

“There is only one science, physics. All the rest is social work.”

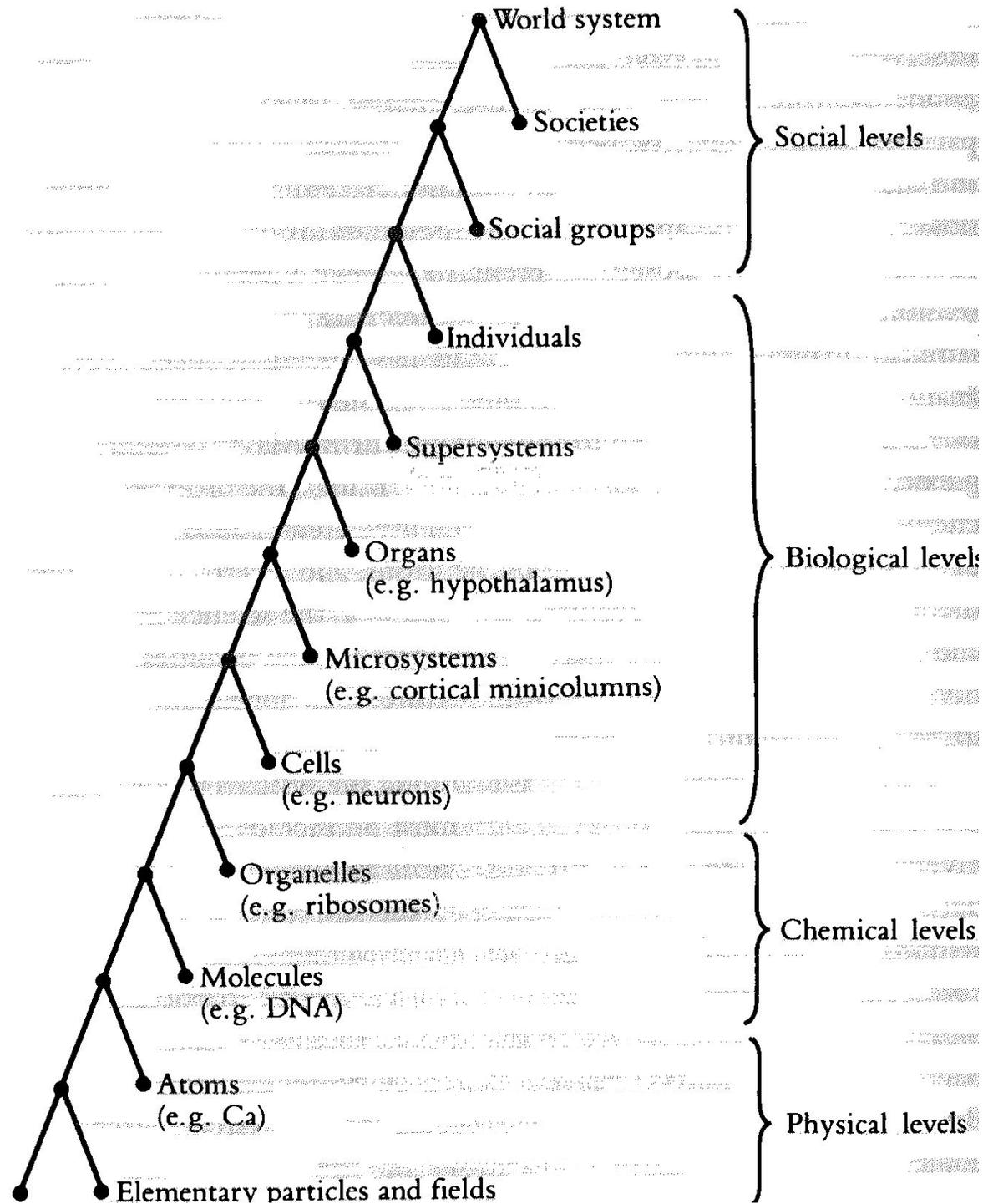
Some reflections on the problem of reductionism

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Outline

- 1) The problem of reductionism
- 2) Reductionist neuroscience
- 3) A success story?
- 4) Anti-reductionism in physics



1) The problem of reductionism

- Can one level be completely reduced to a lower level? ("ontological reductionism")
- (For example, cells are "no more than" molecules. Francis Crick)

- “The reductionist hypothesis may still be a topic for controversy among philosophers, but among the great majority of active scientists I think it is accepted without question. The workings of our minds and bodies, and of all the animate or inanimate matter of which we have any detailed knowledge, are assumed to be controlled by the same set of fundamental laws, which except under certain extreme conditions we feel we know pretty well.” (Anderson: More Is Different 1972)

- “...if everything obeys the same fundamental laws, then the only scientists who are studying anything really fundamental are those who are working on those laws.” (Anderson 1972)

- “There is only one science – physics. All the rest is social work.” (James Watson)

2) Reductionist neuroscience

There is only one sort of stuff, namely *matter* – the physical stuff of physics, chemistry, and physiology – and the mind is somehow nothing but a physical phenomenon [...] we can (in principle) account for every mental phenomenon using the same physical principles, laws, and raw materials that suffice to explain radioactivity, continental drift, photosynthesis (Daniel Dennett: *Consciousness Explained*)

Basic principles

- Our minds are our brains ("You are your brain!")
- Our brains are evolved organs. They are the product of natural selection to maximize our reproductive success.

Man according to Dennett

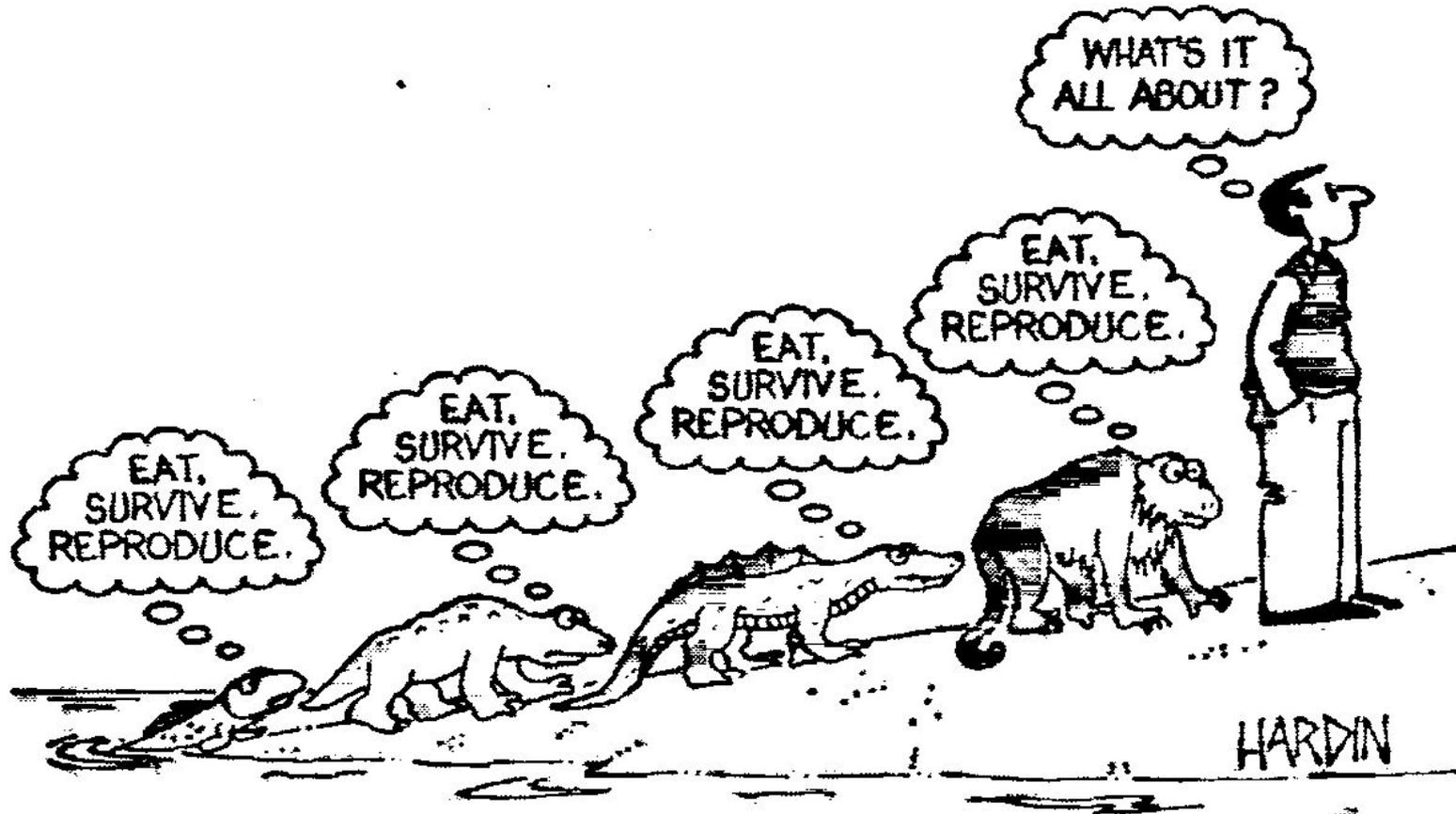


FIGURE 11.1

(From Daniel Dennett: *Darwin's Dangerous Idea. Evolution and the Meanings of Life* (1995))

"A major and erudite statement of a position that is intellectually, morally and spiritually of the first importance"

ROGER SCRUTON

APIING MANKIND

NEUROMANIA, DARWINITIS AND THE MISREPRESENTATION OF HUMANITY

RAYMOND TALLIS

"[W]hat I am attacking is not science but *scientism*: the mistaken belief that the natural sciences (physics, chemistry, biology and their derivatives) can or will give a complete description and even explanation of everything, including human life."

2011

Our minds are our brains

- EEG (electroencephalograph): measures electric activity in the brain
- CAT (Computer Assisted Tomography): uses X-rays
- PET (Positron Emission Tomography): measures the blood flow (and indirectly brain activity)
- MRI (Magnetic Resonance Imaging) and fMRI (functional Magnetic Resonance Imaging) measures the density of protons (and may be used to produce a 3D picture of the brain of a living person)

A typical example of fMRI: "The neural basis of romantic love" (Bartels & Zeki, 2000)

- A person is shown a picture of a person with whom she/he is deeply in love
- The person is then shown pictures of three friends
- The brain activity is measured in all cases, and the activity of the second case is subtracted from the first.
- The result was that romantic love is allegedly localized in a highly restricted area of the brain.

Problems:

- Only additional activity due to the presentation of the stimulus, is recorded. The average activity of the brain is not recorded.
- To localize, all variations must be averaged out. Even simple finger-tapping is very difficult to localize.
- The experiments looked at responses to very simple stimuli (for example viewing a photograph of the loved person), and they were supposed to represent complex phenomena (for example of love).

Problem with the argument

- These devices do not produce pictures of cognitive activity!

Another argument in favor of reductionism

- We can produce conscious sensations by stimulating areas in the brain

Argument in favor of reductionism

- We can produce conscious sensations by stimulating areas in the brain

- Problem with the argument:

We cannot produce out of nothing. We rather affect consciousness by intervening in the brain

Disregarding the problems of evidence and assuming it is true?

The Astonishing Hypothesis is that "You", your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behavior of a vast assembly of nerve cells and their associated molecules.

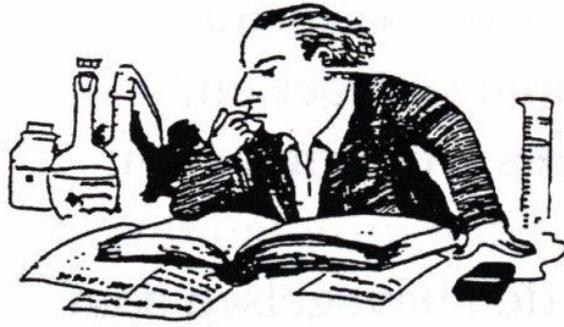
Francis Crick: The Astonishing Hypothesis. The Scientific Search for the Soul (1994)



All thinking is no doubt nothing but physiological processes



All physiological processes are in reality nothing but biochemistry



All biochemistry is in reality nothing but pure chemistry.



All chemistry is after all really nothing but atomic physics...



All atomic physics is in fact nothing but particle physics...



All particle physics is in fact nothing but mathematics...



All mathematics is in reality nothing but thinking...

"If my mental processes are determined wholly by the motions of atoms in my brain, I have no reason to suppose that my beliefs are true ... and hence I have no reason for supposing my brain to be composed of atoms." (J. B. S. Haldane, *Possible Worlds* 1927)

A fundamental problem

Example:

- I see a red hat: Electromagnetic waves pass from the hat to my eye, are refracted in the lense, make an image on my retina, signals are transmitted to my brain....
- It looks like a cause-effect chain.
- But where is the redness that appears in my consciousness?

Seen from my point of view:

- I look at the red hat "out there".
- When I am aware of seeing it, my consciousness is "out there". It is not in my brain.
- My consciousness is *intentional*.
- NB! This is not just a subjective feeling. It is the condition for objectivity. The assertion "The hat is red" is only true if it corresponds to the fact that there is a red hat. (Cf the quotation from Haldane.)

“After decades of concerted effort on the part of the neuroscientists, psychologists, and philosophers, only one proposition about how the brain makes us conscious – how it gives rise to sensation, feeling, subjectivity – has emerged unchallenged: we don't have a clue.”

Alva Noë: *Out of Our Heads* (2009)

- Where should we look for an explanation of consciousness?
- Example: Take a 100 Nkr bill. What makes it money? Should we look at the molecular structure of the paper?
- Alva Noë: Perhaps consciousness is like money?

Maybe consciousness is like money. Here's a possibility: my consciousness now – with all its particular quality for me now – depends not only on what is happening in my brain but also in my history and my current position in and interaction with the wider world. It is striking that the majority of scientists working on consciousness don't even notice there is an overlooked theoretical possibility here. (Alva Noë)

3. A success story?

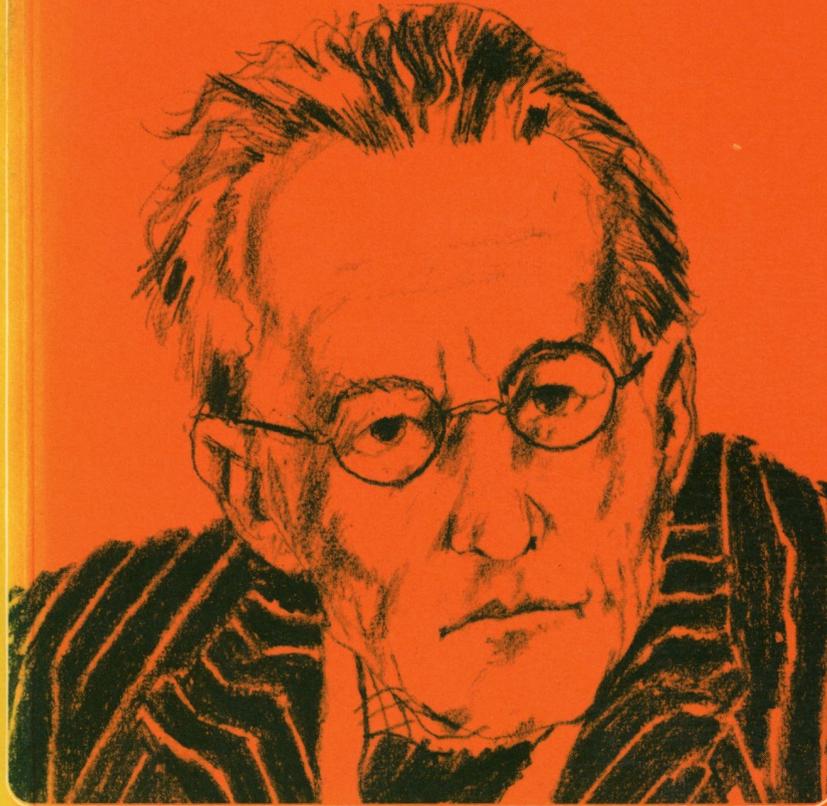
Michael R. Hendrickson: "Exorcizing Schrödinger's Ghost". Reflections on *What is Life?* and its Surprising Relevance to Cancer Biology, in Gumbrecht et. al.: *What is Life? The Intellectual Pertinence of Erwin Schrödinger*, Stanford Univ. Press 2011.

Starting point

- Mortality rates for most types of adult cancer are either stable or increasing
- Improvements not due to gene therapy
- It is due to
 - technological improvements that facilitate early detection
 - surgery, radiation and chemotherapy ("cut", "burn" and "poison")
- It demonstrates the defeat of the reductionist program in genetics and molecular biology

Erwin Schrödinger

**What is Life? &
Mind and Matter**



CAMBRIDGE UNIVERSITY PRESS

1944

“The large and important and very much discussed question is:
How can the events in space and time which take place within the spatial boundary of a living organism be accounted for by physics and chemistry?”

Schrödinger transformed the question from

"What is life?"

to

"What is the physiochemical basis of heredity?"

Heredity

- Passes on a certain order from one generation to the next ("order from order").
- The genome is an "aperiodic crystal" (to be able to pass on information): "We believe a gene – or perhaps the whole chromosome fibre – to be an aperiodic solid."

- The genome contains the "code-script" for the construction of the whole organism.
- The central dogma (coined by Francis Crick):
DNA -> RNA -> protein

The onco-gene theory

"The Schrödingerian paradigm, as played out in cancer biology, had it that there was a handful of genes, normally involved in regulating essential cell functions, that became disfunctional through, for example, mutation.[...]

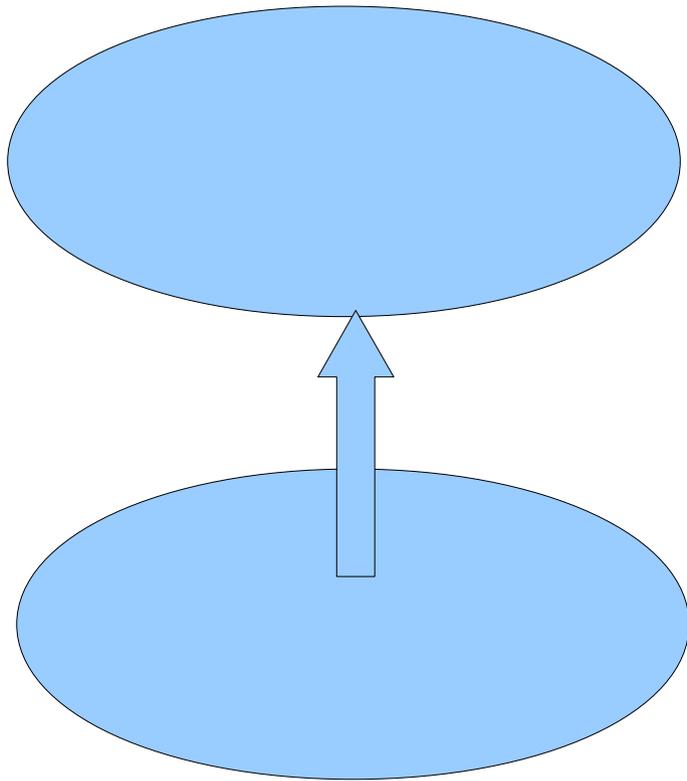
... but it is *reductionist* in believing that all higher-level properties can be explained by lower-level properties." (Hendrickson 2011)

"Post-Schröderian Perspective"

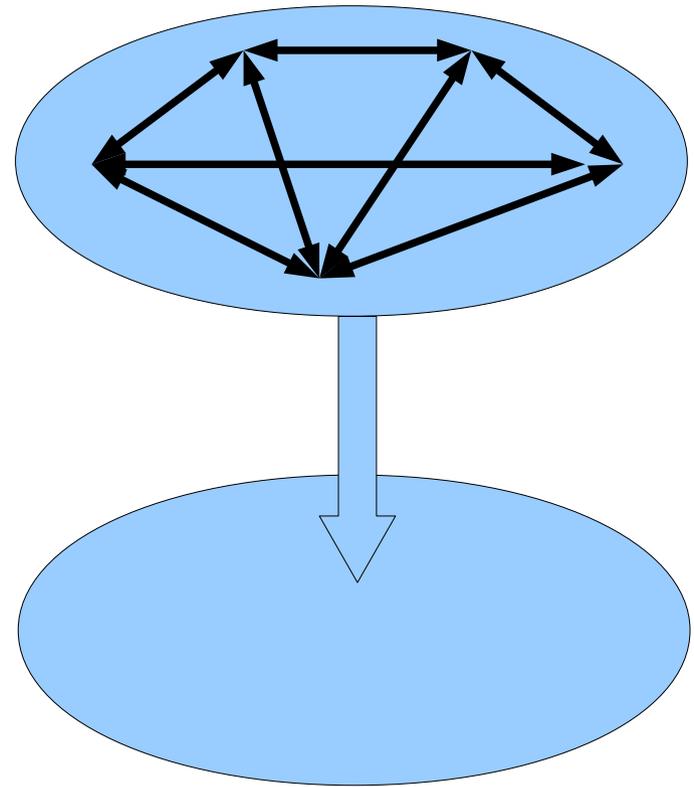
"Genes, it was now understood, operated in context; the expression of a particular gene depended crucially on the state of other genes in its network. [...]"

In short, intervening in the workings of a complex nonlinear network in a targeted way did not lead to a localized change in that targeted metabolic step; it produced instead a disequilibrium for which the entire network attempted to compensate in order to restore the network to its previous state." (Hendrickson 2011)

Not this



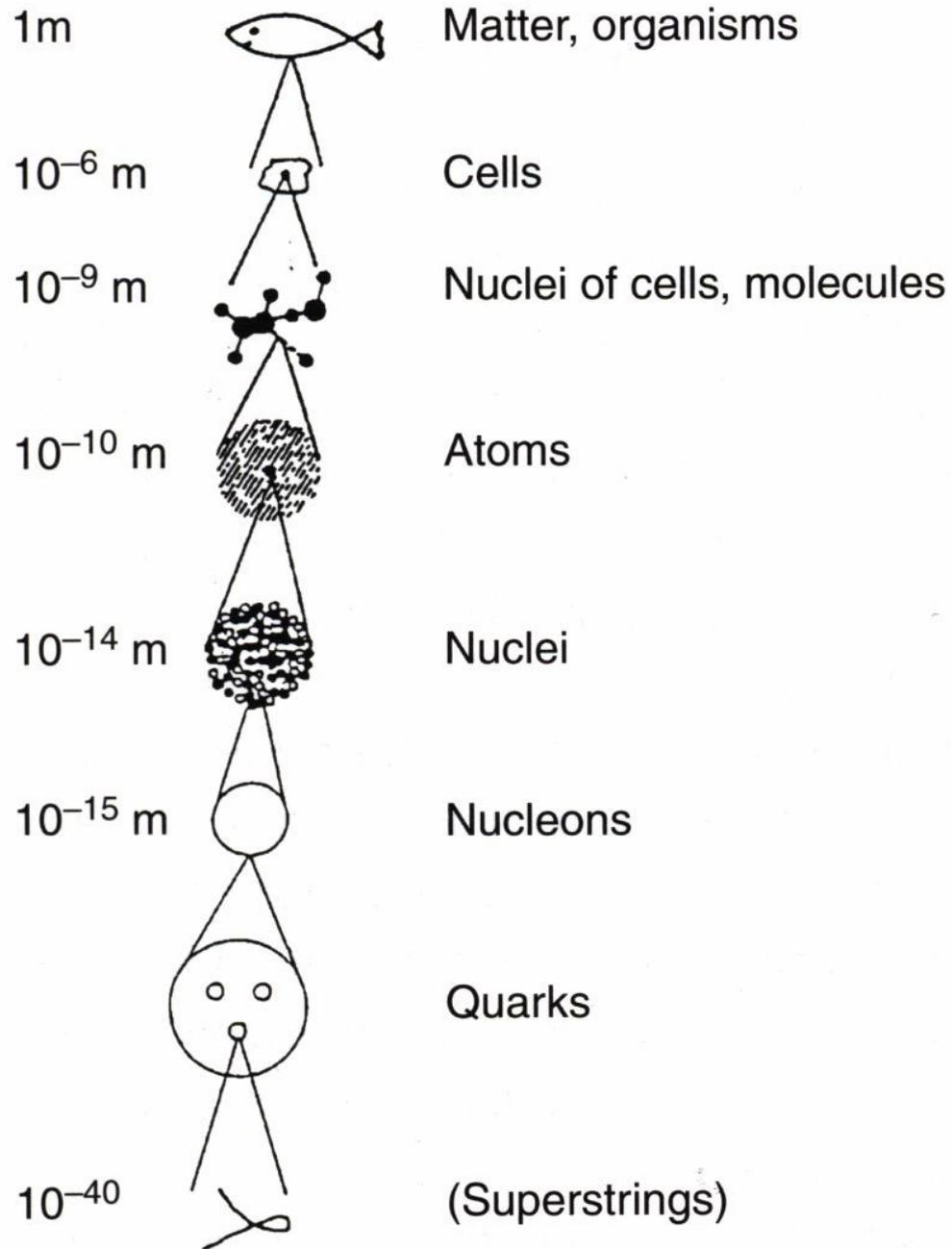
But this



4. Anti-reductionism in physics

- Everything is governed by the laws of physics
- Everything can be explained by the laws of physics

QUANTUM LADDER



Problems with the argument

- Everything is governed by the laws of physics
 - This is a metaphysical assumption. In Galileo, Descartes and Newton it is founded on the idea of God as the creator of the universe
- Everything can be explained by the laws of physics: uses of analogies
 - Important distinction between simulation and duplication

- solid state or many-body physics
- chemistry
- molecular biology
- cell biology
-
-
- psychology
- social sciences
- elementary particle physics
- solid state or many-body physics
- chemistry
- molecular biology
- cell biology
-
-
- psychology
- social sciences

Anderson 1972

Emergence

“At each stage entirely new laws, concepts, and generalizations are necessary, requiring inspiration and creativity to just as great a degree as in the previous one. Psychology is not applied biology, nor is biology applied chemistry.”

(Anderson 1972)

"I heard the great evolutionist Ernst Mayr claiming 30 or 40 years ago, when he described emergence to Niels Bohr, Bohr said: "but we have that in physics as well! - physics is all emergent", but at the time, as usual, only Bohr knew what he meant.

In fact, the story of physics in the last half of the 20th century has been one of emergence – Bohr was also, as usual, basically right."

" (P. Anderson: "What is a Condensed Matter Theorist?", in Philip W. Anderson: *More and Different*, World Scientific 2011

Examples of emergent physical properties

- A simple atom of gold cannot be yellow and shiny and conduct electricity. Properties of gold metal have only meaning at a macroscopic scale.
 - A molecule of salt is not a cube. Only a salt crystal can have cubic symmetry.
- (P. Anderson: "Emergence vs. Reductionism", in Philip W. Anderson: *More and Different*)

Robert B. Laughlin and David Pines: “The Theory of Everything”, PNAS 1999

“The central task of theoretical physics in our time is no longer to write down the ultimate equations but rather to catalogue and understand emergent behavior in its many guises, including potentially life itself. We call this physics of the next century the study of complex adaptive matter.”