THE BIOLOGY OF HISTORY

FROM THE BODY AS MACHINE TO THE METABOLIC COMMUNITY

AMERICAN METABOLISM

1. **Industrial Metabolism and the Logic of Conversion**

   (1839-1910)

2. **Homeostasis and Metabolic Production**

   (the twentieth century)

3. **Post-Industrial Metabolism**

   (1969-today)

METHODS

Ethnography + History + Close Reading

using ethnography to ask new historical questions, and using historical work to map the present differently.

Reading scientific literature as literature, for its temporal forms, for its account of the human condition

- (the human/animal/bacterial/cellular/molecular condition)

FINDINGS

Industrial metabolism	Post-industrial metabolism
Energy	Information
Manufacturing	Regulation
Substrate (calorie)	Signal (timing)
Waste accumulation	Functional asynchrony
Labour and fatigue	Sleeping and ageing

ARGUMENTS

Not a history of biology but *a biology of history*

A recursive relation in which the matters that form centers of concern in contemporary biomedicine are produced in and by previous incarnations of those sciences.

- From controlling disease with antibiotics to antibiotic resistance
- From controlling reproduction and growth with hormones to endocrine disruptors
- From deficiency diseases to the malnutrition of excess

OTHER ARGUMENTS

- The history of metabolic science and thinking reveals the long and concerted work that has gone into separating “metabolic” properties of life from “reproductive” ones.

- The contemporary is full of “strange biologies” that fracture this nineteenth century ontology.

- Certain scientific concepts can be theoretical resources for social and cultural theory, as much about ontologies and critique as any philosophical text.

THE FIRST KIND OF BOUNDARY

"In a surprising number of contemporary feminist and queer texts…one of their core conceptual commitments is a repudiation of biological explanation. An antibiological gesture is often the ignition that starts the theoretical engine."

- Elizabeth Wilson, "Underbelly," *differences* 21(1).

“It is my concern that we have come to be astute about the body while being ignorant about anatomy and that feminism’s relations to biological data have tended to be skeptical or indifferent rather than speculative, engaged, fascinated, surprised, enthusiastic, amused, or astonished.”

- Elizabeth Wilson, “Gut Feminism,” *differences* 15(3).

OTHER BOUNDARIES

Epigenetics/genetics

Reproduction/metabolism

Sense/viscera

Outside/inside

Matter/information

PART 1. INDUSTRIAL METABOLISM

Metabolism was an industrial concept that did not exist before the 19th century.

THEODOR SCHWANN, 1839

MICROSCOPICAL RESEARCHES

INTO THE

ACCORDANCE IN THE STRUCTURE AND GROWTH

OF

ANIMALS AND PLANTS.

SCHWANN'S PROCESS WITHOUT MIND

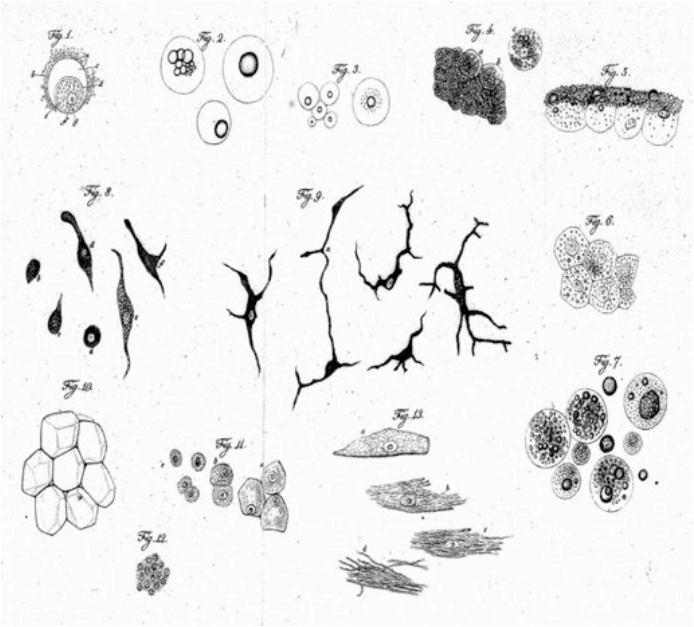
those phenomena which result from chemical change either in…the cell itself, or in the surrounding cytoblastema. These may be called *metabolic* phenomena, implying that which is liable to occasion or suffer change.

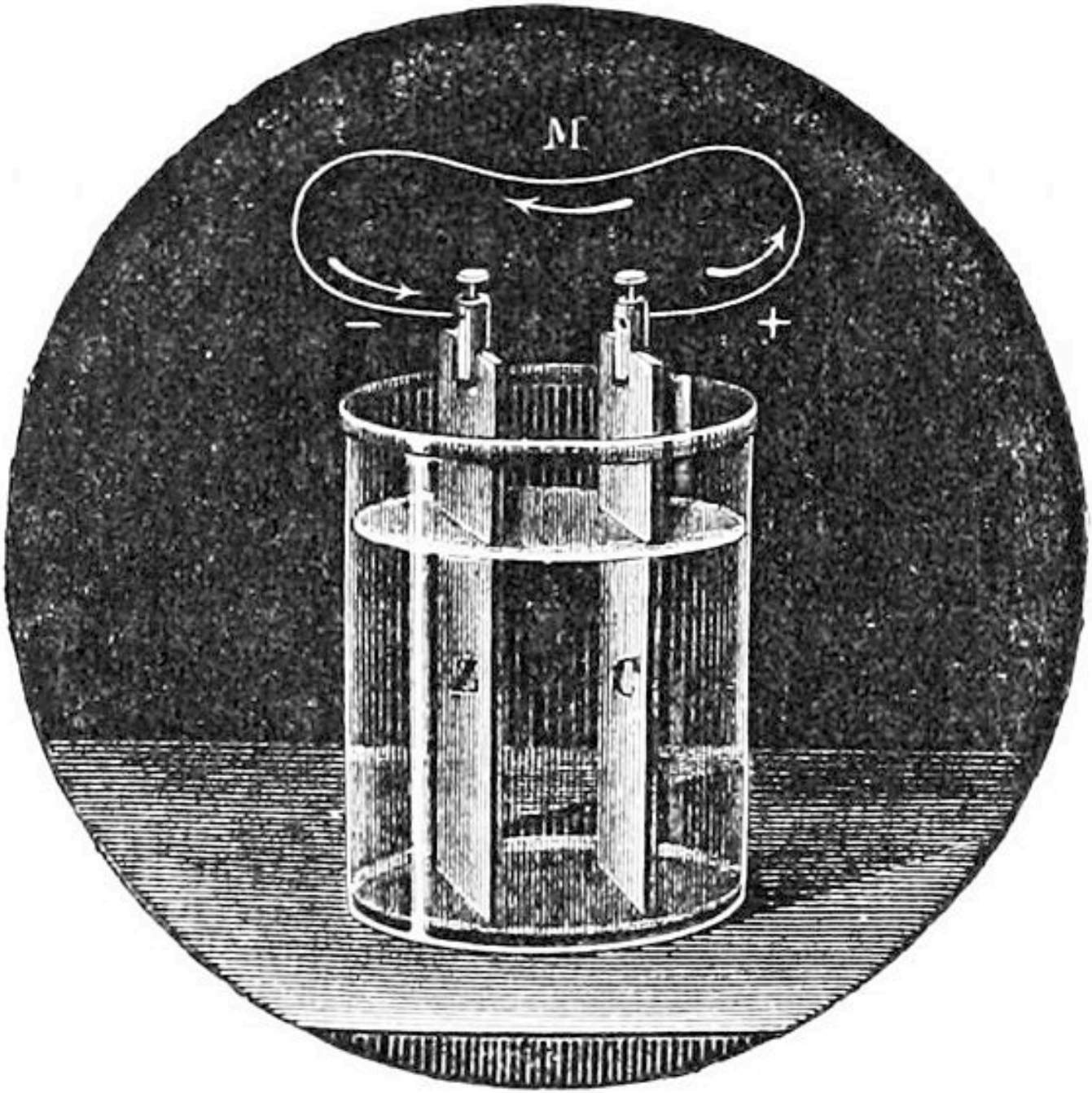
Can be separated from those attending the formation of cells: the *plastic*.

- Theodor Schwann, *Mikroskopische Untersuchungen, 1839*

CELL THEORY

the attractive and metabolic powers of cells are ‘set free only by a certain combination of molecules, as, for instance, electricity is set free by the combination of a zinc and copper plate’

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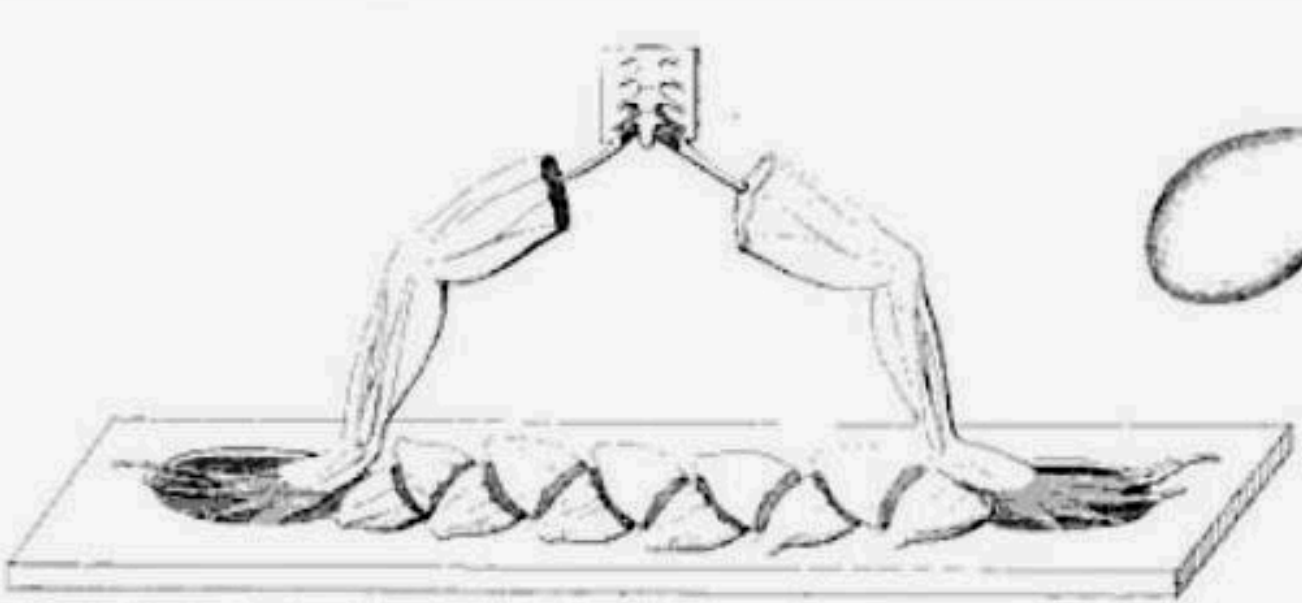
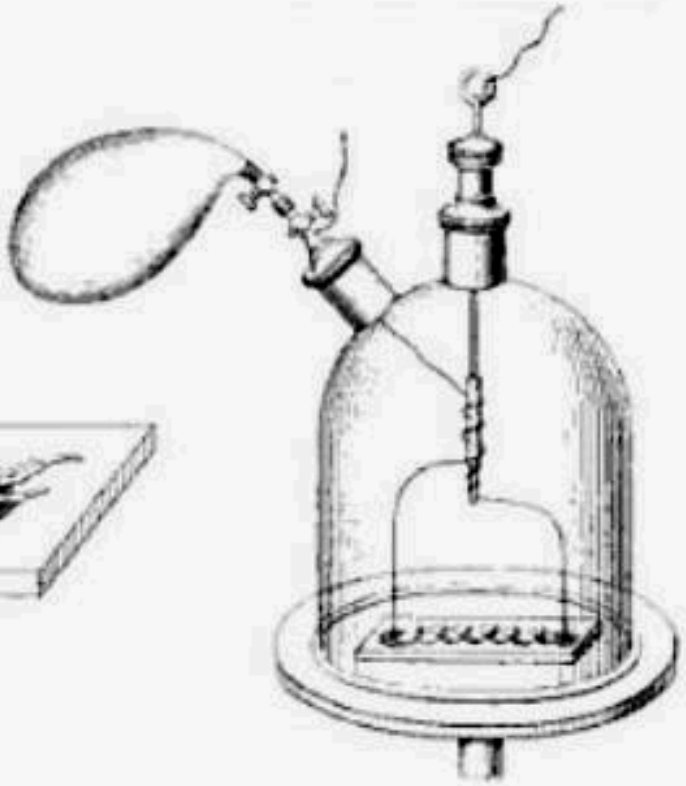
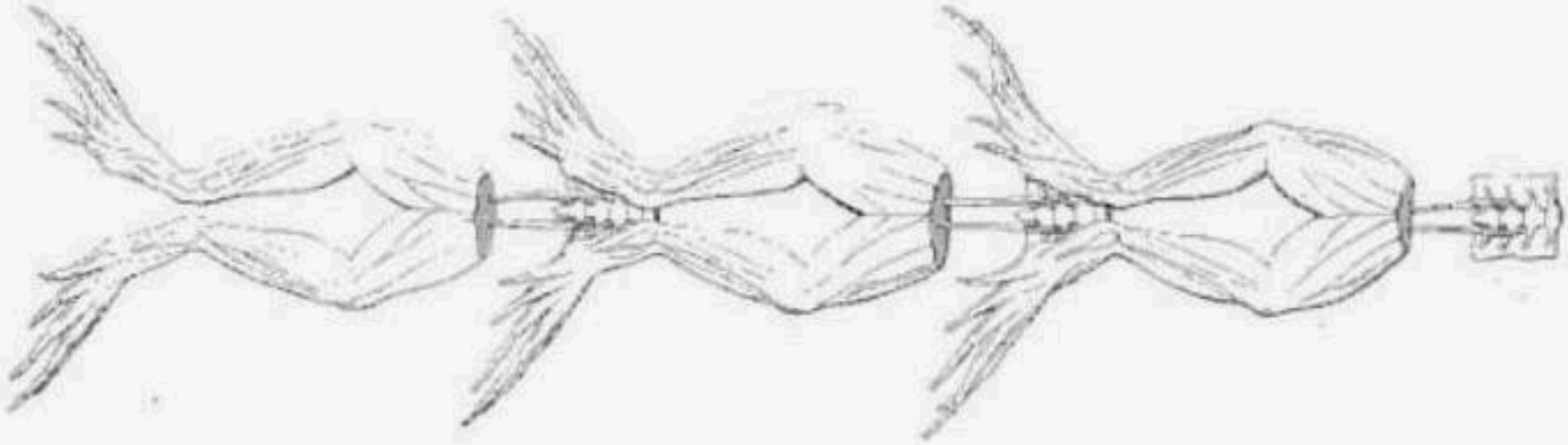






A

New Digeſter

OR

ENGINE

FOR SOFTNING

BONES,

CONTAINING THE

DESCRIPTION

Of its *Make* and *Uſe* in theſe Particulars :

VIZ.

Cookery, Voyages at Sea , Confectionary, Making of Drinks, Chymiſtry, and Dying.

WITH AN

Account of the Price a good big Engine will coſt, and of the Profit it will afford.

By *DENYS PAPIN* M. D. Fellow of the ROYAL SOCIETY.

LONDON,

Printed by *J. M.* for *Henry Bonwicke* at the *Red Lyon* in S. *Paul's* Church-yard. 1681.

CLAUDE BERNARD

CLAUDE BERNARD'S NUTRITION

Nutrition and digestion are completely separate.

The dog does not get fat on mutton fat, it makes dog fat.

One does not live by his present food, but by that which he has eaten previously, modified. The food first disappears, as a definite chemical material, and it is only after extensive organic work, after a complex vital elaboration, that the food comes to constitute the reserves, always identical, that serve for the nutrition of the organism.

Claude Bernard
The Phenomena of Life Common to Plants and Animals, 1878

EPISTEMIC SPACE

"…the transition, in the late nineteenth century, of heredity as a *space* of thought and practice to heredity as embodied in particular objects."

The model organism, the pea plant etc.

The transition of metabolism as a space of thought and practice to embodied in particular objects:

The enzyme-catalyzed reaction

(Rheinberger & Müller-Wille, *A Cultural History of Heredity)*

IN SHORT

The logic of total conversion

And the politics of hunger, labour, & energy

Gets inserted into the cell

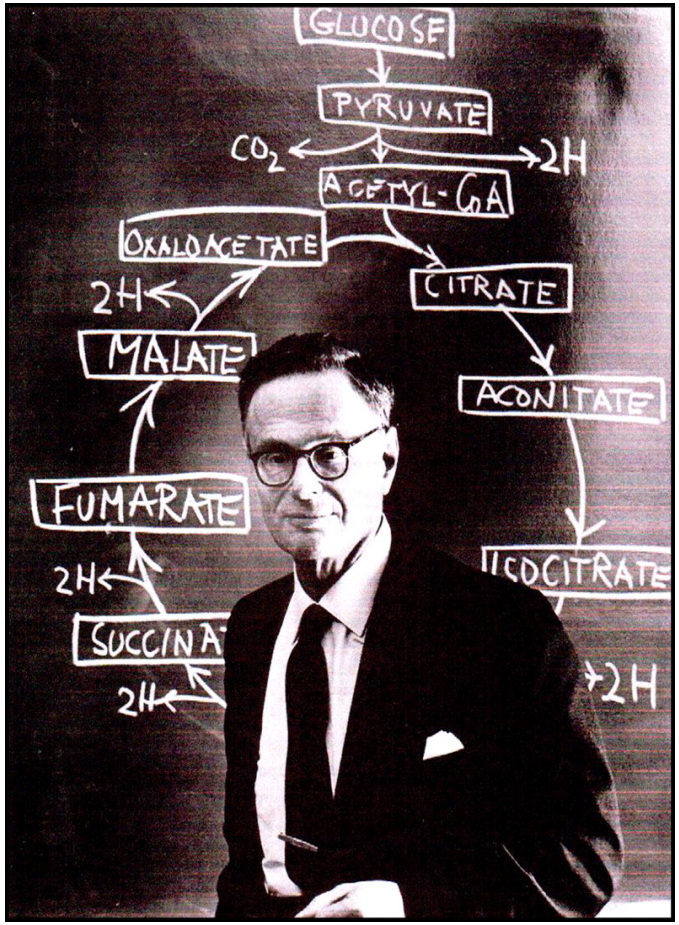
And called metabolism

Which is a separate (chemical) power and process from the hereditary

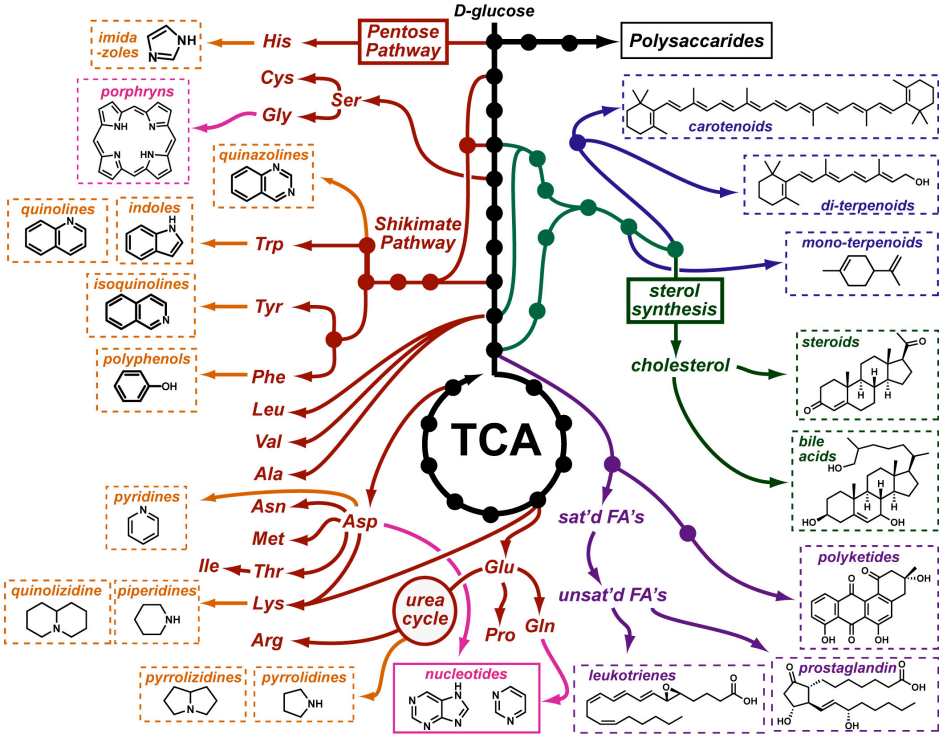
The ultimate aim of biochemists may be stated as a complete account of intermediary metabolism, that is to say, of the transformations undergone by matter in passing through organisms.

- JBS Haldane, “The Biochemistry of the Individual”, 1937

KREBS CYCLE, 1937



THE TWENTIETH CENTURY



PART 2: SOCIETY AS A METABOLIC LANDSCAPE

Food as information

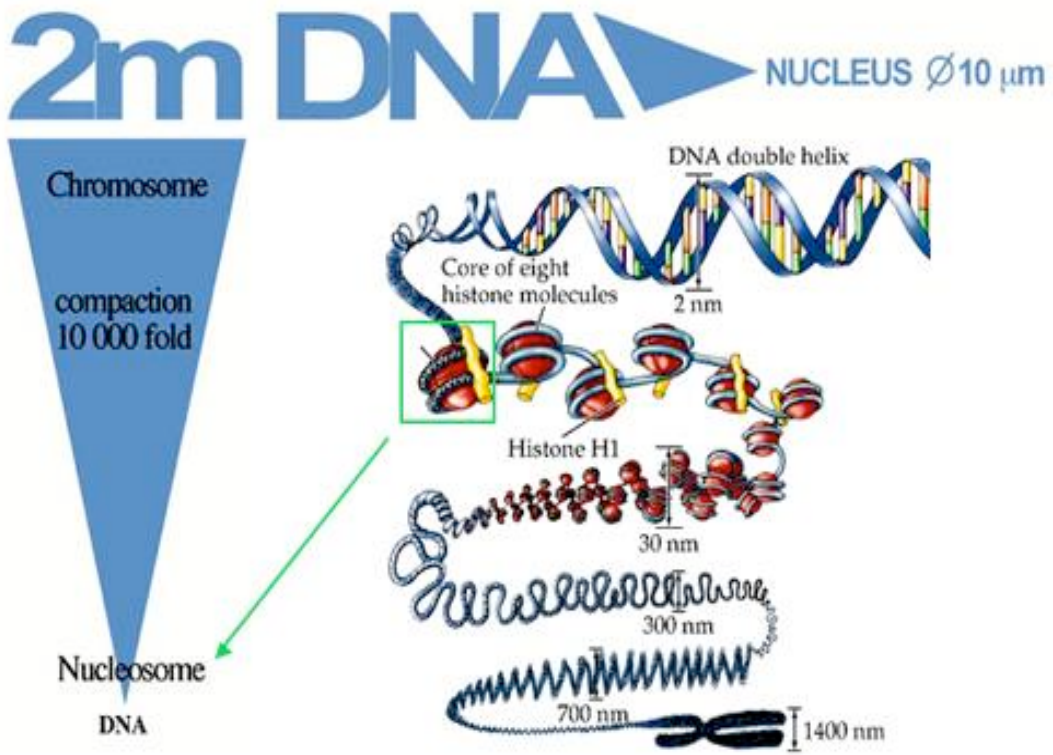
Nutrition or energy balance as a (temporal) signal

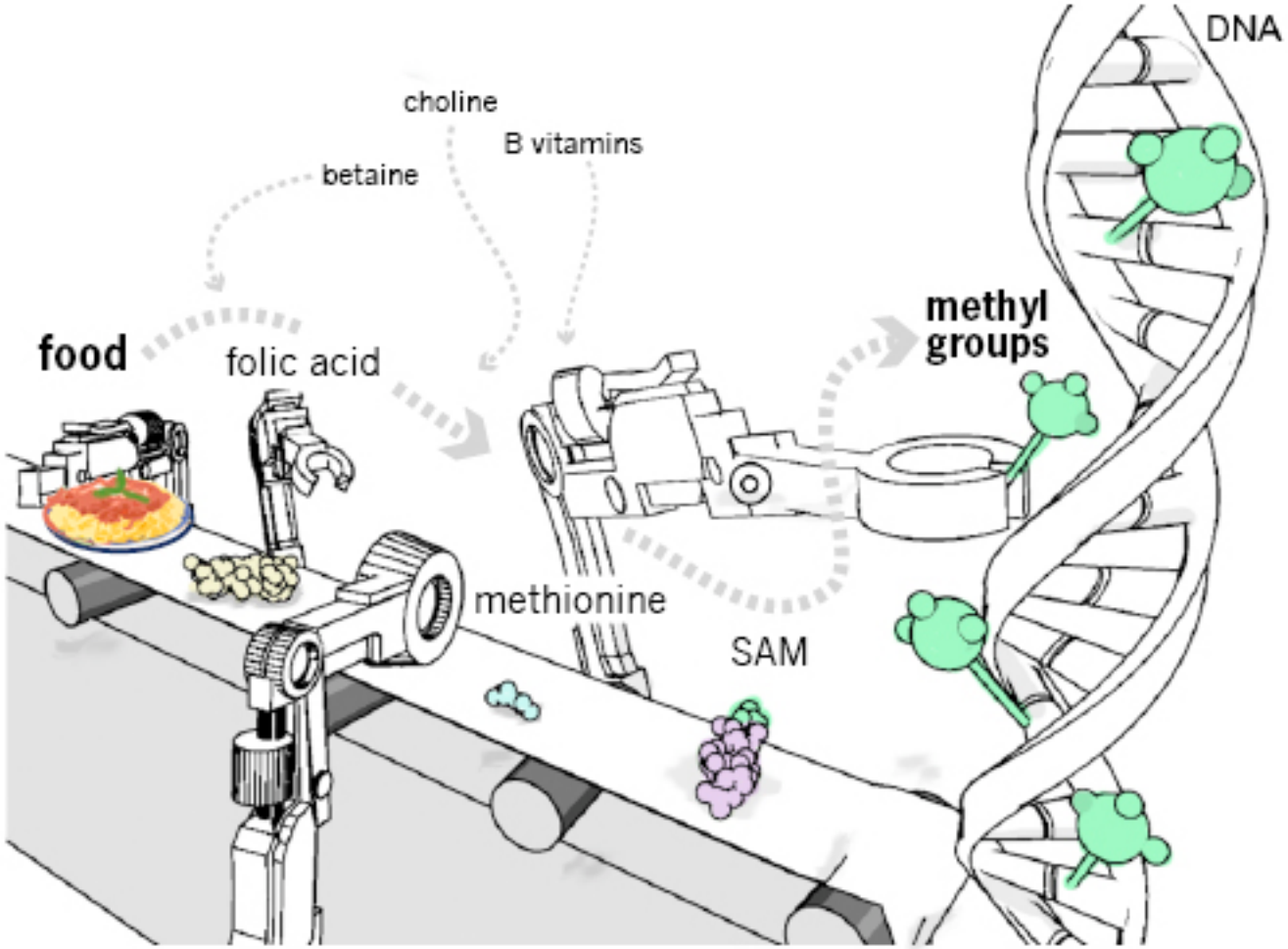
Foodstuffs as specific in terms of the epigenetic imprint they leave

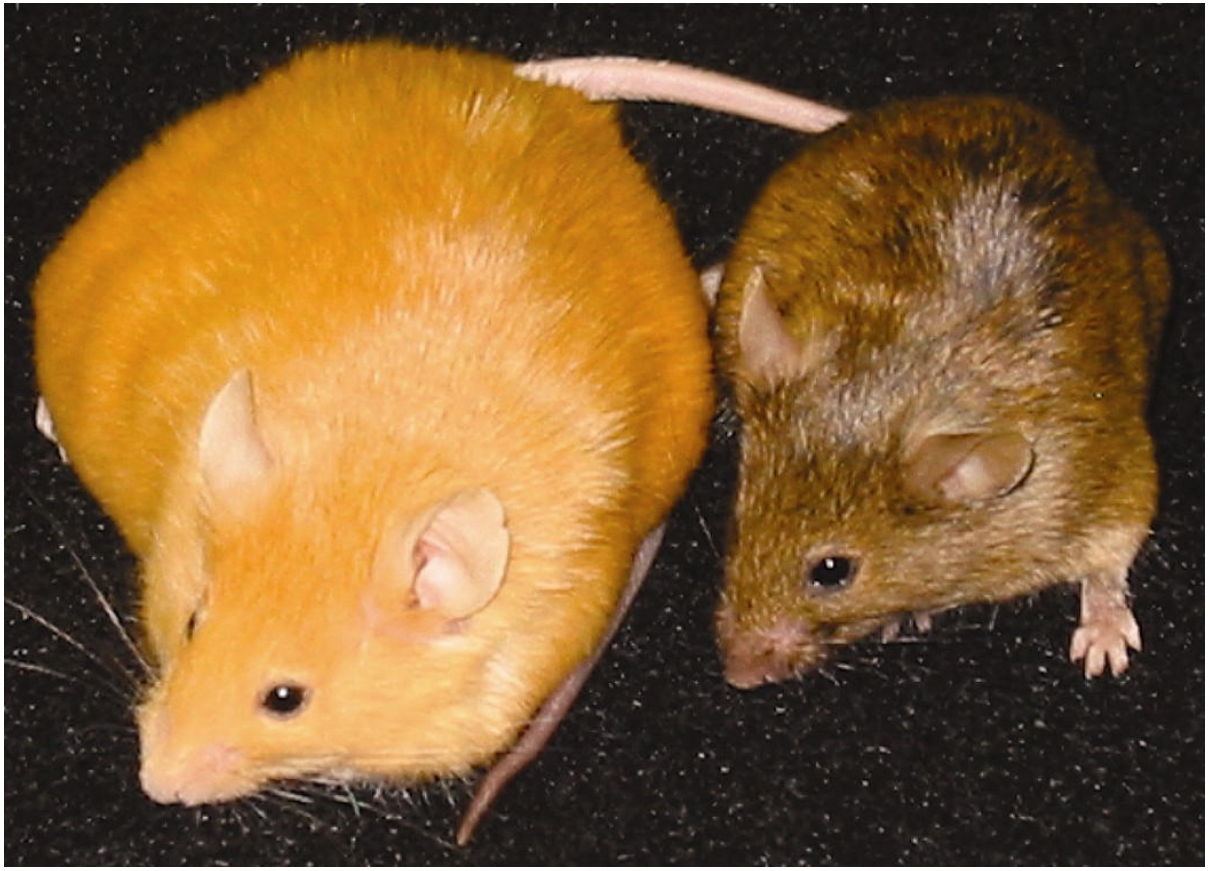
THE BODY OF CHROMATIN

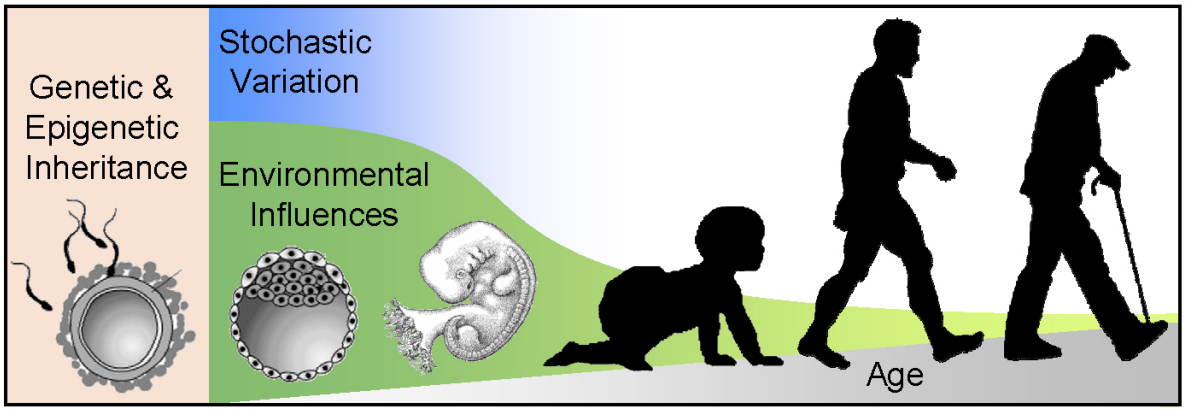
- “the physiological form of our genome” (David Allis)
- “the gene’s phenotype” (Eva Jablonka)

Fig.1 Chromatin organization of higher eukaryotes.



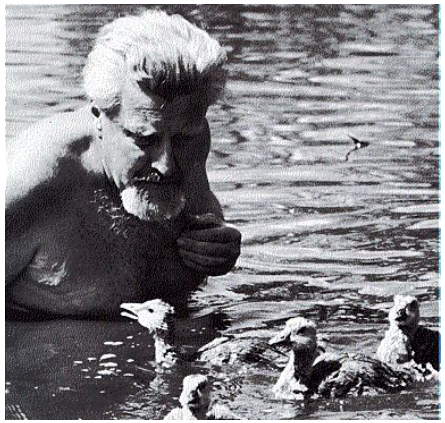

DNA
choline
B vitamins
betaine
food
folic acid
methyl groups
methionine
SAM





Courtesy of R. Waterland

THE LOGIC OF THE IMPRINT



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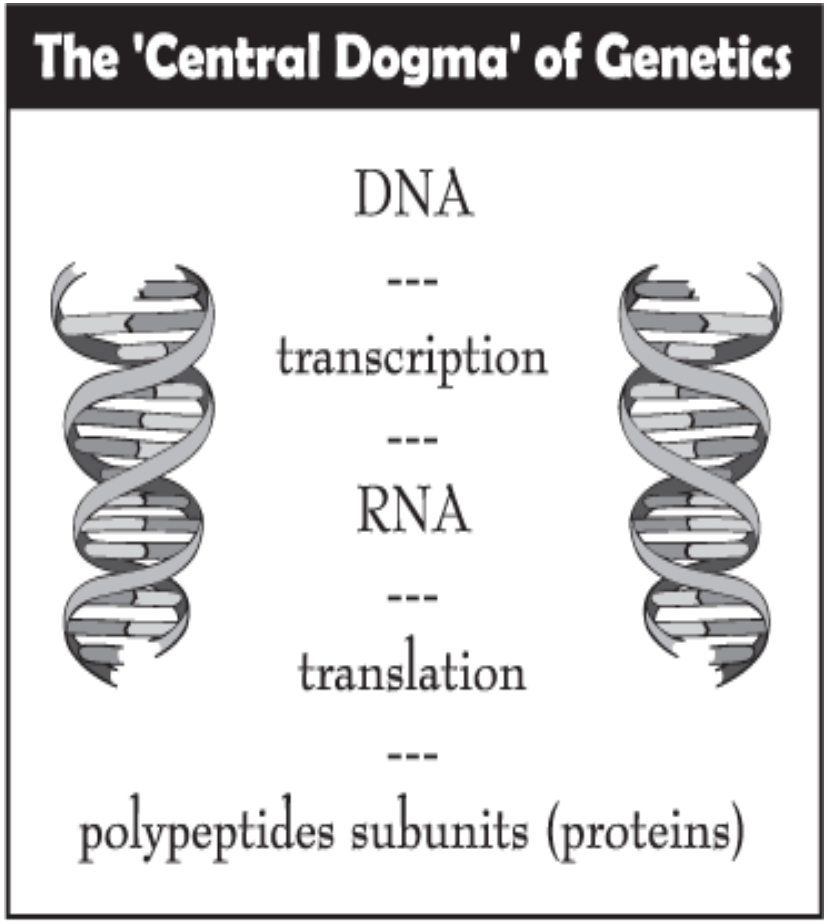
Cell Metabolism

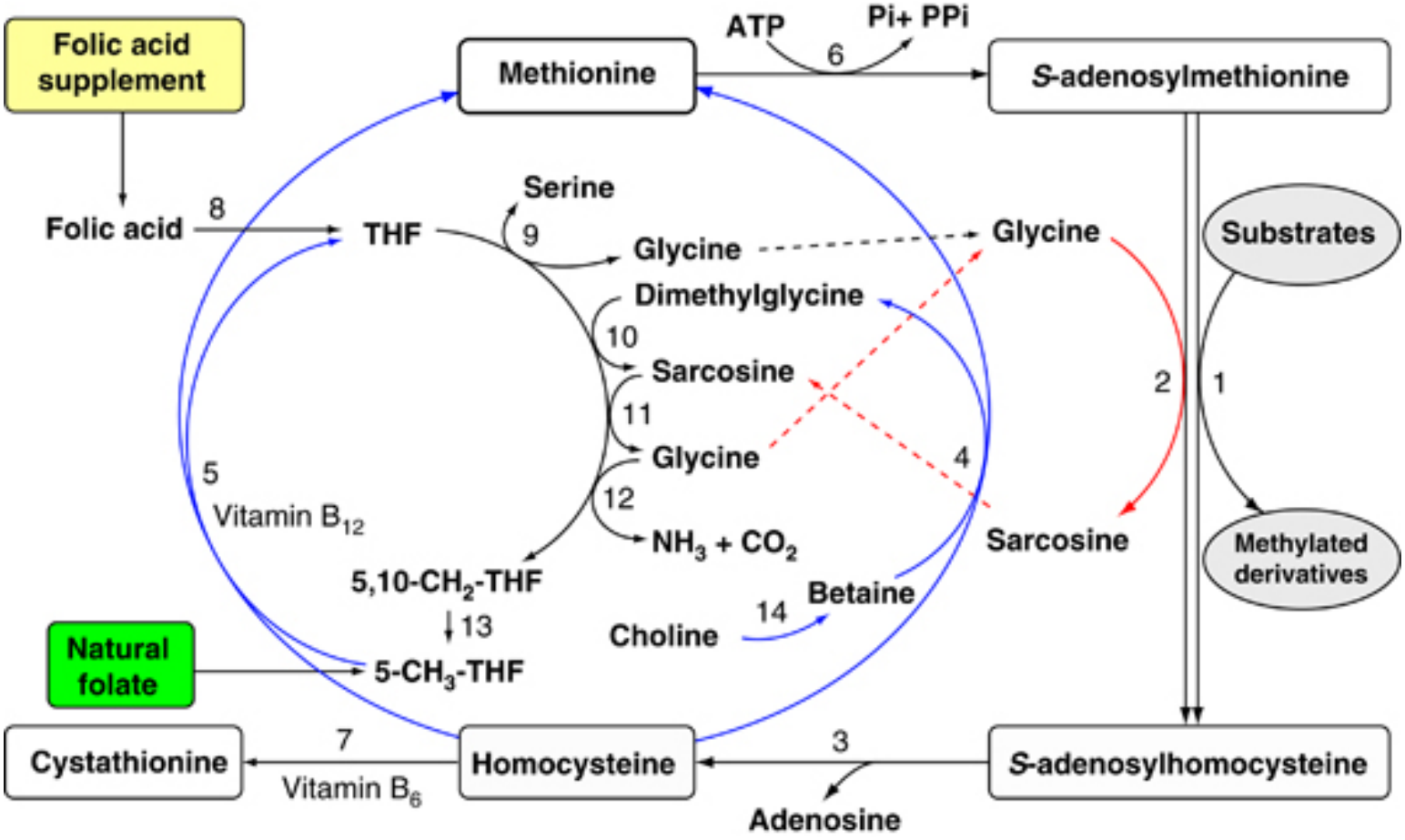
Time-Restricted Feeding Prevents Obesity

THE METABOLIC POLITICS OF THE EPIGENOME

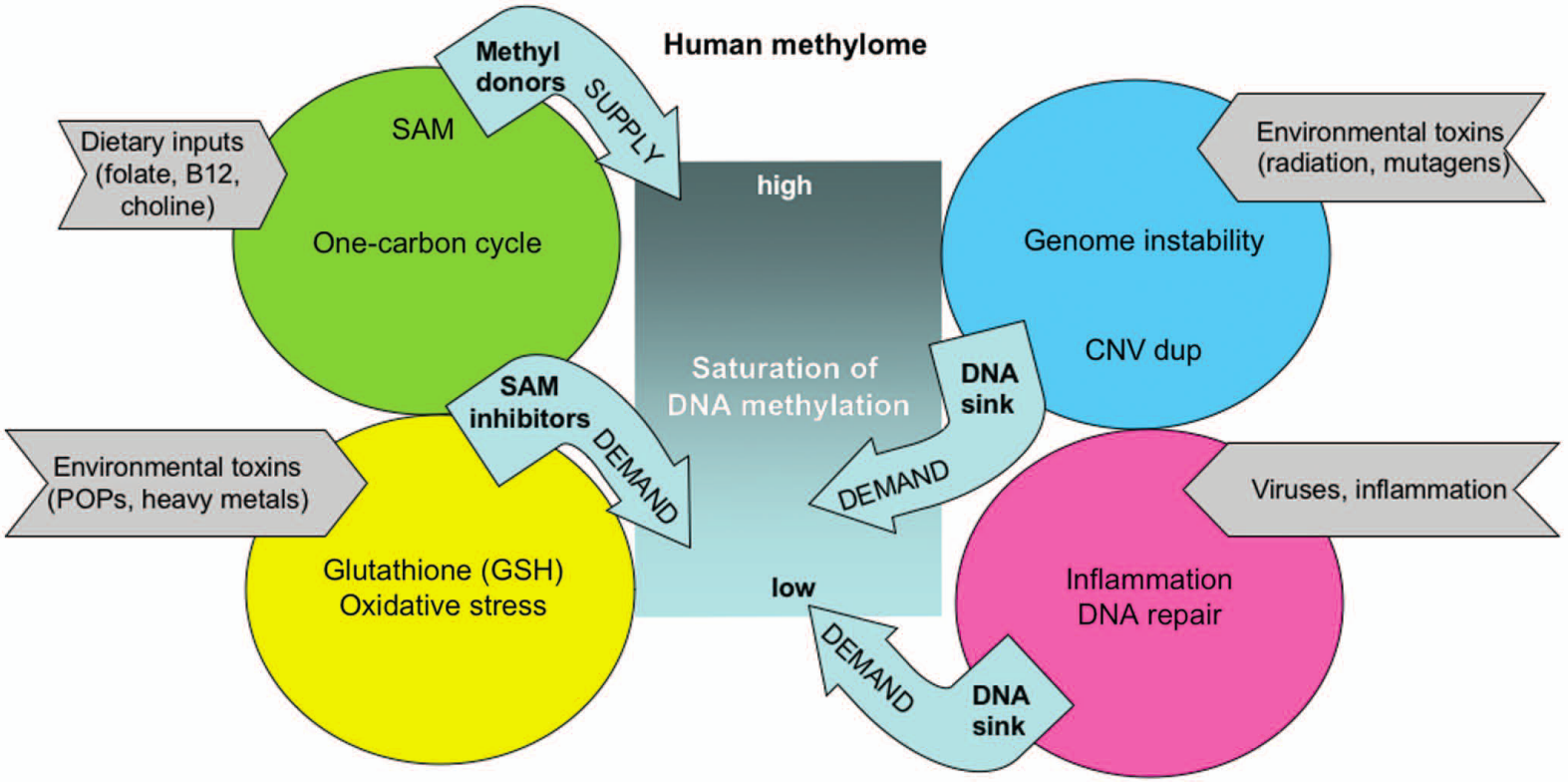


Where is Metabolism?

METABOLISM IS HERE:



SUPPLY AND DEMAND



J. LaSalle *Epigenetics* 6(7):862-869, 2011

GENOME INSTABILITY

Human DNA is 70-80% methylated (high compared to other species)

CNVs/retrotransposons highly methylated

METABOLISM

The chemical processes that occur within a living organism in order to maintain life; the interconnected sequences of mostly enzyme-catalyzed chemical reactions by which a cell, tissue, organ etc. sustains energy production, and synthesizes and breaks down complex molecules.

To metabolize: to alter within metabolism

NURTURE *METABOLIZES* NATURE

The concepts underlying genetics and metabolism are in effect merging…there is metabolism at all levels of biological organization, from the whole organism, to the cell, and finally down to the genome.

Power and Schulkin 2009, 297-298.

SOCIETY AS A METABOLIC LANDSCAPE

Mandatory folic acid fortification policies

Shift work: obesity, breast cancer, metabolic disorders

Air pollution: hypomethylation

Stress, glucocorticoids, and neurodevelopment

- Glucocorticoids in immunity, metabolism, and behavior

Malnutrition in utero: metabolic disorder in adulthood

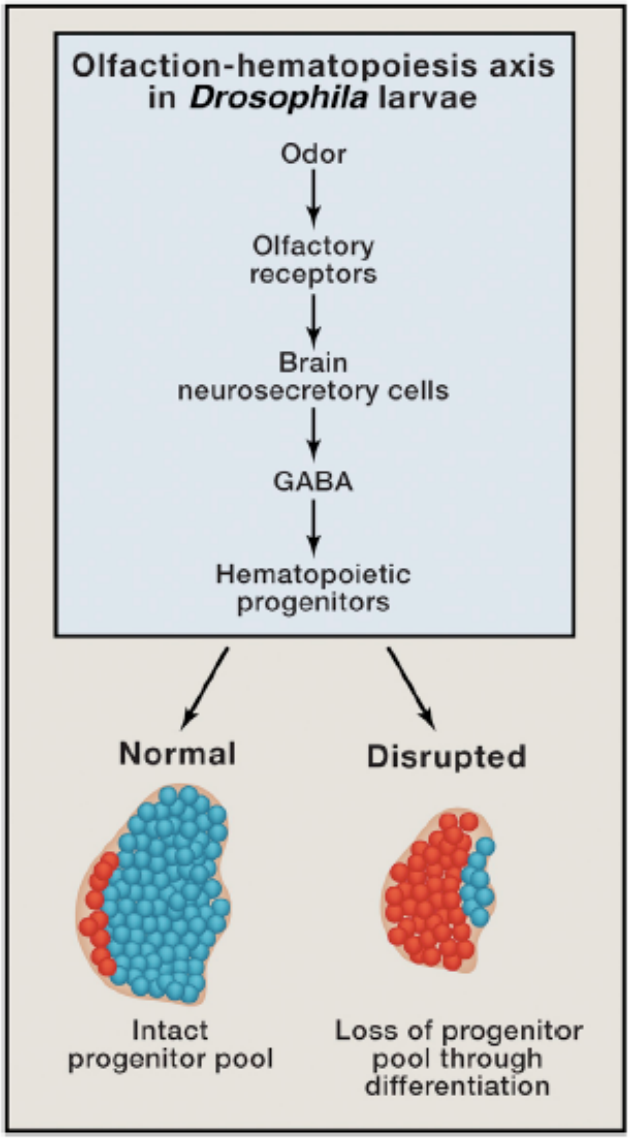
Flame retardants, lead, pesticides

Sugar

Antibiotics

PART 3: INSIDE/ OUTSIDE

Olfactory control
Of Blood Progenitor
Maintenance

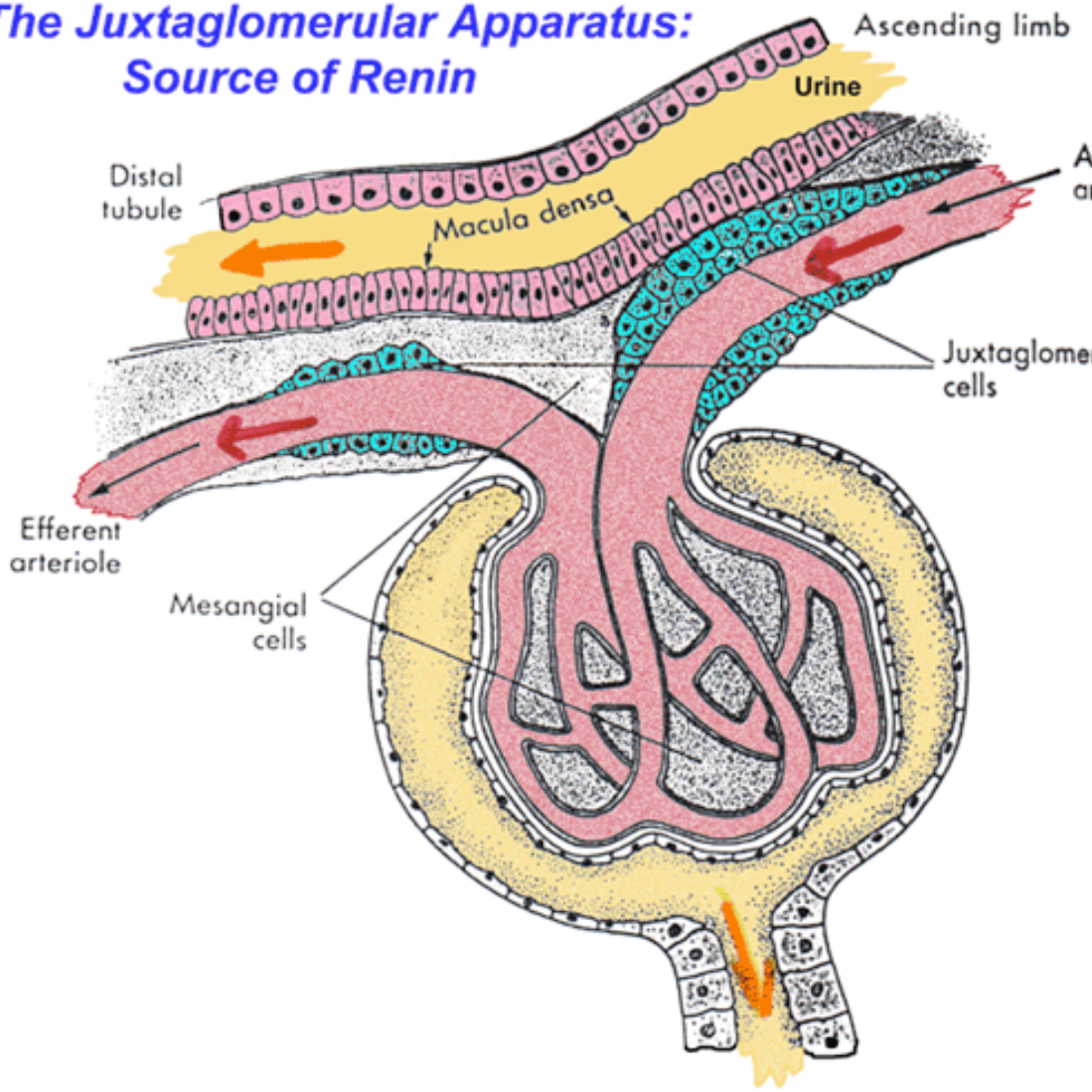


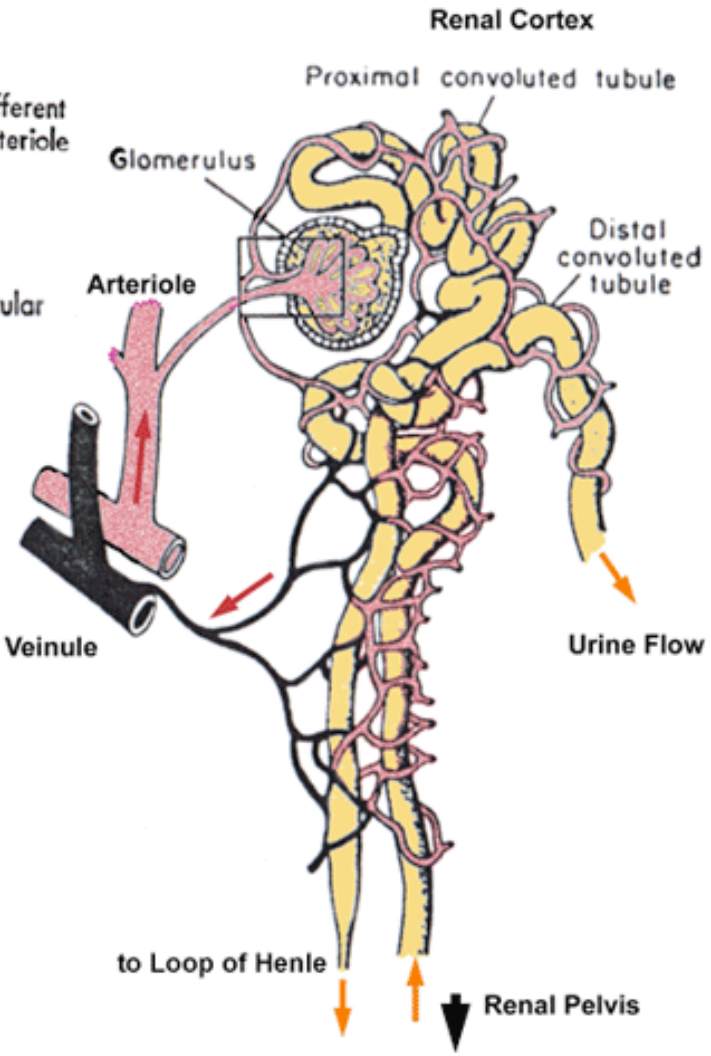
HYPERTENSION

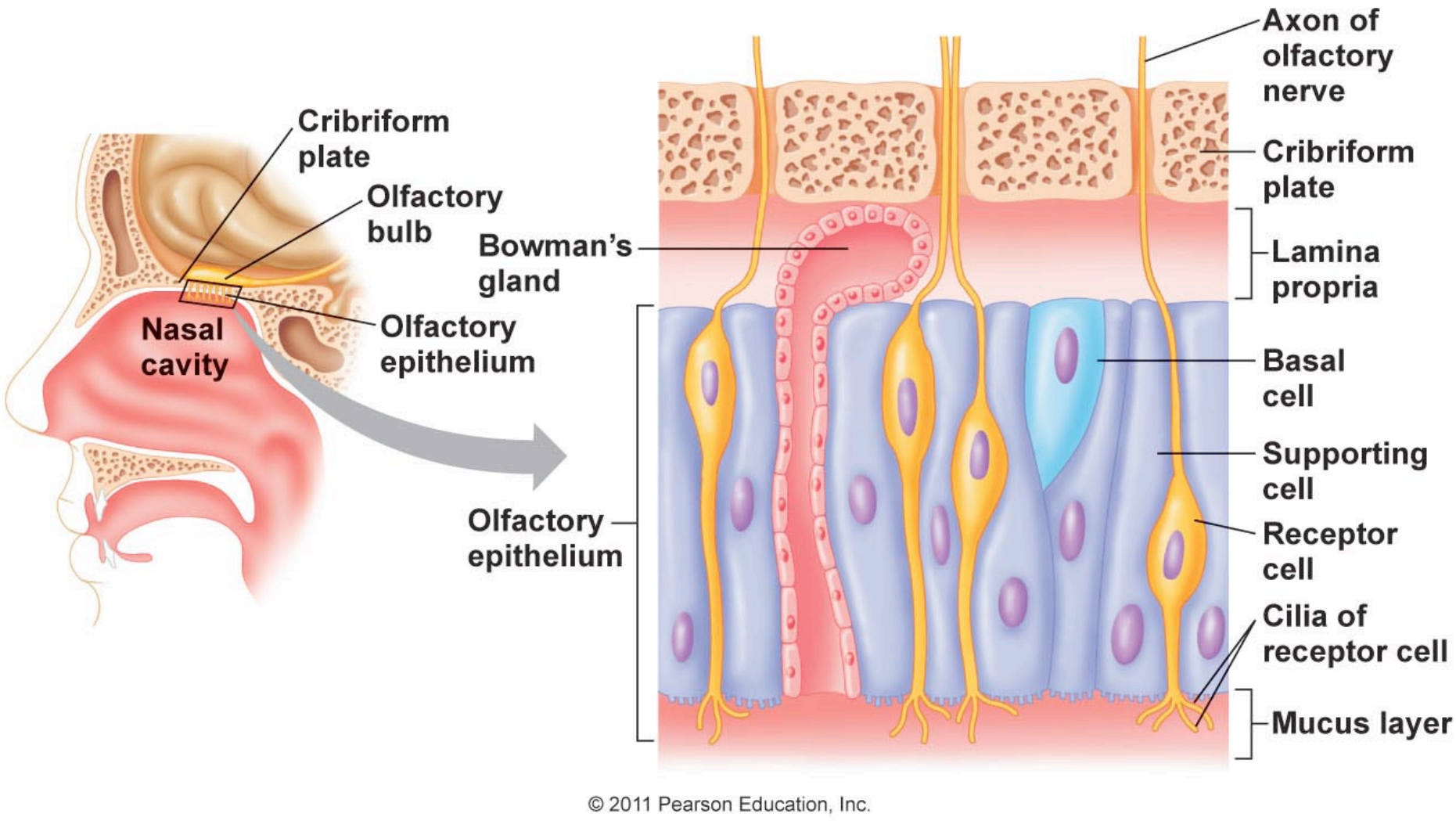
Blood pressure supposed to be a prime example of homeostatic regulation

But many live with chronic hypertension

The Juxtaglomerular Apparatus: Source of Renin







DISCOVERY IN THE MOLECULAR ERA

- **1991: family of olfactory receptors (OR) identified**
  - (Linda Buck & Richard Axel Nobel 2004)
- **Activated by chemical ligands - odorants**
- **Ability to identify receptors and their expression outpaced connection with ligands, leaving many "orphans"**
- **1992: present in sperm, function in chemotaxis**

FAST FORWARD

- G protein coupled receptors “play key roles in organs and tissues traditionally thought of as non-sensory” (Pluznick & Caplan, 2014)

- Example:
- Olfr78 expressed in nerves and smooth muscle cells in kidney: afferent arteriole and in resistance vasculature beds
- Activation induces renin release from juxtaglomerular apparatus, resulting in rise in blood pressure

Olfactory receptor responding to gut microbiota-derived signals plays a role in renin secretion and blood pressure regulation

Jennifer L. Pluznick[a,1], Ryan J. Protzko[a], Haykanush Gevorgyan[b], Zita Peterlin[c], Arnold Sipos[b], Jinah Han[d], Isabelle Brunet[e], La-Xiang Wan[f], Federico Rey[g], Tong Wang[f], Stuart J. Firestein[c], Masashi Yanagisawa[h,i], Jeffrey I. Gordon[g], Anne Eichmann[d], Janos Peti-Peterdi[b], and Michael J. Caplan[f]

[a]Department of Physiology, The Johns Hopkins University School of Medicine, Baltimore, MD 21205; [b]Departments of Physiology and Biophysics and

Also:
Pluznick, Jennifer L., and Michael J. Caplan.
"Chemical and Physical Sensors in the Regulation of Renal Function."
Clinical Journal of the American Society of Nephrology (2014).

AND

- Polycystin-1-like-3 and polycystin-2-like-1 proteins associate to form sour taste receptor in tongue

And

- Detect pH in the spinal column.

- Bitter taste receptors in lung regulate bronchodilation and ciliary beat frequency

IN OTHER WORDS

The outside isn't always converted into the self

Metabolism is not just building and rebuilding a phenomenal unity that is self-same

The input is not just a substrate, or a reagent, but its own entity, with its own agency and temporal persistence

A topochemical theory of experience

The ultimate aim of biochemists may be stated as a complete account of intermediary metabolism, that is to say, of the transformations undergone by matter in passing through organisms.

- JBS Haldane, “The Biochemistry of the Individual”, 1937

Organisms passing through matter

OTHER CONCLUSIONS

Kidneys can be as interesting as philosophers.

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