palacio industrial  
(Man as a Palace of Industry)  
Fritz Kahn 1888-1968, 1930

Image courtesy of Wellcome Images, London

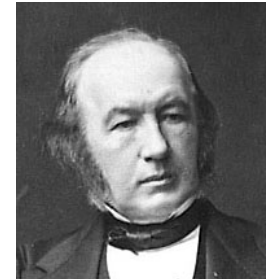
# Modern roots of medical reductionism

*Confidence in absolute determinism in the phenomena of life leads... to real science*

*When faced by complex questions, physiologists and physicians, as well as physicists and chemists, should divide the total problem into simpler and more and more clearly defined partial problems*

*A living organism is nothing but a wonderful machine*

An Introduction to the Study of Experimental Medicine  
(1865)



Claude Bernard (1813-1879)

The new reductionist-deterministic direction:

- *I don't see any fundamental technical obstacle to altering personality with drugs. After all, the traits that make up personality are rooted in neurochemicals.* Malcolm Lader
- *Feeling irritable and melancholic, you reach for your computer and call up Normopsych. After downloading your life history and personality profile data, the screen fills with a rotating, three-dimensional image of the brain. The diagnosis reads: 'Serotonin levels 15 per cent below par in limbic system. Boost with 100 milligrams per day of MoodStim and AntiGrief.'*

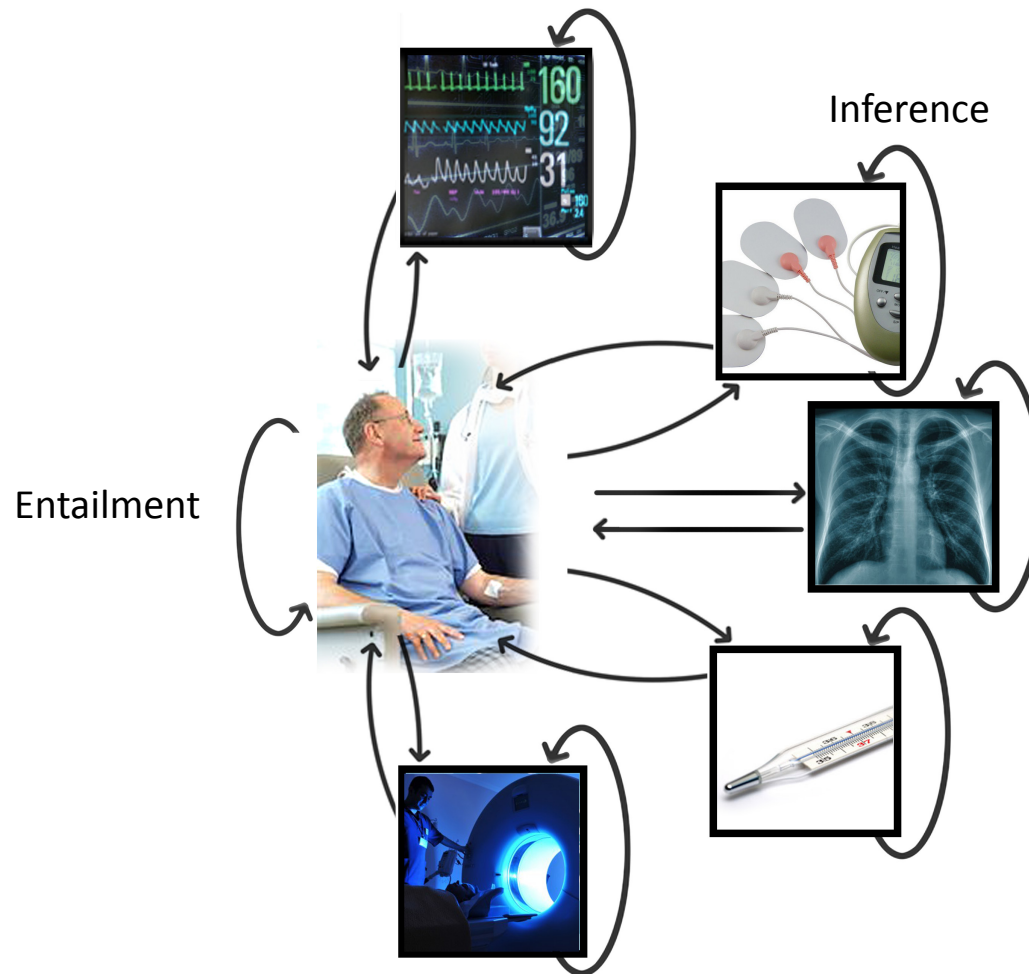
Jerome Kagan, Harvard University, cf. D. Concar, Design your own personality. New Scientist, 1994

*The ultimate aim of the modern movement in biology is to explain all biology in terms of physics and chemistry* Francis Crick (1966)

Consciousness and mental states can be reduced to chemical reactions that occur in the brain

Bickle, 2003; Van Regenmortel, 2004

# Giving up the whole for data streams



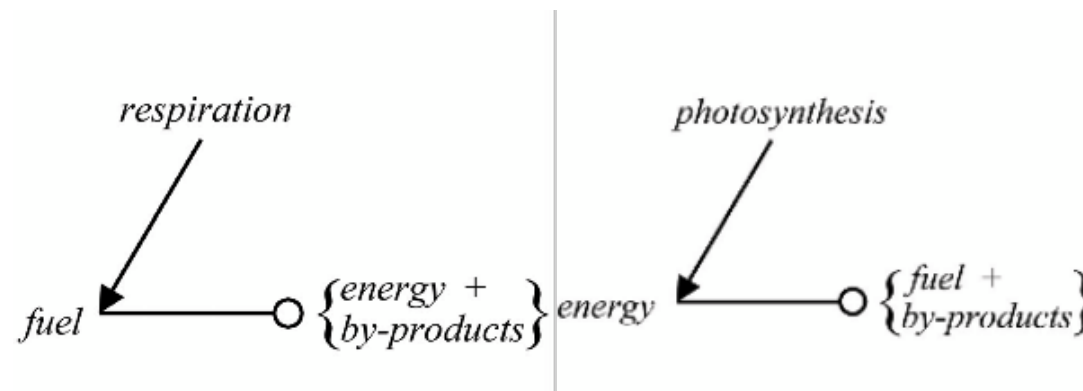
Representation is always incomplete

# The living and the physical

Physical and chemical processes have well-defined outcomes; living processes have multiple outcomes (some reciprocally antagonistic)

Natural processes have multiple outcomes (cf. Bernstein)

- physicochemical theories are only surrogates of biological theories
- living matter is organized fundamentally different from non-living matter
- each activity in the living has its own dynamics



cf. A. H. Louie

# Medical education captive to reductionism



Thomas Cowperthwaite Eakins, *The Agnew Clinic*



# G-Complexity

*Any effectively generated theory capable of expressing elementary arithmetic cannot be both consistent and complete. In particular, for any consistent, effectively generated formal theory that proves certain basic arithmetic truths, there is an arithmetical statement that is true, but not provable in the theory.*

- Kurt Gödel (1931): Theorem VI in “On Formally Undecidable Propositions in *Principia Mathematica* and Related Systems, I”

G-complexity is the characteristic of the living

The physical is decidable

Undecidable science is the outcome of undecidable cognitive processes

## A holistic view

- Nomothetic science: advances descriptions of reality through general laws
- Idiographic science: advances descriptions of specific events (Windelband, 1915)
- The living is the domain of infinite diversity: repetition without repetition (N.A. Bernstein, 1937)
- The living can be investigated
  - from the perspective in which all entities are alike (homogeneity)
  - from an interest in understanding infinite heterogeneity



The ideal of the magic bullet, a substance or therapy capable of providing a remedy for an ailment without deleterious side-effects is not achievable

The living is the expression of creativity: nothing is the same (Elsasser, 1987)

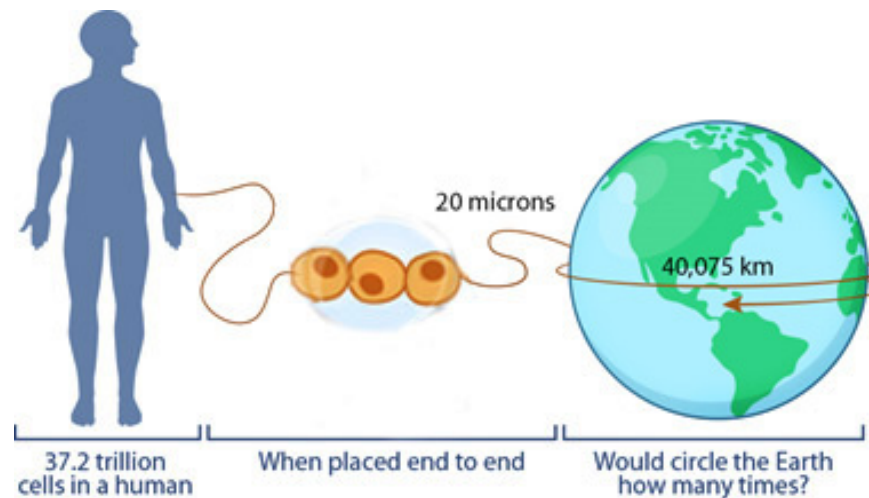
# The living: complex adaptive undecidable system

- number of constitutive elements (and kinds of aggregate parts) and the number of relations among them not reducible to the scale of the commonly experienced
- endowed with memory
- self-adapting dynamics
- interacting with the environment in non-predictive manner
- non-linear
- characterized by endogenous and exogenous dynamics
- highly sensitive to initial conditions
- subject to birth and death



# G-Complexity and medicine

The human being cannot be fully and consistently described



**An estimation of the number of cells in the human body** (Bianconi E, et al. Ann Hum Biol. 2013 Nov-Dec; 40(6):463-71)

Cell interactions affect cell adhesion, tissue development, cellular communication, inflammation, tumor metastasis, and microbial infection.

# The living is defined by anticipation

**Anticipatory System** - Current state depends on previous state and possible future state.

$$X = f(x(t-1), x(t), x(t+1))$$



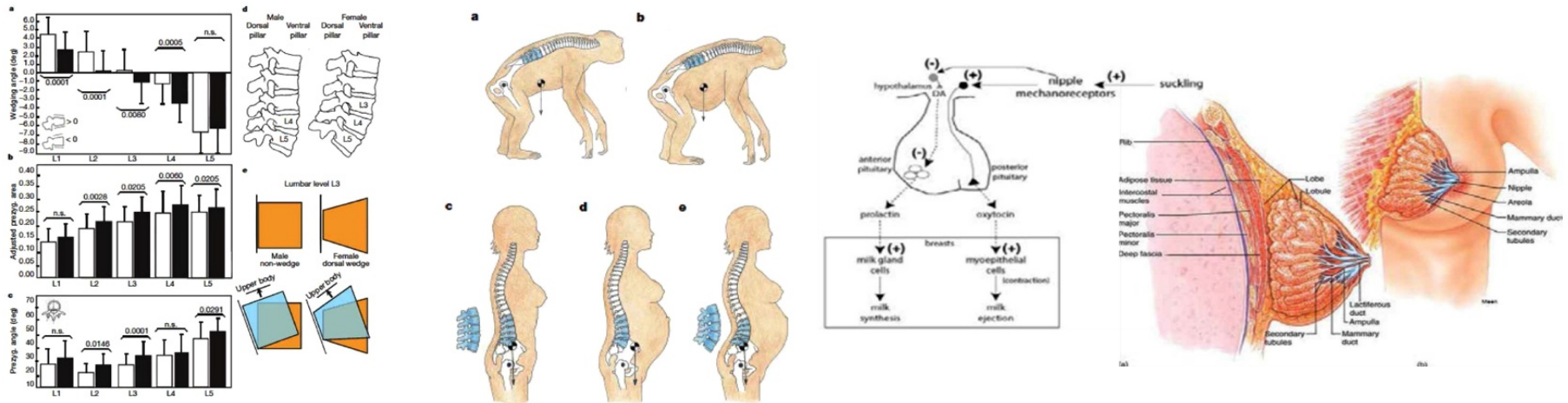
The domain of  
the probable

The domain of  
the possible

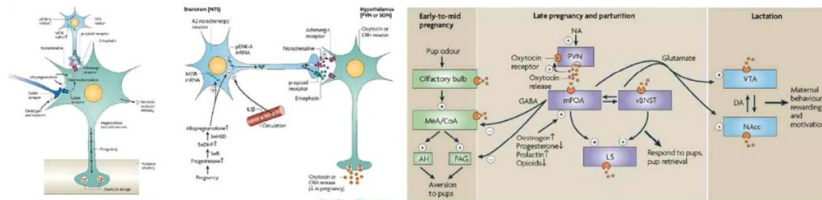


# Experimental evidence

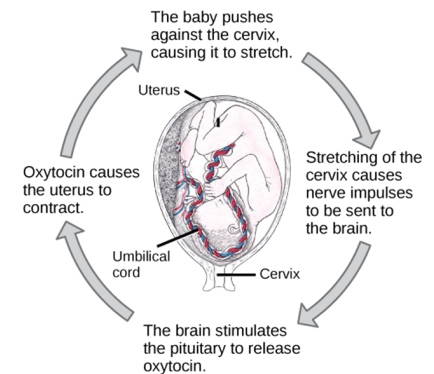
## Anticipation expression in pregnancy



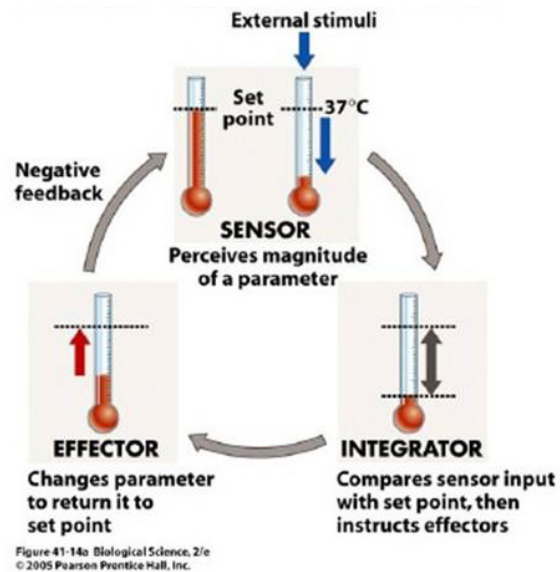
A pregnant woman's body changes in anticipation



A pregnant woman's brain changes in anticipation



# Homeostasis and anticipation



Walter Bradford Cannon inspired by Claude Bernard's *milieu interieur*

Homeostasis: maintenance of physiological variables within very narrow ranges  
defining allostasis as “constancy through change”

Allostasis: incorporates circadian, circannual, and other life-history changes

Anticipation is always expressed in action

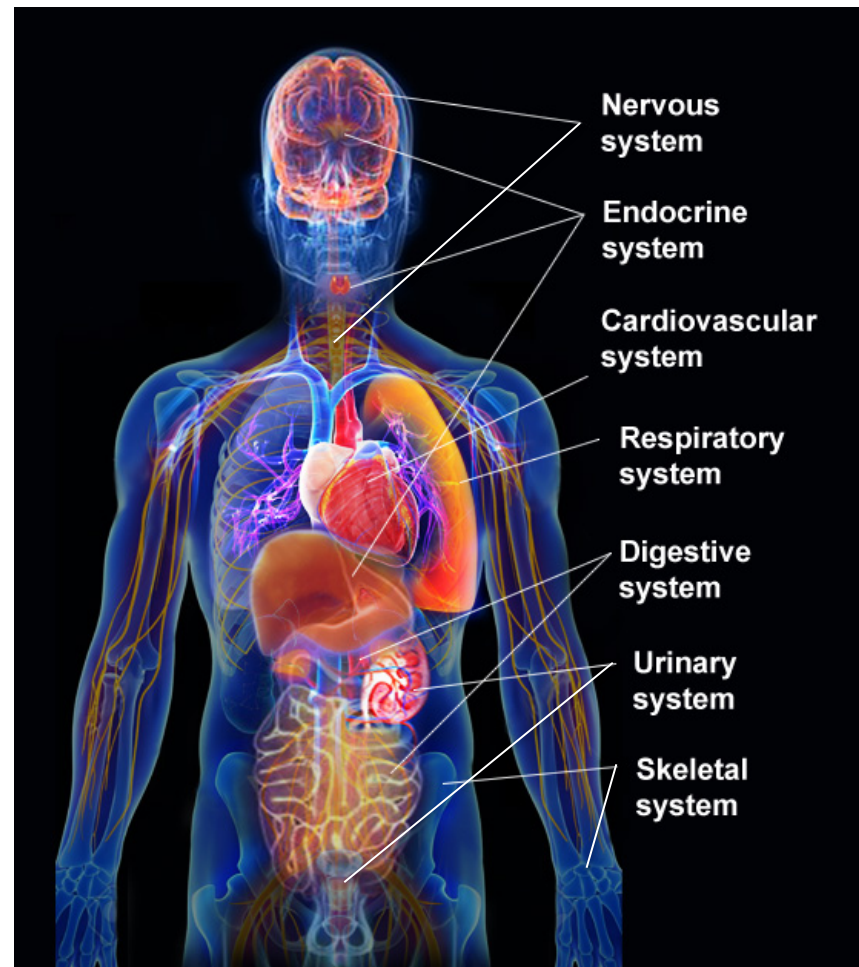
Health: maintain homeostasis? Allostasis? – Deterministic aspects

Anticipation: non-deterministic

# The living: complex adaptive undecidable system

The contradictory unity between stability and change, between reaction and anticipation

All systems in the human body are anticipatory

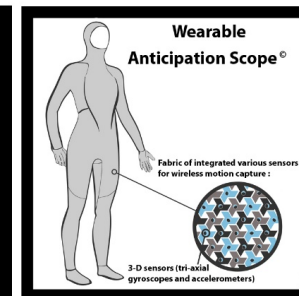
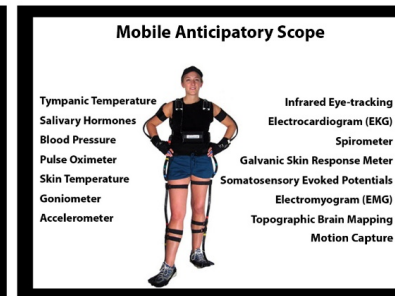
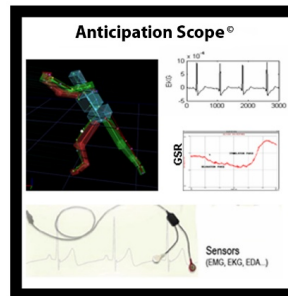
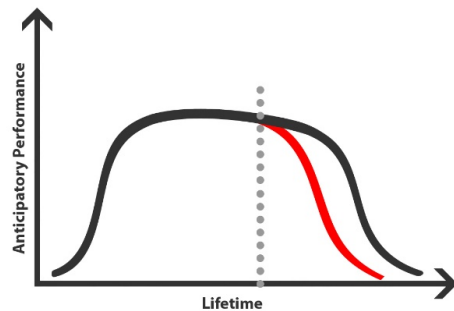


# We are what we do

Purpose drives the action (Gallese, 2000)

The spectrum condition:

- Parkinson's Disease
- Dementia due to Alzheimer's (AD)
- schizophrenia (associated with impaired inhibitory control)
- obsessive compulsive disorder
- attention deficit hyperactivity disorder
- epilepsy, bipolar disorders, restless leg syndrome



**Anticipation scope** can benefit understanding of conditions such as back pain, cerebral palsy, opsoclonus myoclonus, dyslexia, epilepsy, alternating hemiplegia, etc.

**Functions of anticipation scope:**

- early detection of changed adaptive conditions, in particular, synchronizing processes;
- evaluation of functional reorganization in the motor cortex and the associated behavioral recovery of functions after rehabilitative training (e.g., following a stroke or traumatic brain injury);
- identification of anticipatory and reward mechanisms, and their corresponding neural substrates
- platform for evaluation of pharmacological, behavioral, surgical, or other treatments;
- performance evaluation platform, in the form of medical profiling, for activities requiring anticipatory skills (neurosurgeons, pilots, high performance sport, improvisational art, etc.).

# Alternative medicine – an opportunity

Disease management vs Healthcare – economics drives medicine

Individualized medicine

Healthcare – anticipatory

The art and science of medicine