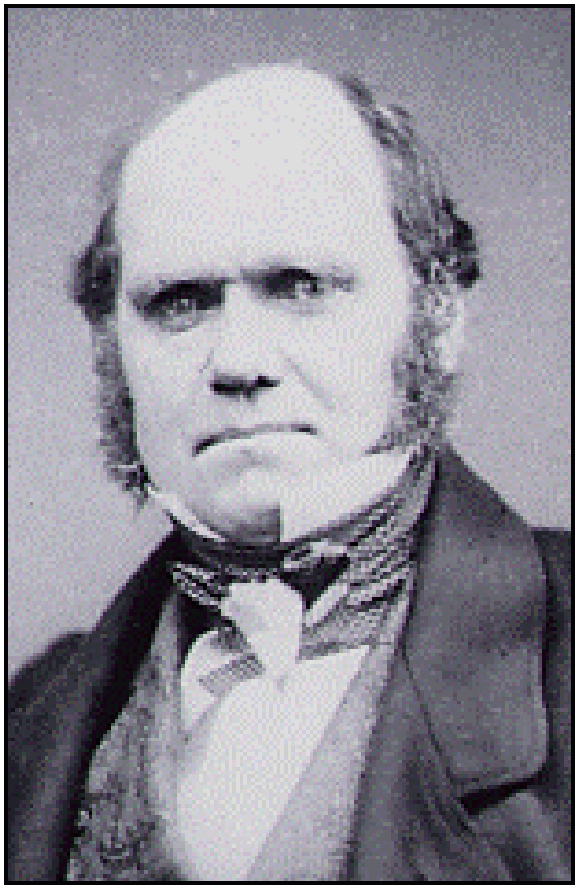
Evolution, Molekularbiologie und Weltbild

Peter Schuster

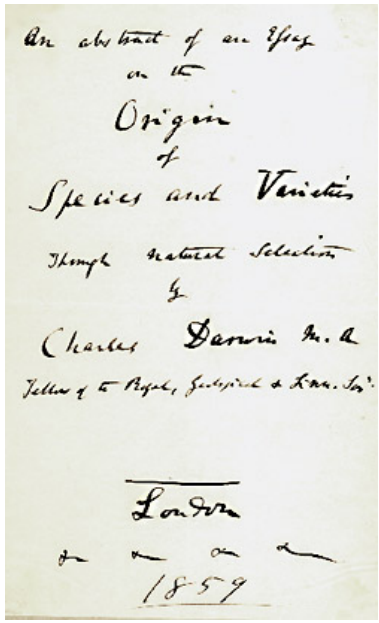
Institut für Theoretische Chemie
Universität Wien, Österreich

Naturwissenschaftlich-Humanistischer Tag

Wien, BG19, 22.02.2005



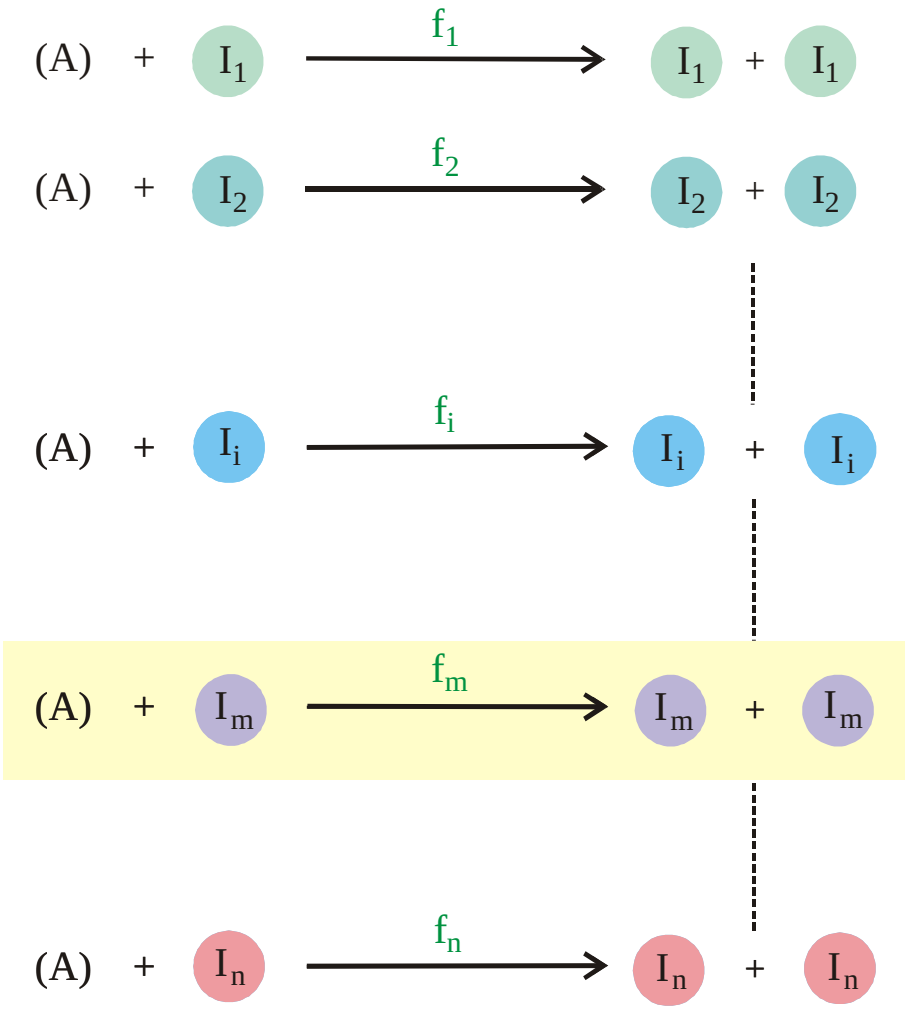
Charles Robert Darwin, 1809-1882



Earlier abstract of the
‚Origin of Species‘

Alfred Russell Wallace, 1823-1913

The two competitors in the formulation of evolution by natural selection



$$dx_i / dt = f_i x_i - x_i \Phi = x_i (f_i - \Phi)$$

$$\Phi = \Sigma_j f_j x_j ; \quad \Sigma_j x_j = 1 ; \quad i,j = 1,2,...,n$$

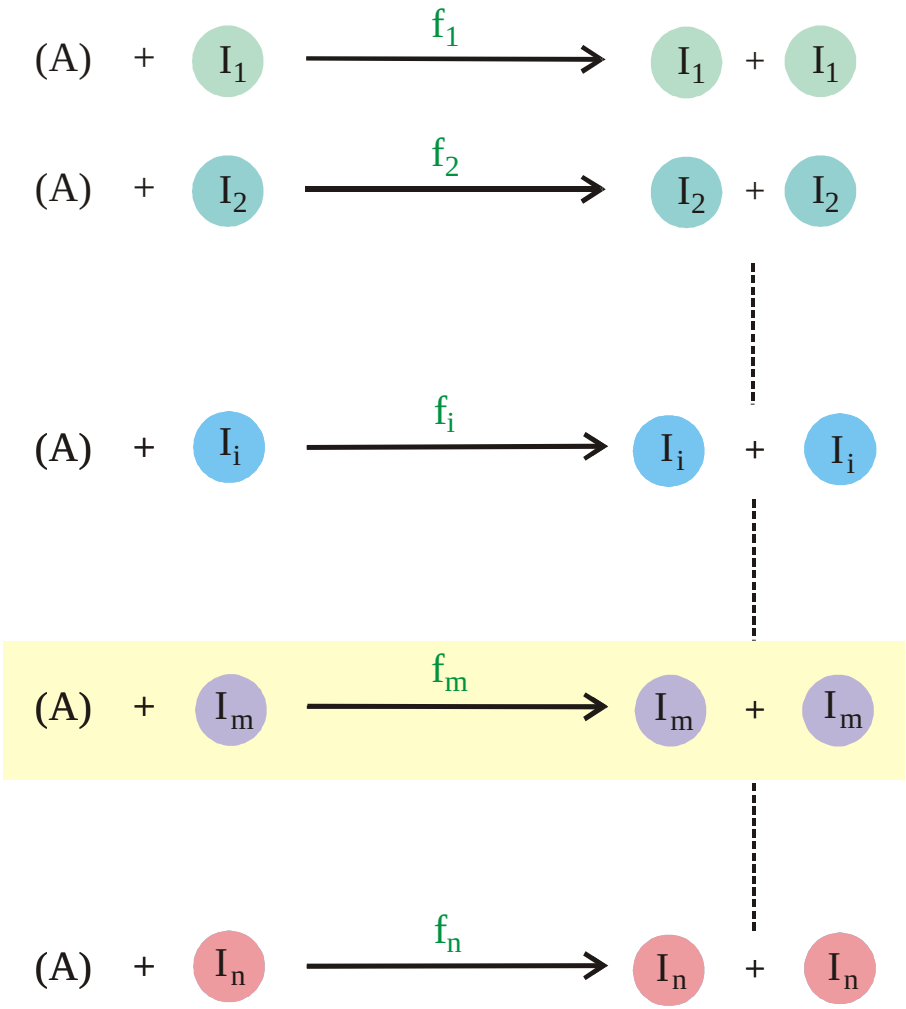
$$[I_i] = x_i \geq 0 ; \quad i = 1,2,...,n ;$$

$$[A] = a = \text{constant}$$

$$f_m = \max \{f_j; j=1,2,...,n\}$$

$$x_m(t) \rightarrow 1 \quad \text{for} \quad t \rightarrow \infty$$

Reproduction of variants as the basis of selection



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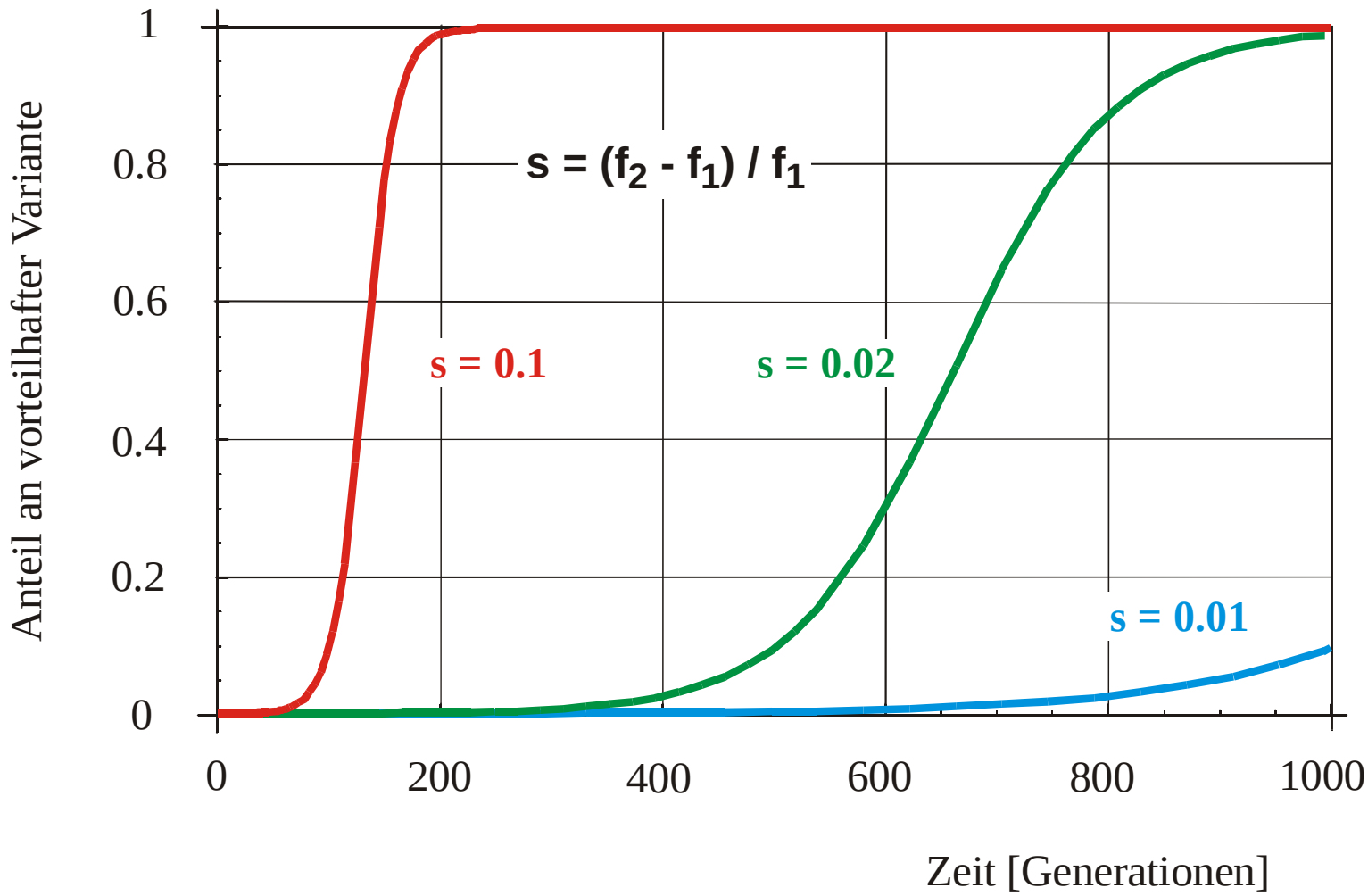
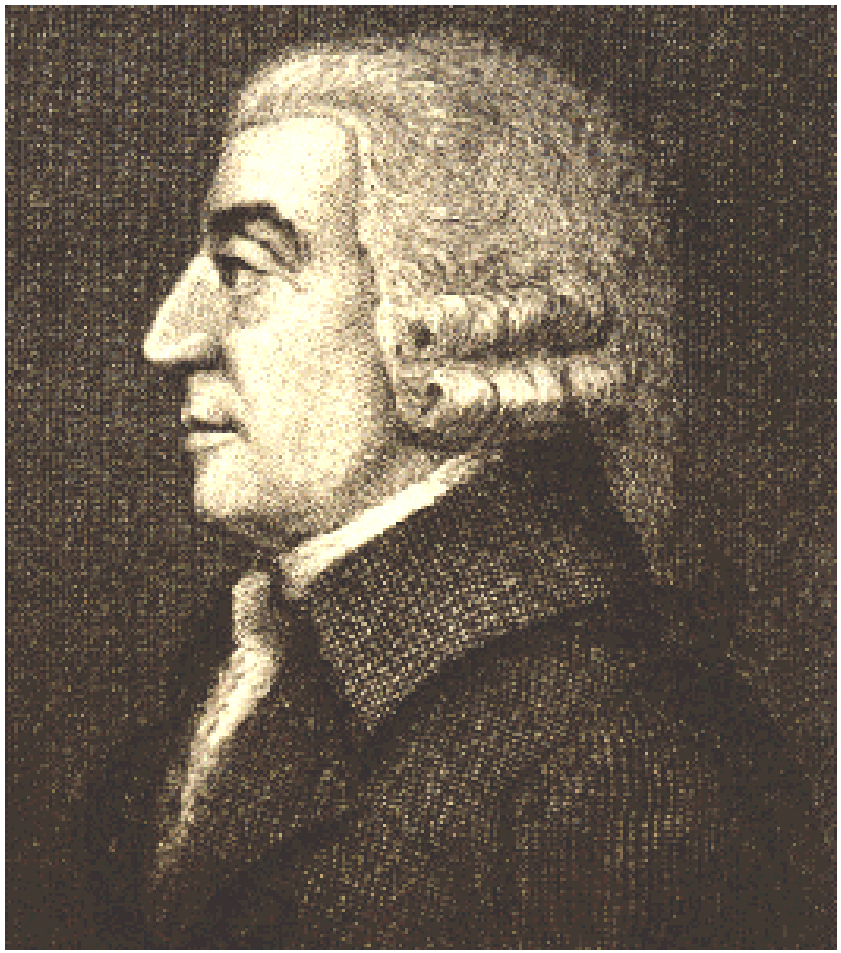
Reproduction of variants as the basis of selection


Anteil an vorteilhafter Variante
1
0.8
0.6
0.4
0.2
0
s = (f2 - f1) / f1
s = 0.1
s = 0.02
s = 0.01
0
200
400
600
800
1000
Zeit [Generationen]

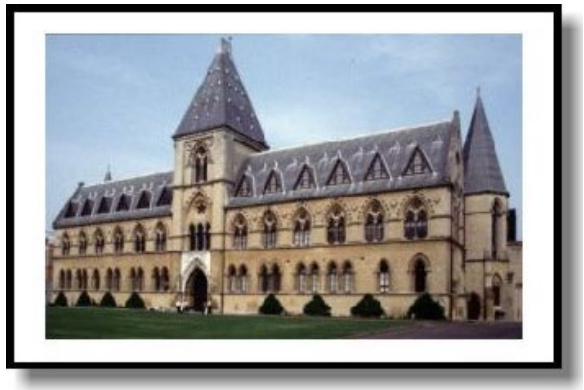
Thomas Robert Malthus, 1766 – 1834



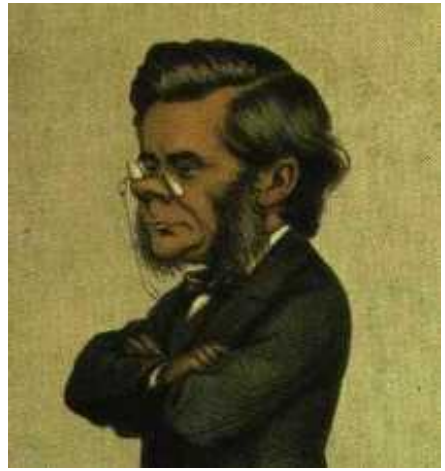
Adam Smith, 1723 - 1790

Samuel Wilberforce, 1805-1873,

asked Huxley whether it was through his grandfather or his grandmother that he claimed descent from monkeys.



British Association for the Advancement of Science: Meeting, Oxford 1860

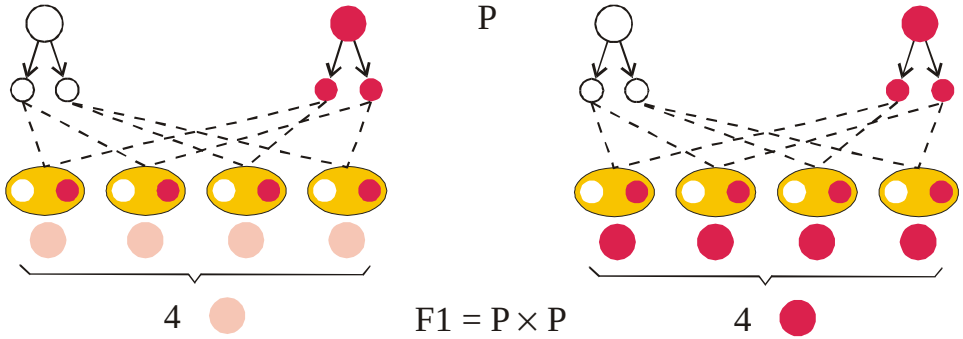


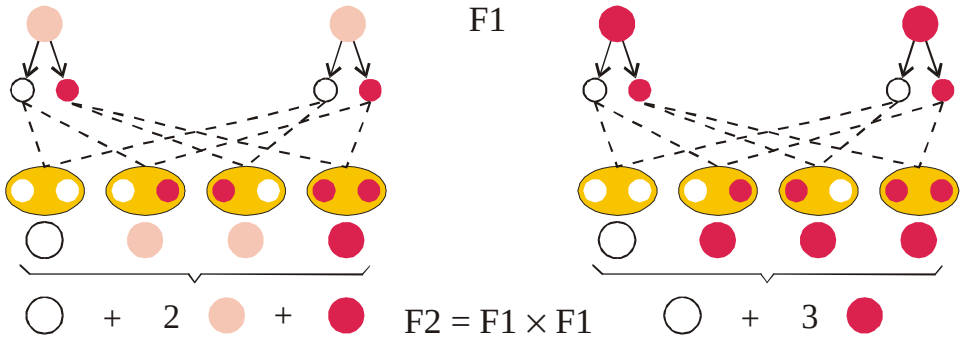
Thomas Henry Huxley, 1825-1895,

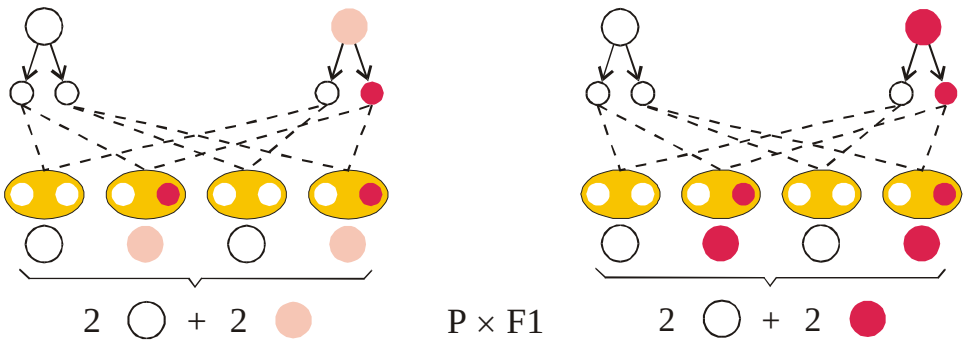
replied that if faced with the question, „would I rather have a miserable ape for a grandfather, or a man highly endowed by nature and possessed of great means and influence, and yet who employs these faculties and that influence to the mere purpose of introducing ridicule into a grave scientific discussion – I unhesitatingly affirm my preference for the ape.“

Darwin, 1809-1882,
On the Origin of Species by Means of Natural Selection; or the Preservation of Favored Races in the Struggle for Life,
First edition, 24.11.1859,
London: John Murray, Albemarle Street

The Bishop Wilberforce –Huxley debate: Oxford, 30.06.1860







Intermediate pair of alleles

Dominant/recessive pair of alleles

Gregor Mendels laws of inheritance:

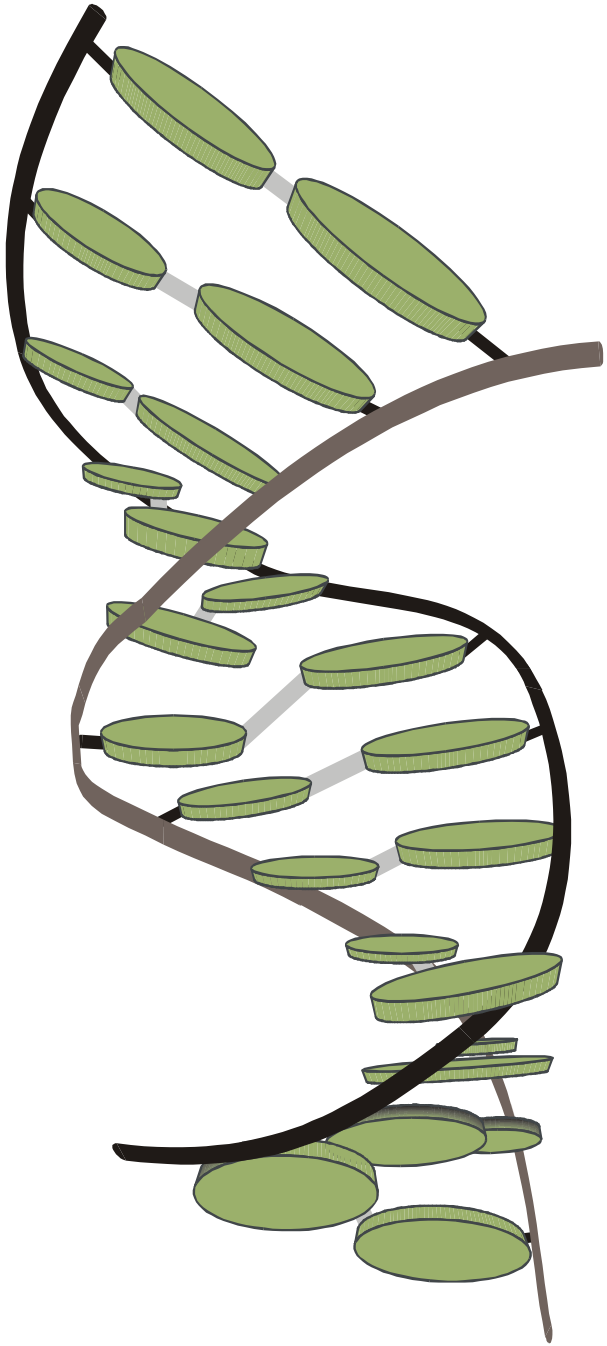
Versuche über Pflanzen-Hybriden.
Verhandlungen des naturforschenden Vereins in Brünn, **4**: 3-47 (1865)
Presented at the Meetings of 08.02. and 08.03.1865

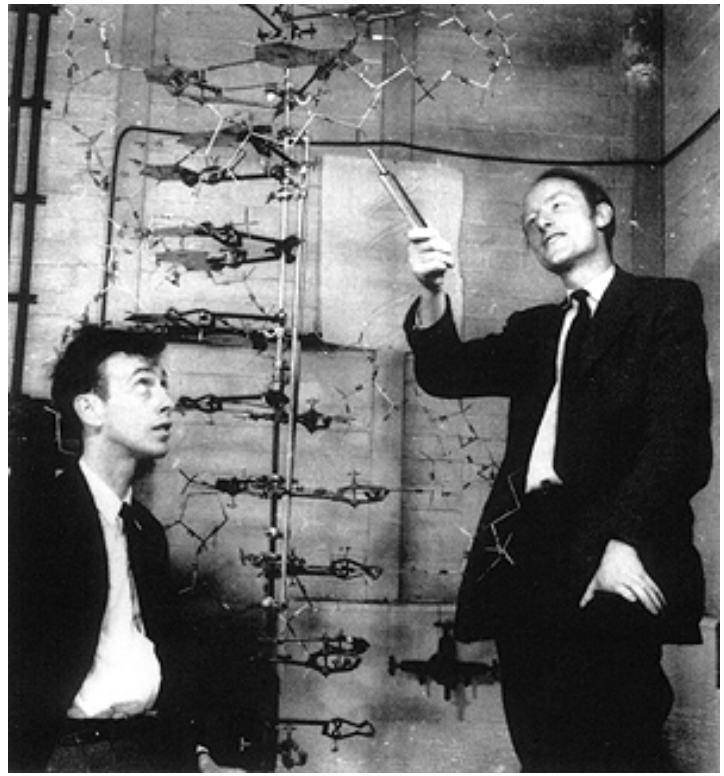
Sir Ronald Aylmer Fisher, 1890-1962

John Burdon Sanderson Haldane, 1892-1964

Sewall Wright, 1889-1988

The three scholars of theoretical population biology





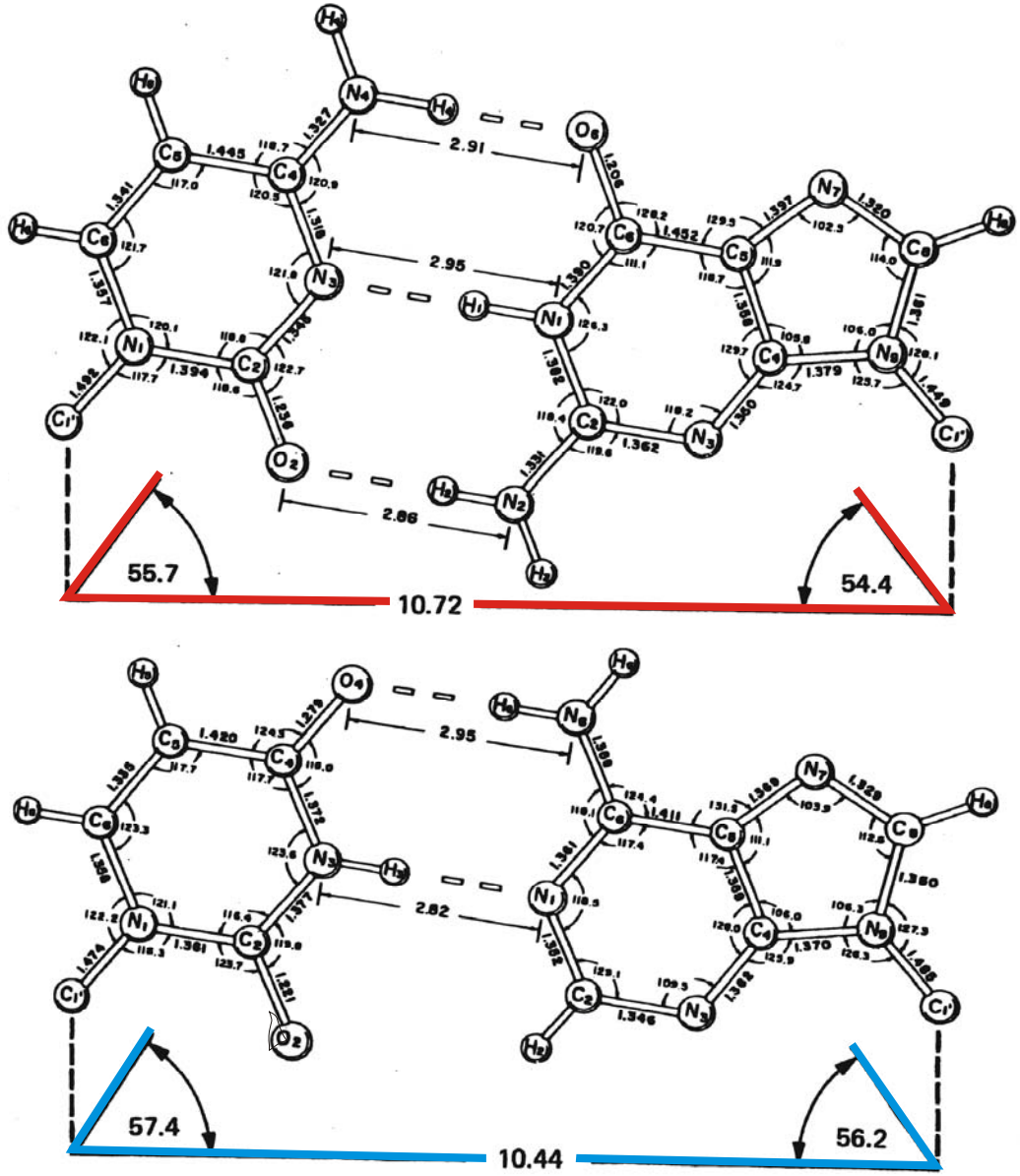
James D. Watson (1928 -) and Francis Crick (1916 – 2004)

Nobel Prize 1962

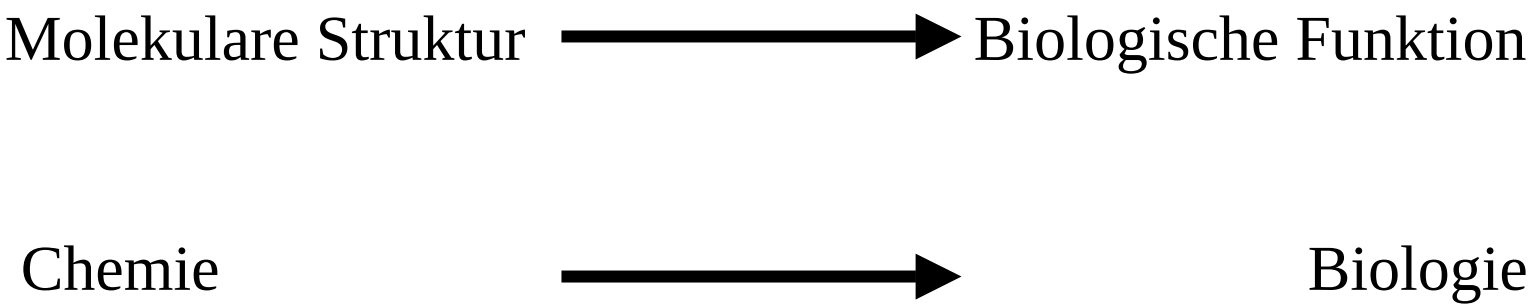
The three-dimensional structure of a short double helical stack of B-DNA

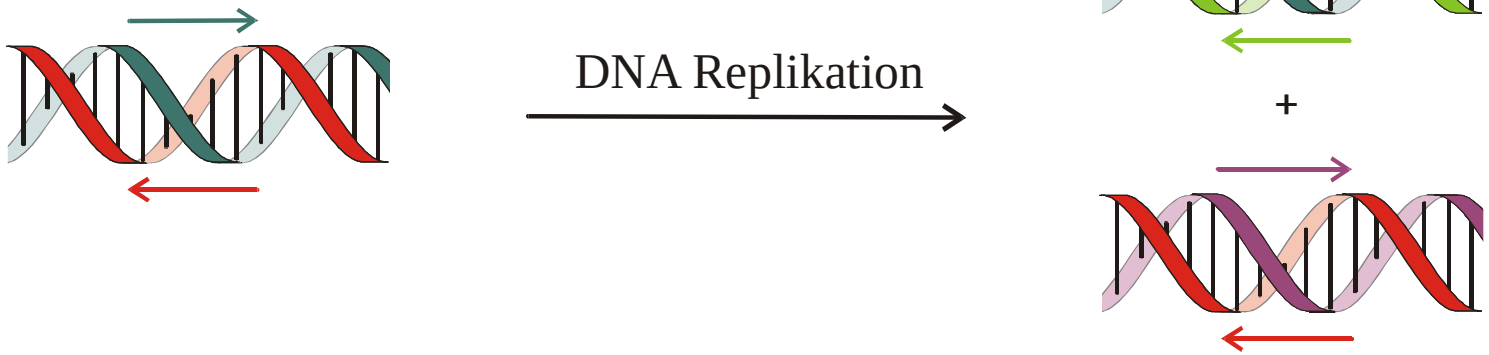
Canonical Watson-Crick base pairs:

cytosine – guanine
uracil – adenine

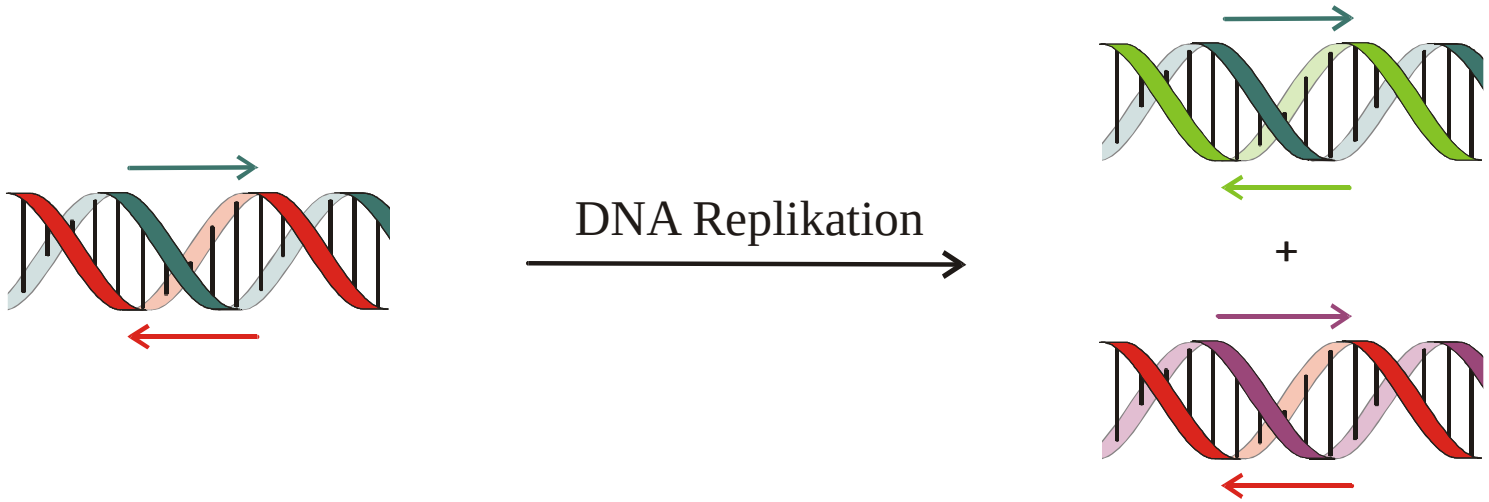


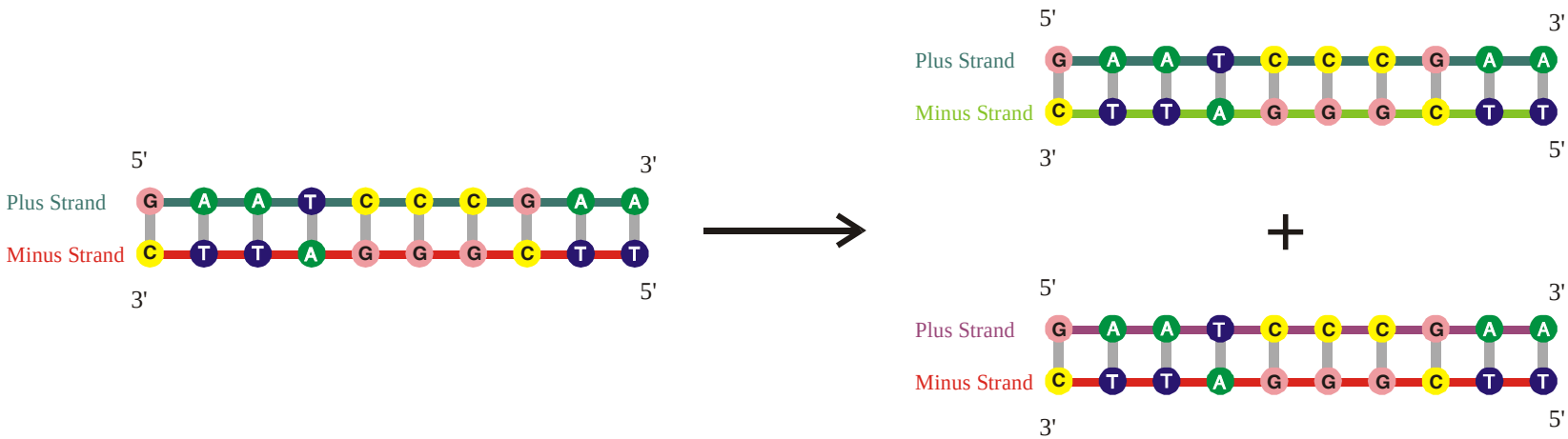
W.Saenger, Principles of Nucleic Acid Structure, Springer, Berlin 1984


Molekulare Struktur
Biologische Funktion
Chemie
Biologie



Verdopplung von DNA-Molekülen durch Kopieren – “**Direkte Replikation**”





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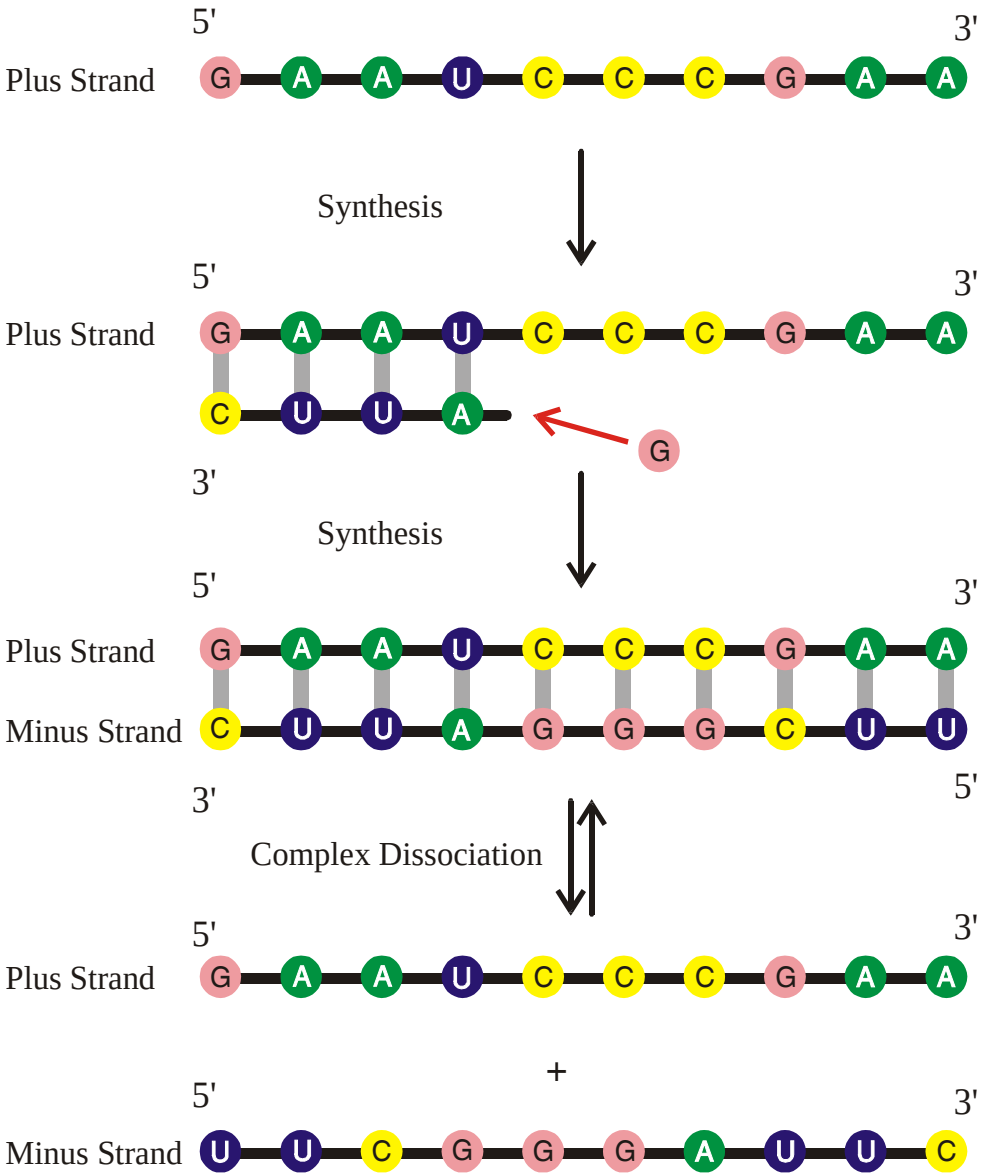
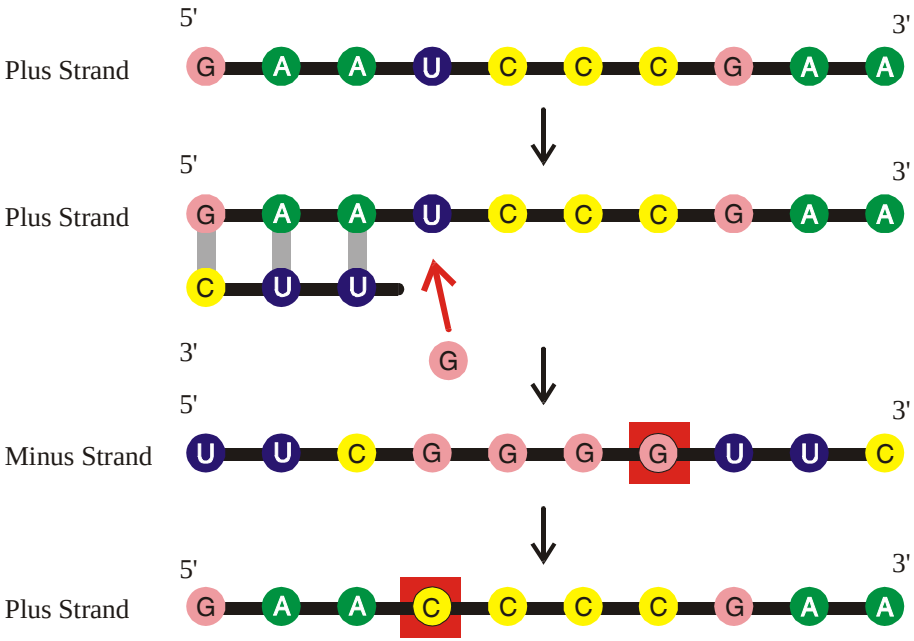


Complementary replication as the simplest copying mechanism of RNA Complementarity is determined by Watson-Crick base pairs:

G≡C and **A=U**



Point Mutation

GAAUCCCGAA → GAAUCCCGUCCCGAA

Insertion

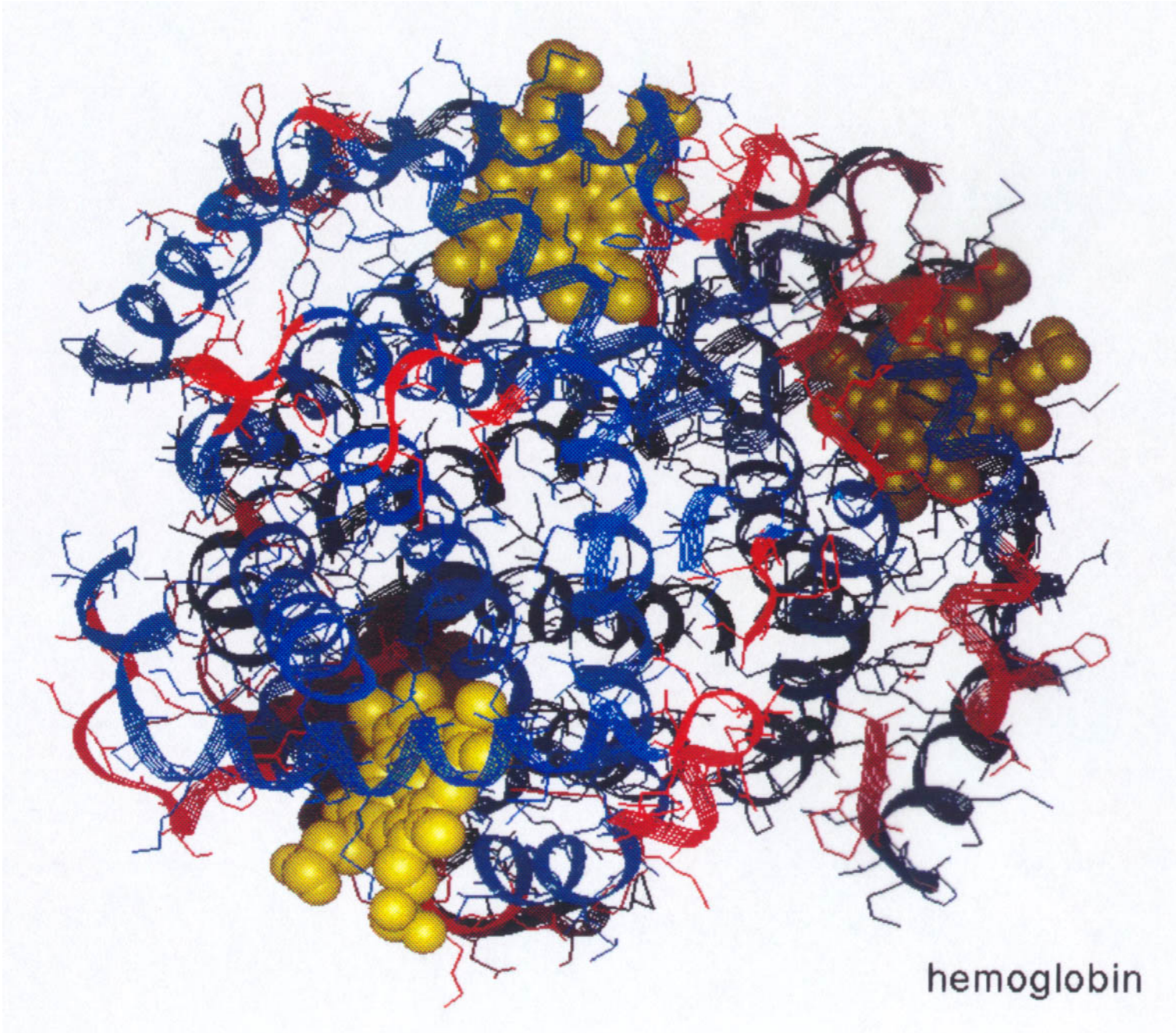
GAAUCCCGAA → GAAUCCCA

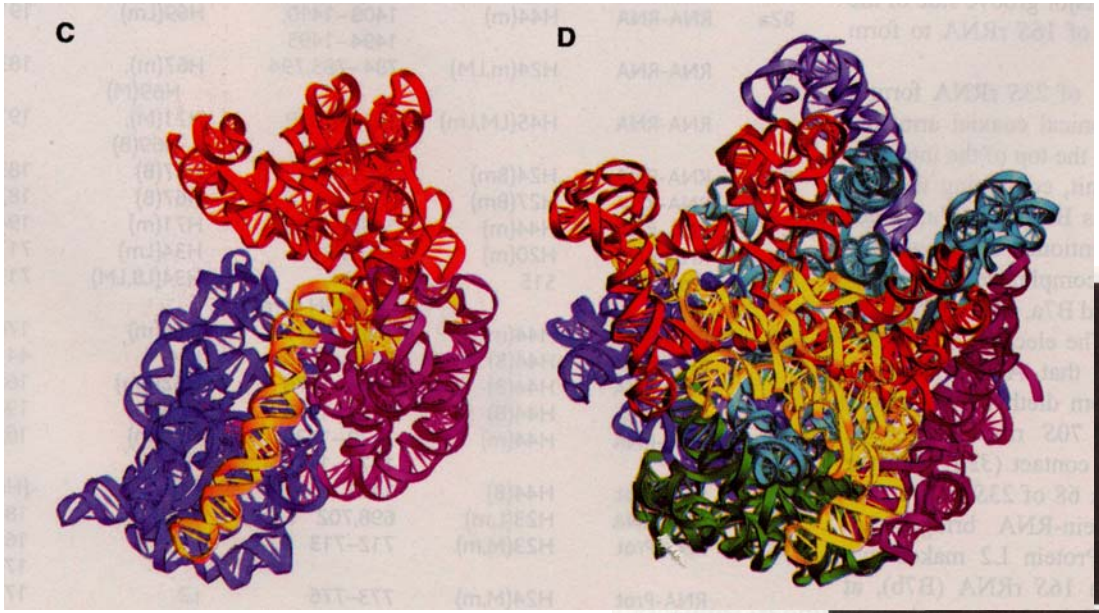
Deletion

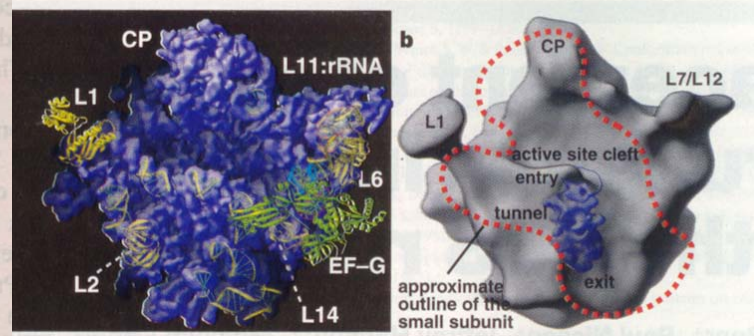
Mutations in nucleic acids represent the mechanism of **variation** of **genotypes**.

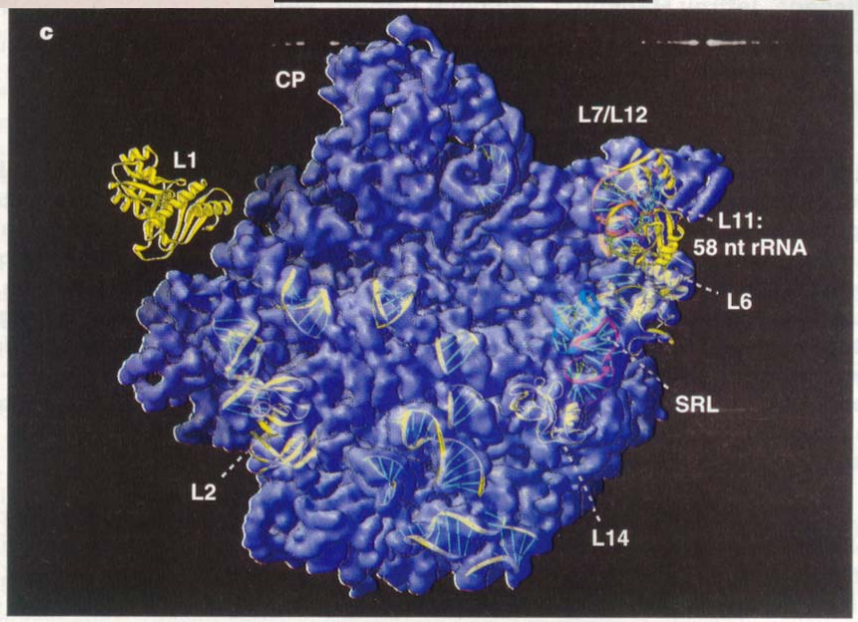
Gerhard Braunitzer, 1929 - 1989

Max Perutz, 1914-2002, at the opening of the Max Perutz-Library, Vienna BioCenter, in 1994
Nobel Prize 1962

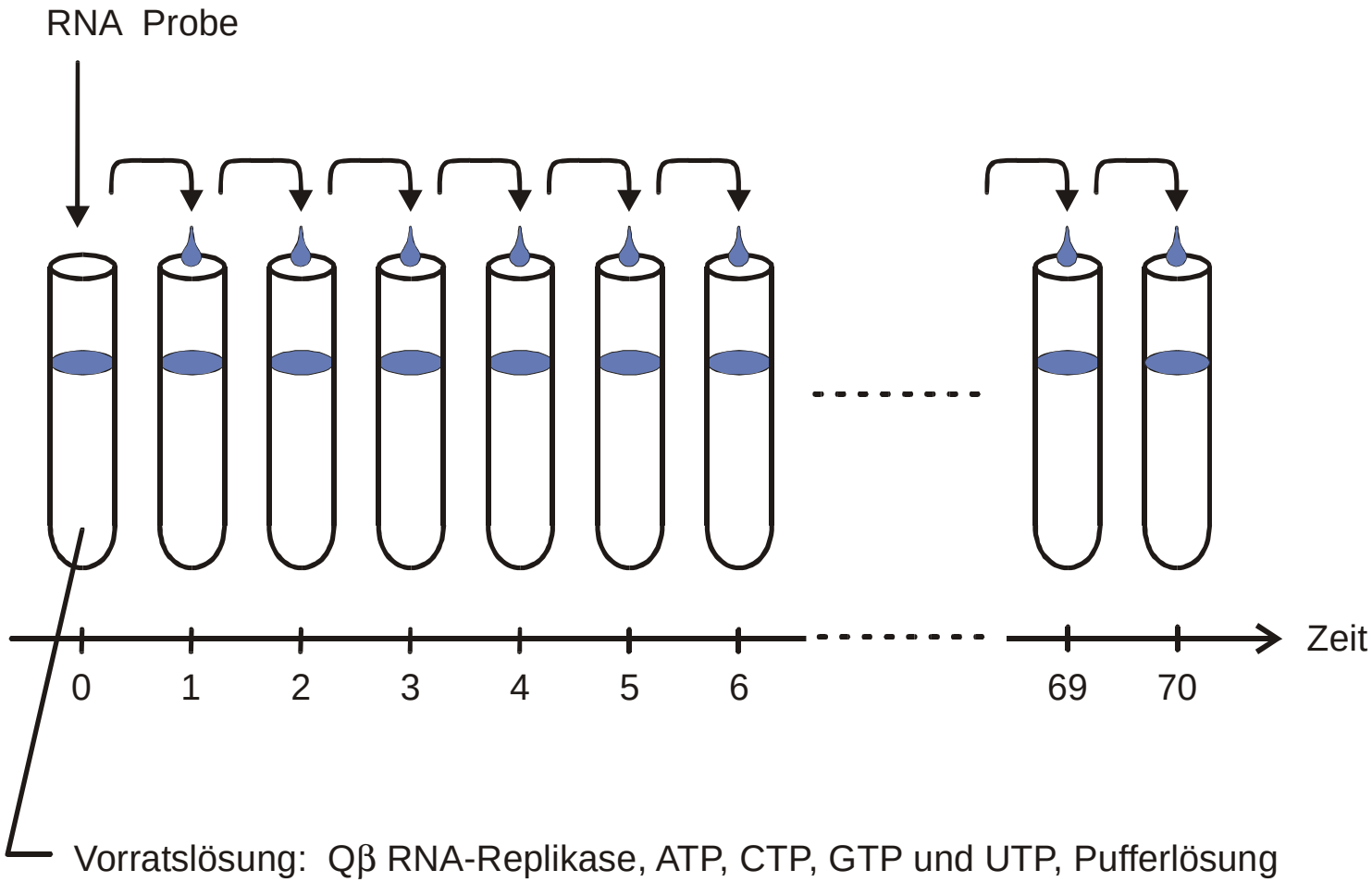

hemoglobin


C
D


CP
L11:rRNA
L1
L6
EF–G
L2
L14
b
CP
L7/12
L1
active site cleft
entry
tunnel
exit
approximate
outline of the
small subunit

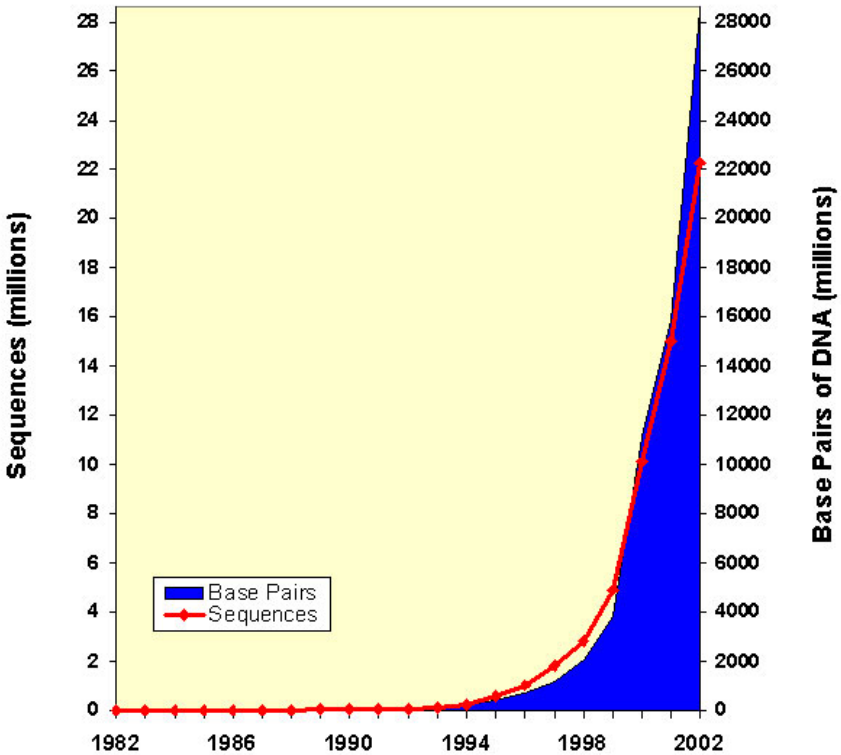

c
CP
L7/12
L1
L11:
58 nt rRNA
L6
SRL
L2
L14

ribosom



S.Spiegelman, ***An approach to the experimental analysis of precellular evolution***. Quart.Rev.Biophys. **4** (1971), 213-253

E. coli:	Length of the Genome	4×10^6 Nucleotides
	Number of Cell Types	1
	Number of Genes	4 000
Man:	Length of the Genome	3×10^9 Nucleotides
	Number of Cell Types	200
	Number of Genes	40 000 - 60 000



Source: NCBI

Fully sequenced genomes

- *Organisms* 751 projects

153 complete (16 A, 118 B, 19 E)

(*Eukarya* examples: mosquito (pest, malaria), sea squirt, mouse, yeast, homo sapiens, arabidopsis, fly, worm, …)

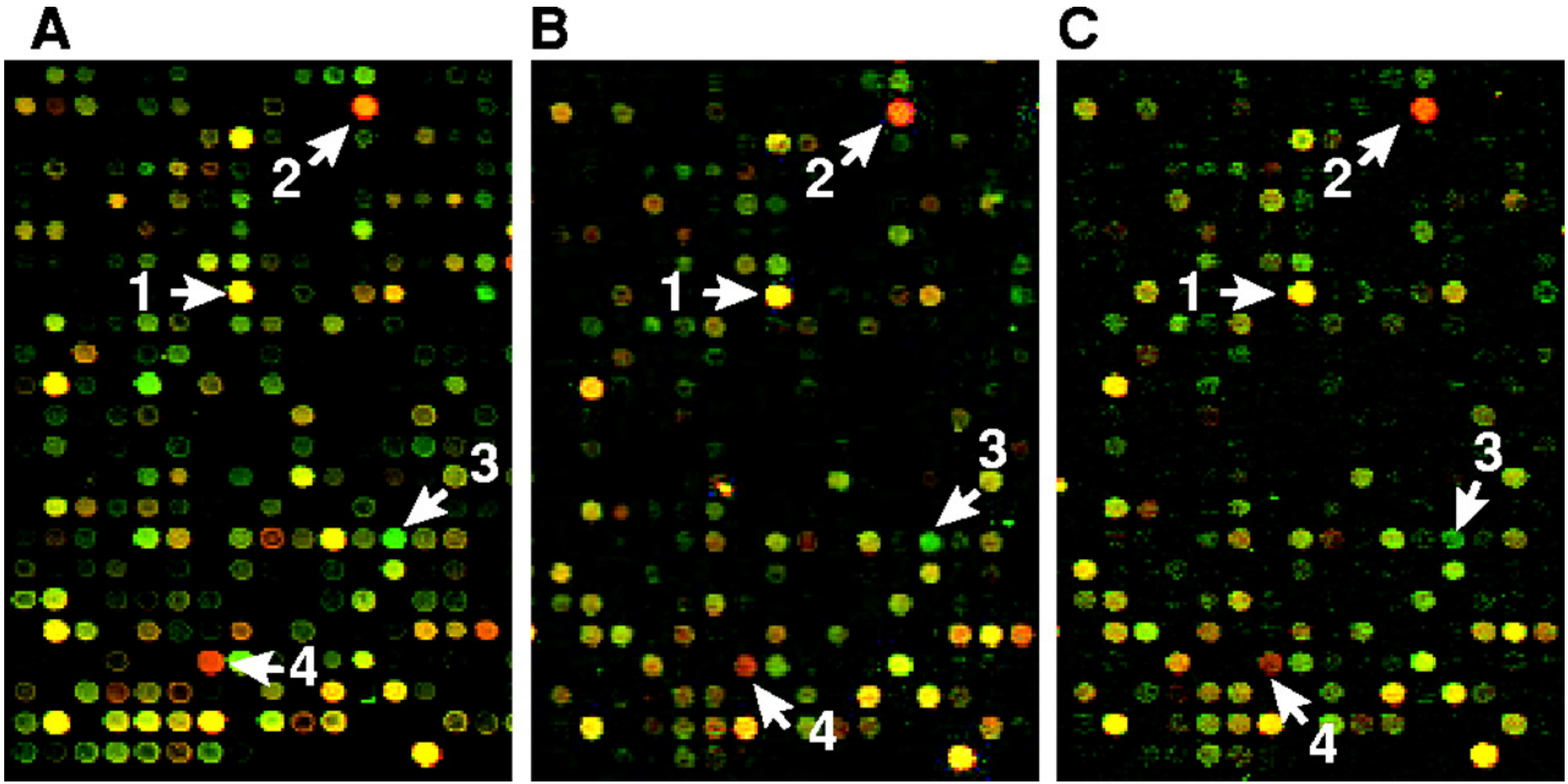
598 ongoing (23 A, 332 B, 243 E)

(*Eukarya* examples: chimpanzee, turkey, chicken, ape, corn, potato, rice, banana, tomato, cotton, coffee, soybean, pig, rat, cat, sheep, horse, kangaroo, dog, cow, bee, salmon, fugu, frog, …)

- *Other structures with genetic information*

68 phages
1328 viruses
35 viroids
472 organelles (423 mitochondria, 32 plastids, 14 plasmids, 3 nucleomorphs)

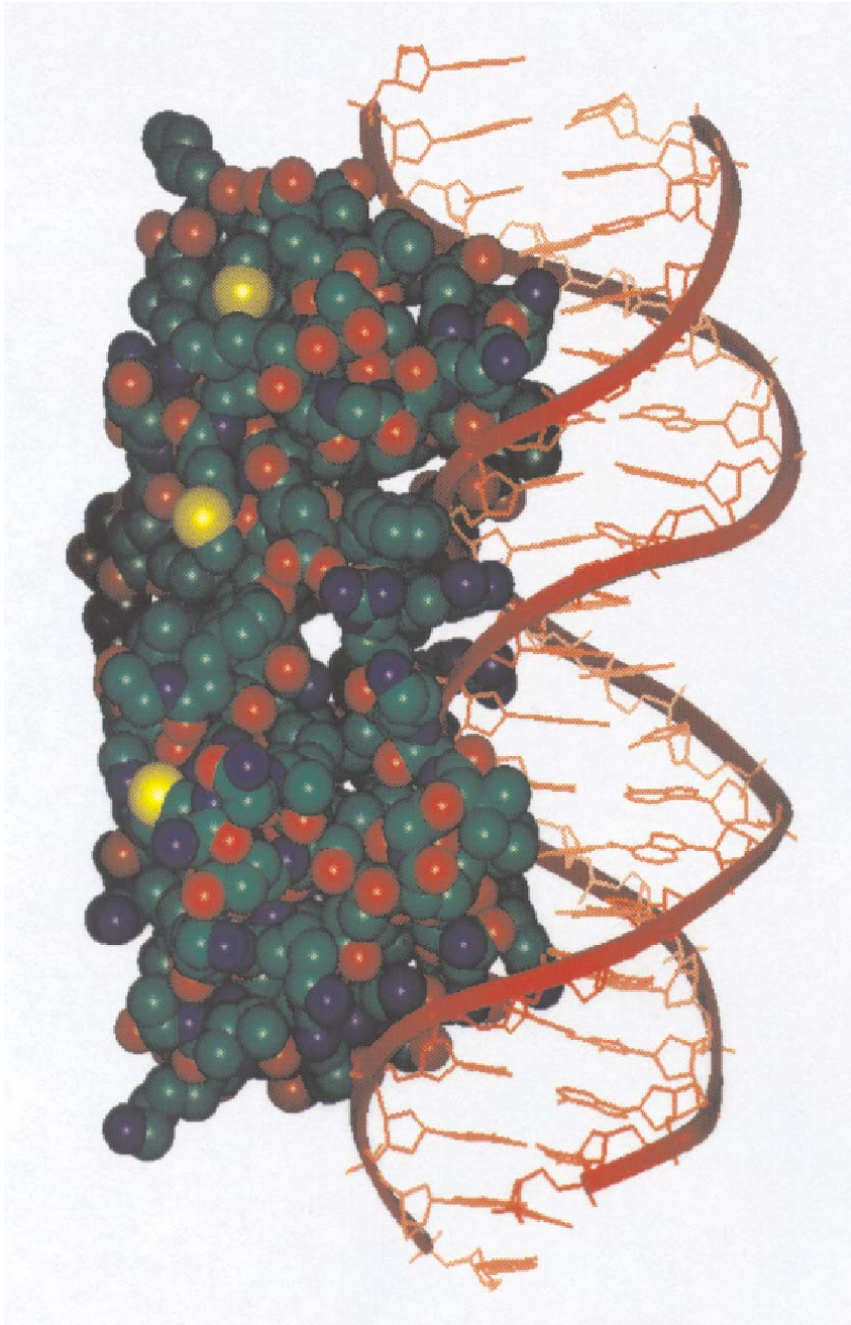
Source: Integrated Genomics, Inc.
August 12th, 2003



The same section of the microarray is shown in three independent hybridizations. Marked spots refer to: (1) protein disulfide isomerase related protein P5, (2) IL-8 precursor, (3) EST AA057170, and (4) vascular endothelial growth factor

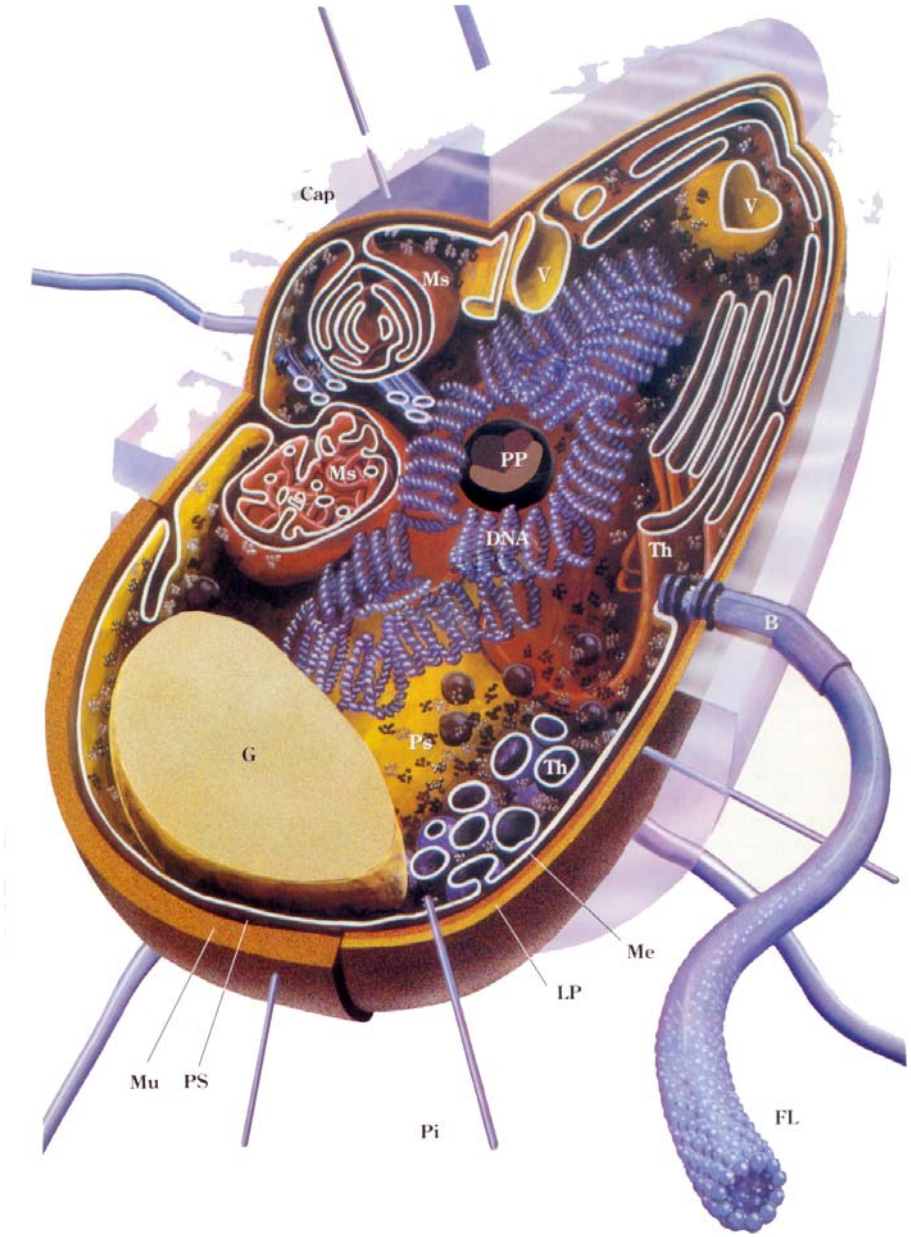
Gene expression DNA microarray representing 8613 human genes used to study transcription in the response of human fibroblasts to serum

V.R.Iyer *et al.*, *Science* **283**: 83-87, 1999



Three-dimensional structure of the complex between the regulatory protein **cro-repressor** and the binding site on λ-phage **B-DNA**

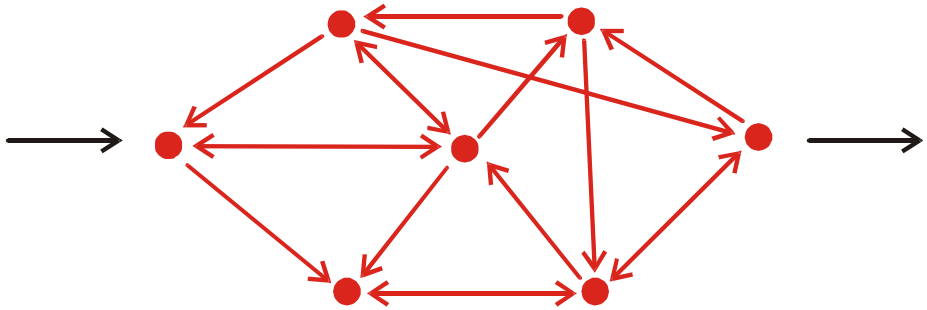
The bacterial cell as an example for the simplest form of autonomous life



The human body:

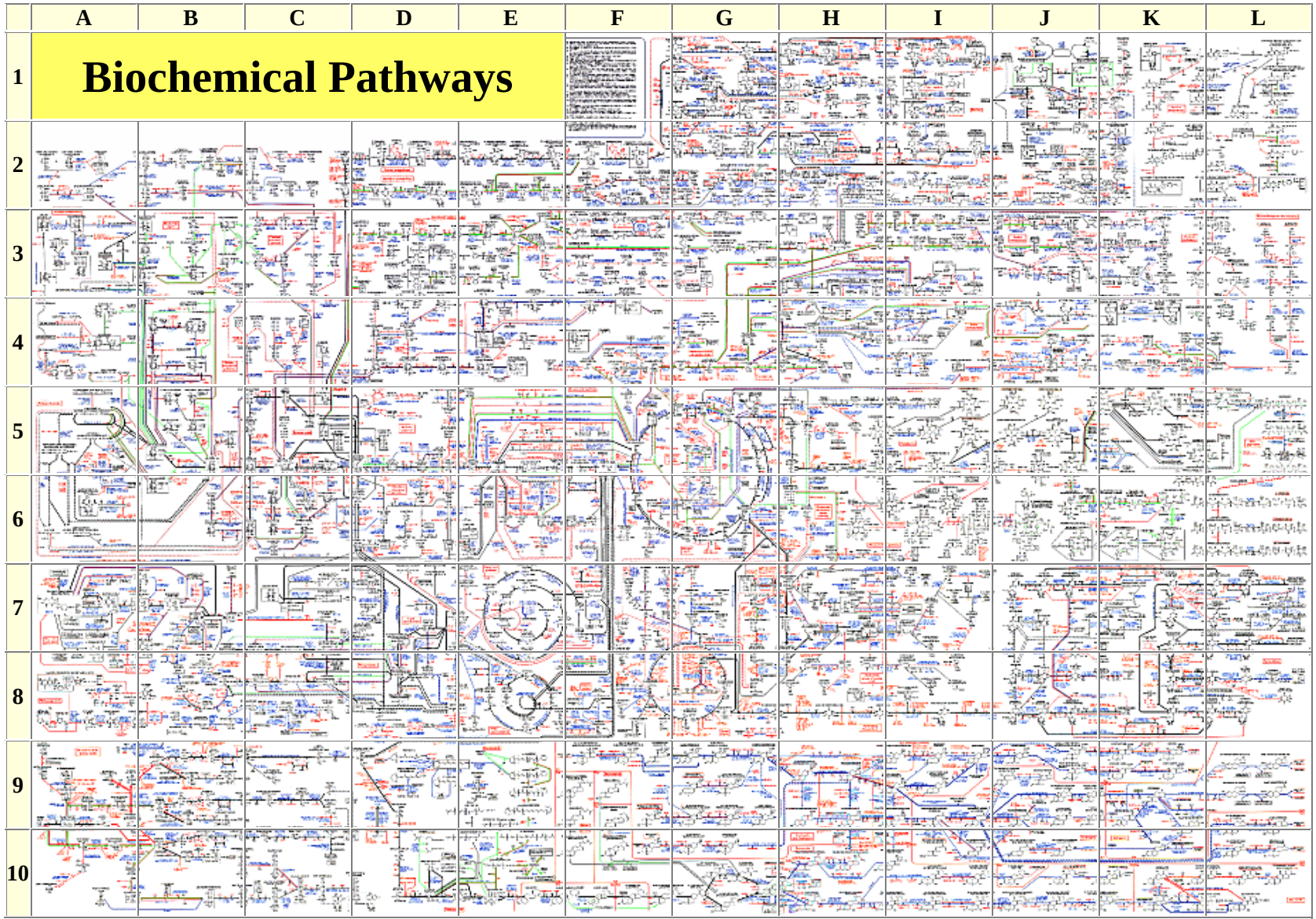
10^{14} cells = 10^{13} eukaryotic cells +
$\approx 9 \times 10^{13}$ bacterial (prokaryotic) cells;
$\approx$ 200 eukaryotic cell types

Linear chain



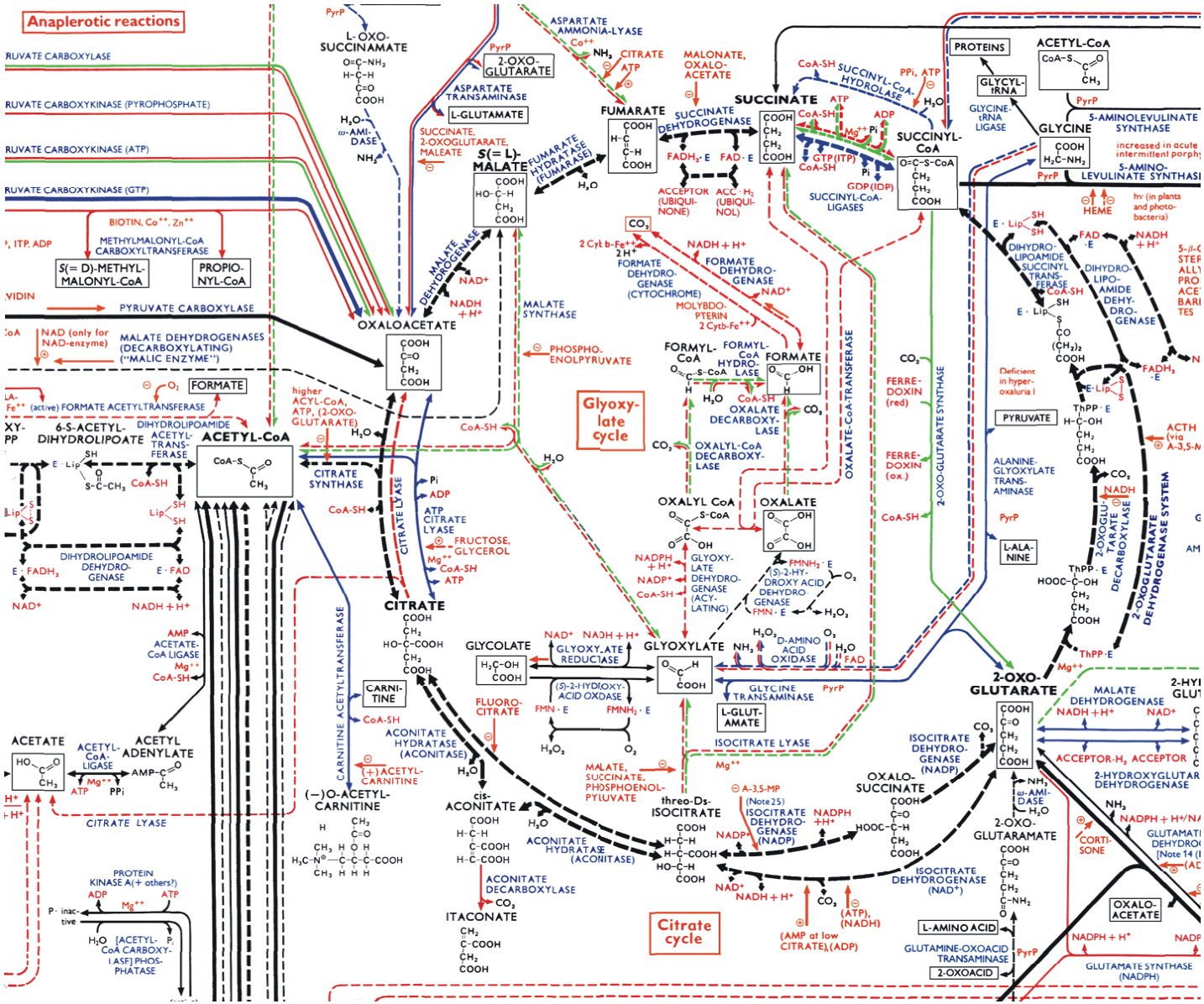
Network

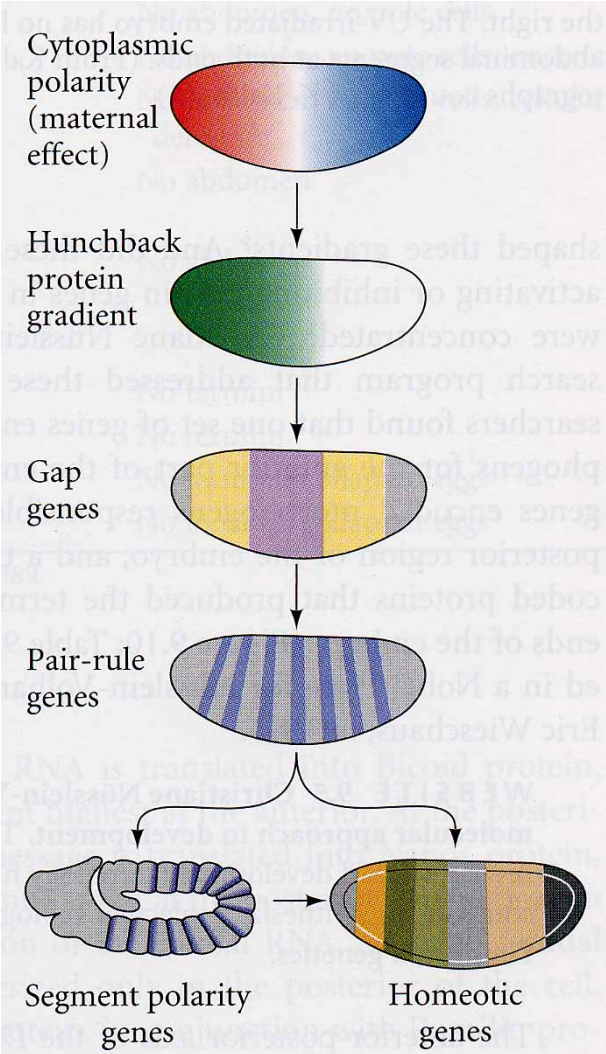
Processing of information in cascades and networks

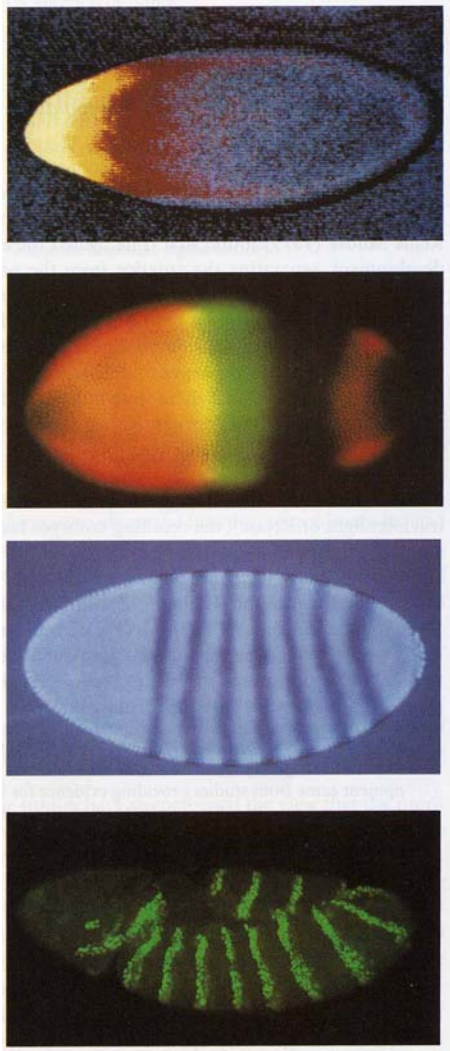


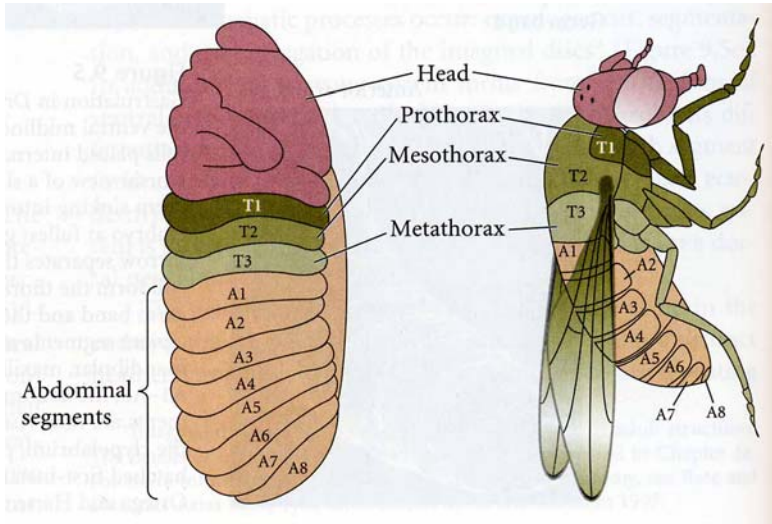
The reaction network of cellular metabolism published by Boehringer-Ingelheim.

The citrate, tri-carboxylic acid or Krebs cycle (enlarged from previous slide)







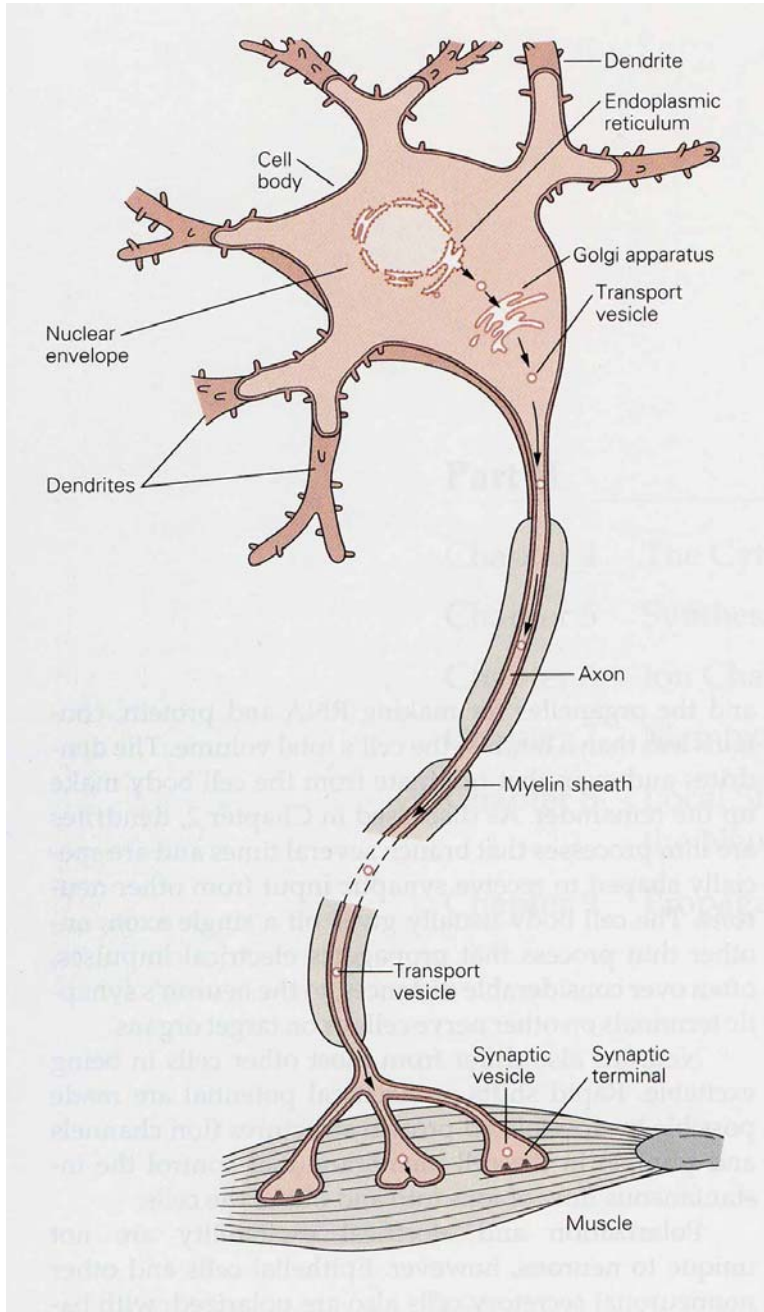


Cascades, A ⇒ B ⇒ C ⇒ ... , and networks of genetic control

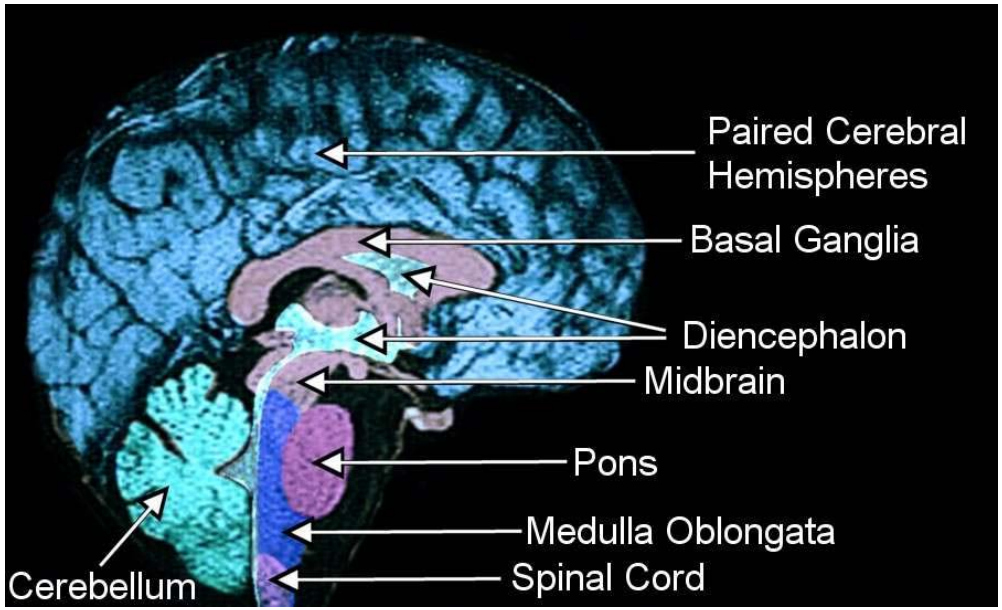
Turing pattern resulting from reaction-diffusion equation ?

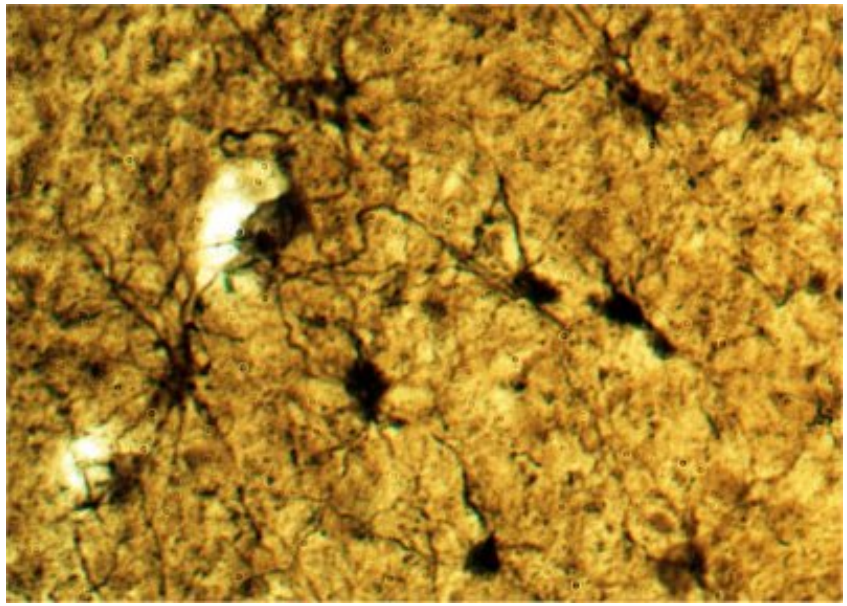
Intercelluar communication creating positional information

Development of the fruit fly *drosophila melanogaster*: Genetics, experiment, and imago



A single neuron signaling to a muscle fiber





The human brain

10^{11} neurons connected by ≈ 10^{13} to 10^{14} synapses

Web-Page for further information:

http://www.tbi.univie.ac.at/~pks