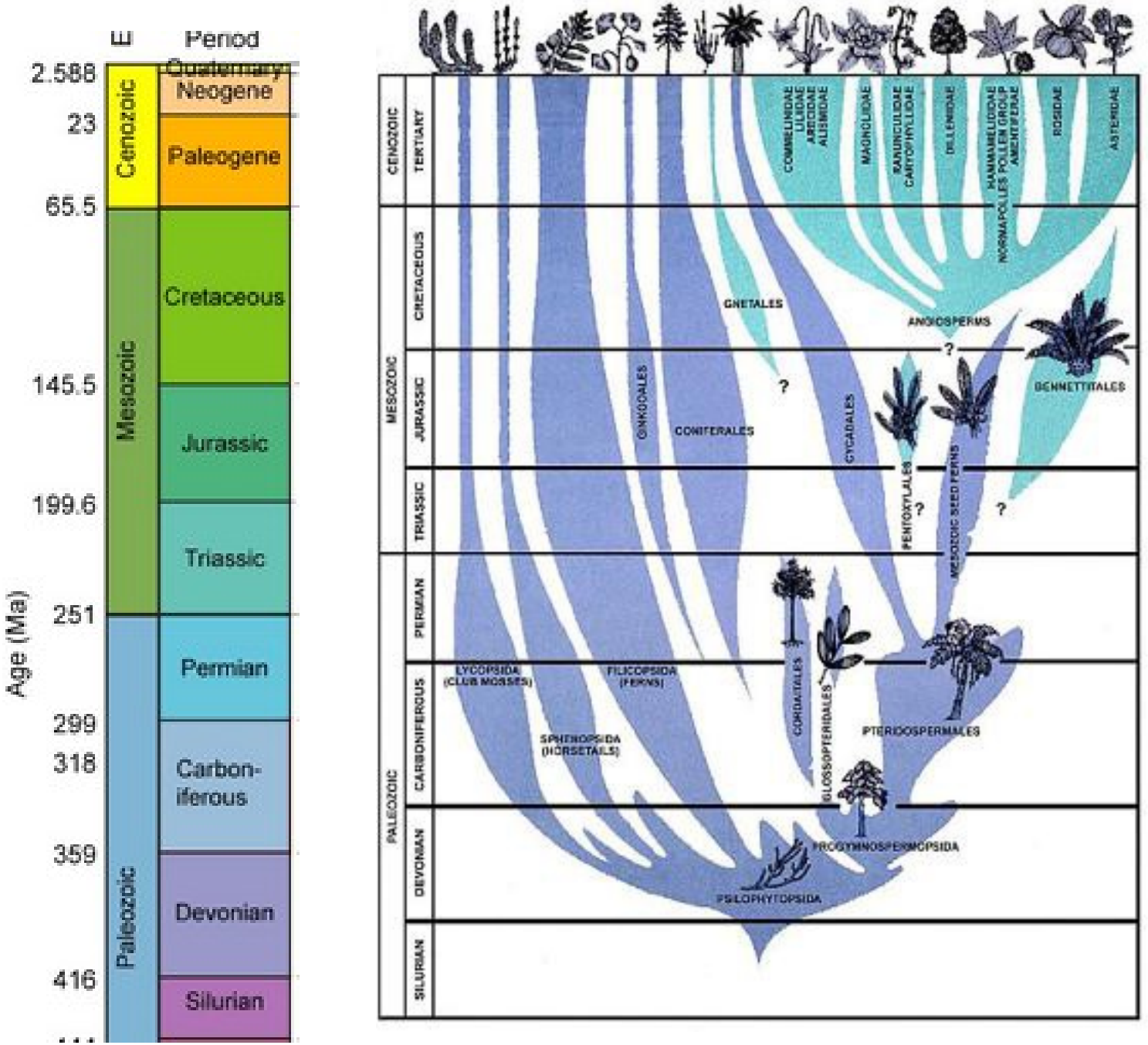
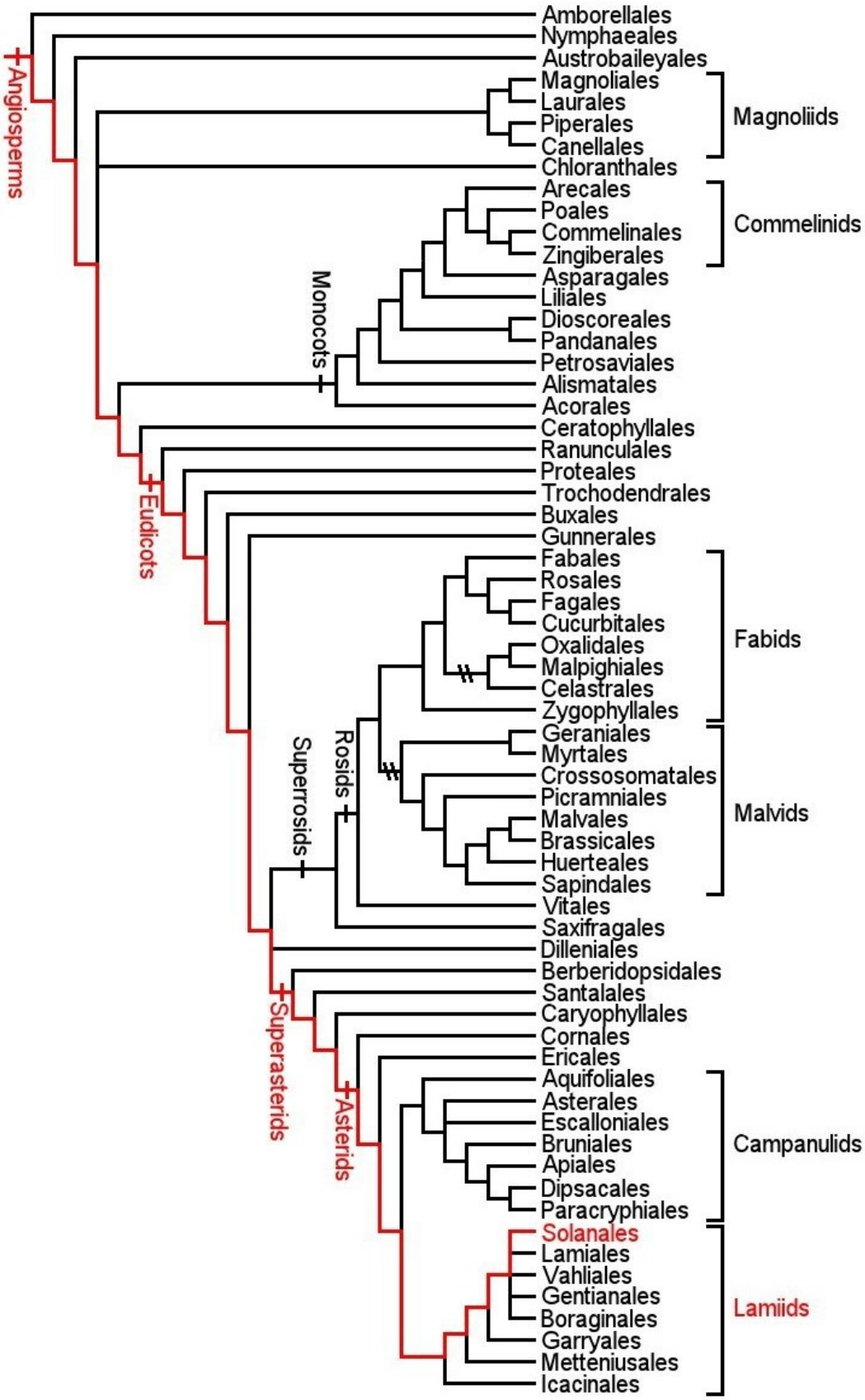
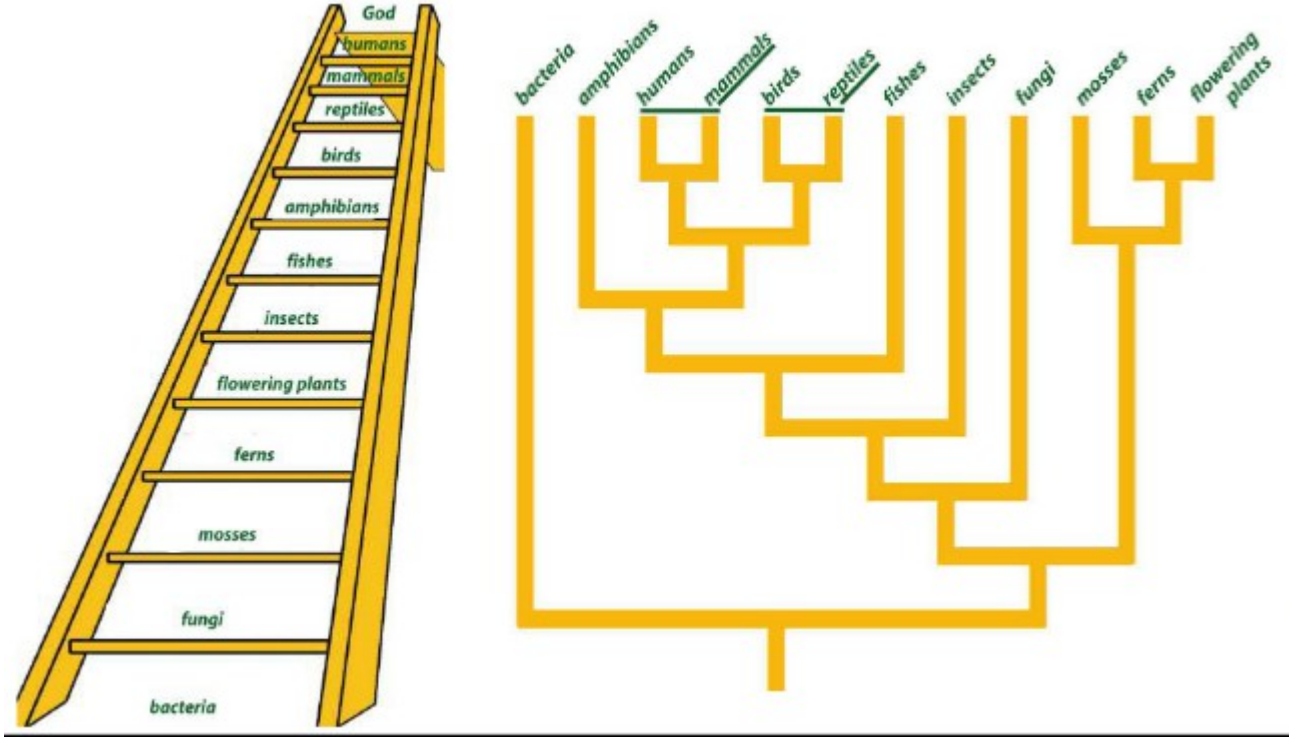
CORSO DI BOTANICA SISTEMATICA

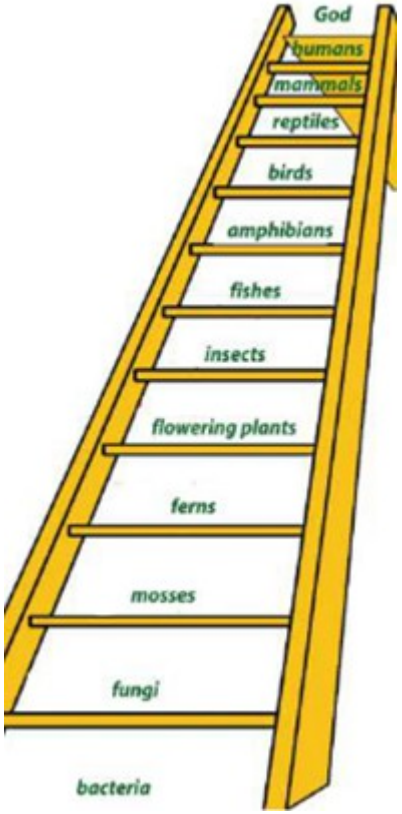
LEZIONE 42

L’evoluzione degli organismi

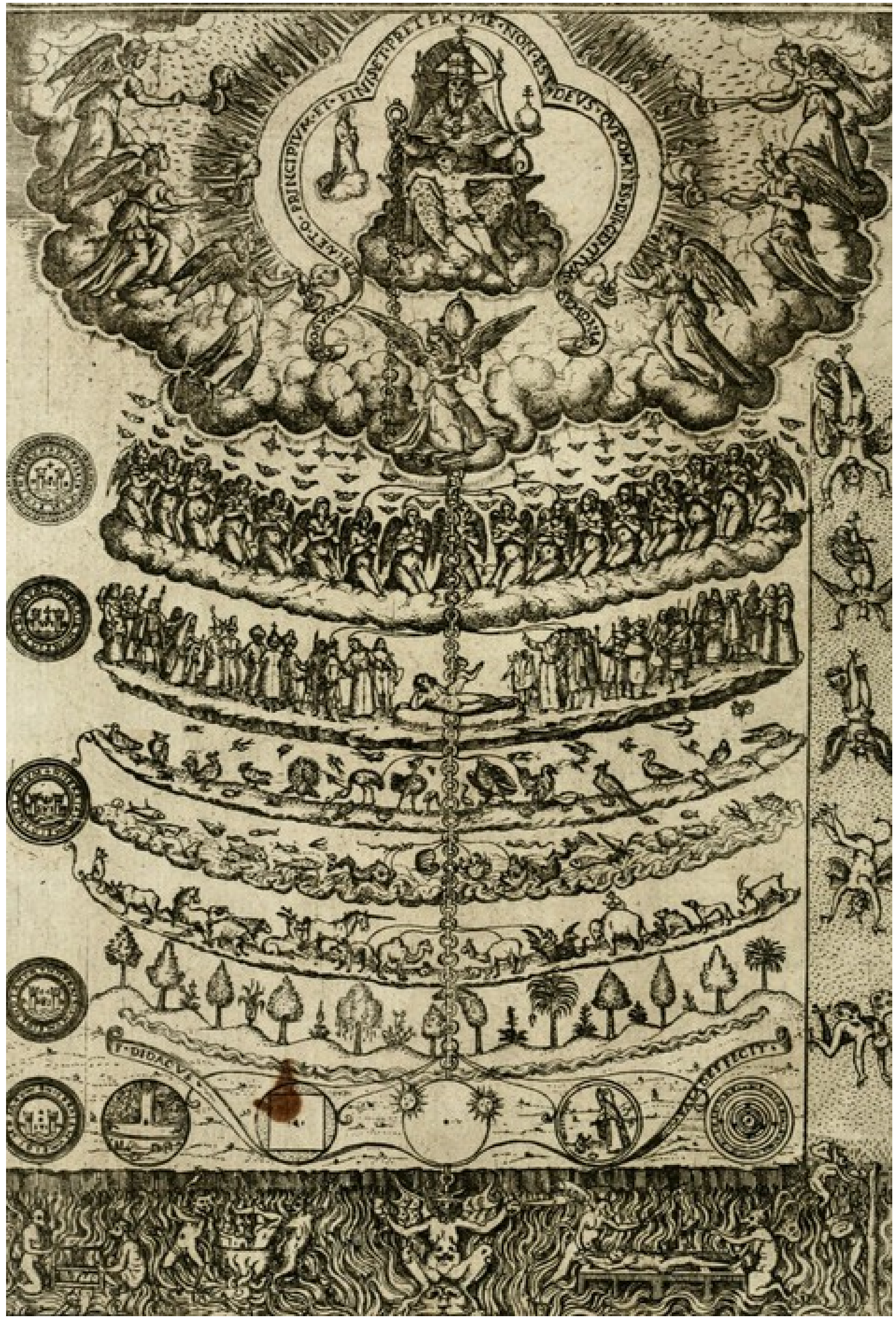

Era
Period
Age (Ma)
2.588
23
65.5
145.5
199.6
251
299
318
359
416
Cenozoic
Mesozoic
Paleozoic
Quaternary
Neogene
Paleogene
Cretaceous
Jurassic
Triassic
Permian
Carbon-
iferous
Devonian
Silurian
CENOZOIC
MESOZOIC
PALEOZOIC
TERTIARY
CRETACEOUS
JURASSIC
TRIASSIC
PERMIAN
CARBONIFEROUS
DEVONIAN
SILURIAN
COMMELINIDAE
LILIIDAE
ARECIDAE
ALISMIDAE
MAGNOLIIDAE
RANUNCULIDAE
CARYOPHYLLIDAE
DILLENIIDAE
HAMAMELIDIDAE
NORMAPOLLES POLLEN GROUP
AMENTIFERAE
ROSIDAE
ASTERIDAE
GNETALES
ANGIOSPERMS
BENNETTITALES
GINKGOALES
CONIFERALES
CYCADALES
PENTOXYLALES
MESOZOIC SEED FERNS
LYCOPSIDA
(CLUB MOSSES)
FILICOPSIDA
(FERNS)
SPHENOPSIDA
(HORSETAILS)
CORDAITALES
GLOSSOPTERIDALES
PTERIDOSPERMALES
PROGYMNOSPERMOPSIDA
PSILOPHYTOPSIDA

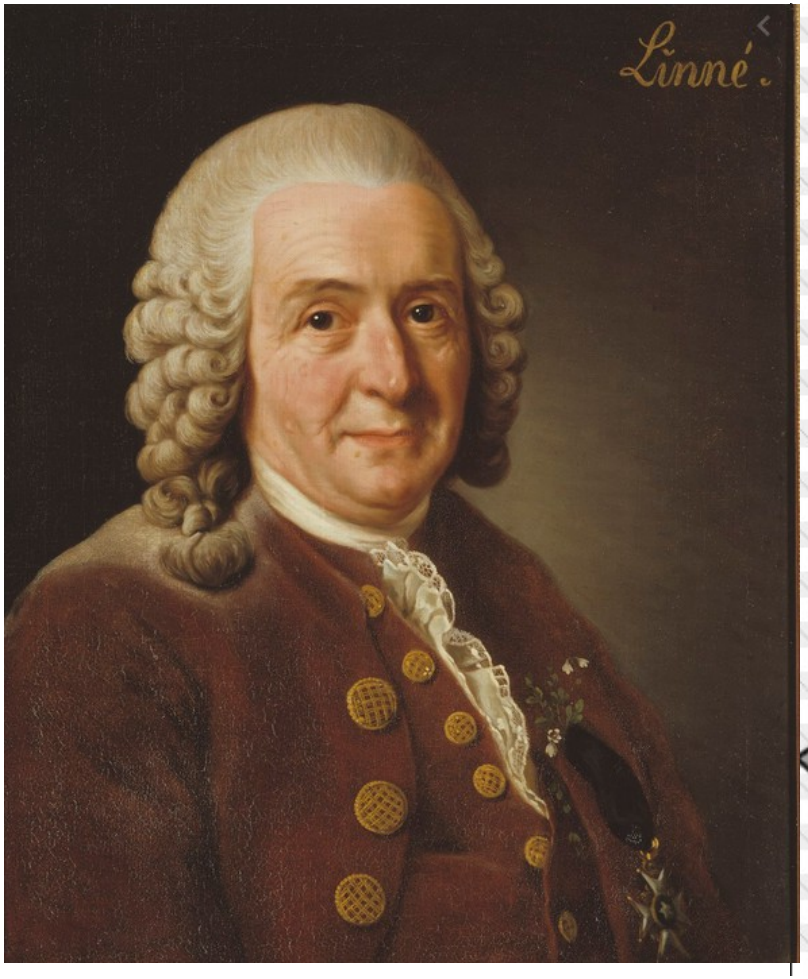

Amborellales
Nymphaeales
Austrobaileyales
Magnoliales
Laurales
Piperales
Canellales
Magnoliids
Chloranthales
Arecales
Poales
Commelinales
Zingiberales
Commelinids
Asparagales
Liliales
Dioscoreales
Pandanales
Petrosaviales
Alismatales
Acorales
Monocots
Ceratophyllales
Ranunculales
Proteales
Trochodendrales
Buxales
Gunnerales
Eudicots
Fabales
Rosales
Fagales
Cucurbitales
Oxalidales
Malpighiales
Celastrales
Zygophyllales
Fabids
Geraniales
Myrtales
Crossosomatales
Picramniales
Malvales
Brassicales
Huerteales
Sapindales
Malvids
Rosids
Superrosids
Vitales
Saxifragales
Dilleniales
Berberidopsidales
Santalales
Caryophyllales
Cornales
Ericales
Superasterids
Aquifoliales
Asterales
Escalloniales
Bruniales
Apiales
Dipsacales
Paracryphiales
Campanulids
Asterids
Solanales
Lamiales
Vahliales
Gentianales
Boraginales
Garryales
Metteniusales
Icacinales
Lamiids
Angiosperms

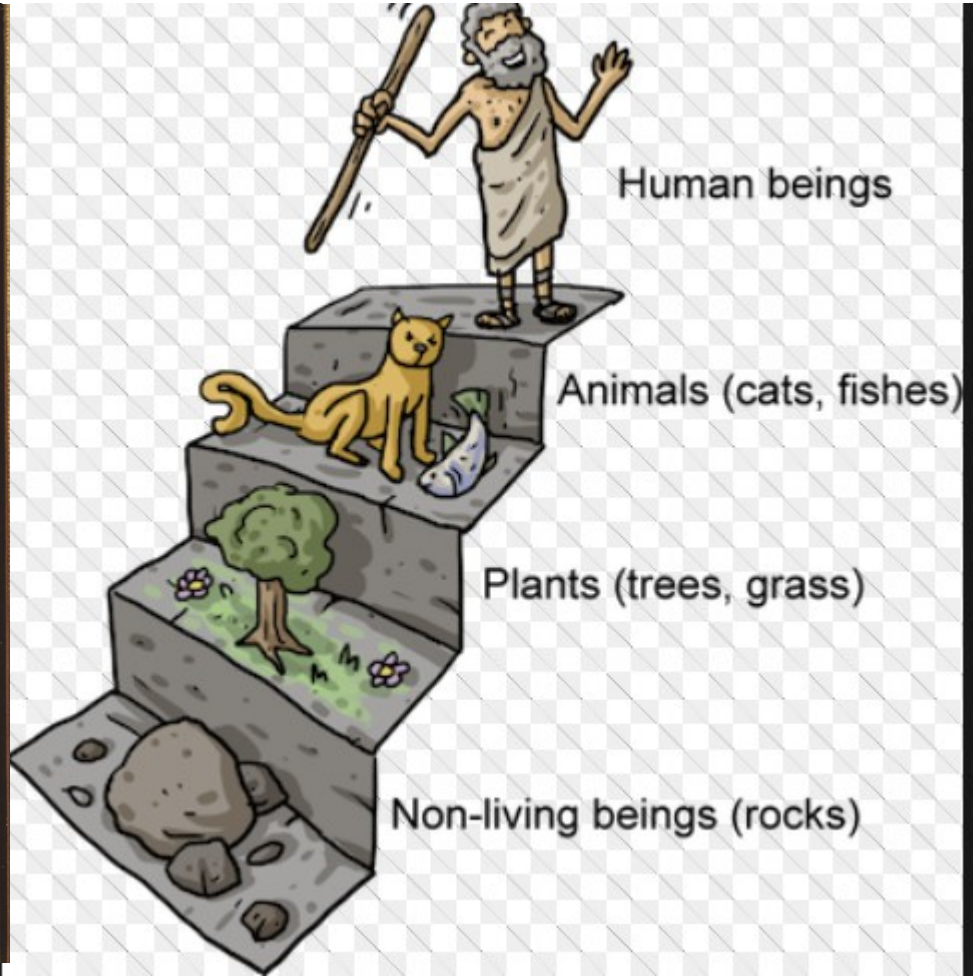

God
humans
mammals
reptiles
birds
amphibians
fishes
insects
flowering plants
ferns
mosses
fungi
bacteria
bacteria
amphibians
humans
mammals
birds
reptiles
fishes
insects
fungi
mosses
ferns
flowering plants


God
humans
mammals
reptiles
birds
amphibians
fishes
insects
flowering plants
ferns
mosses
fungi
bacteria

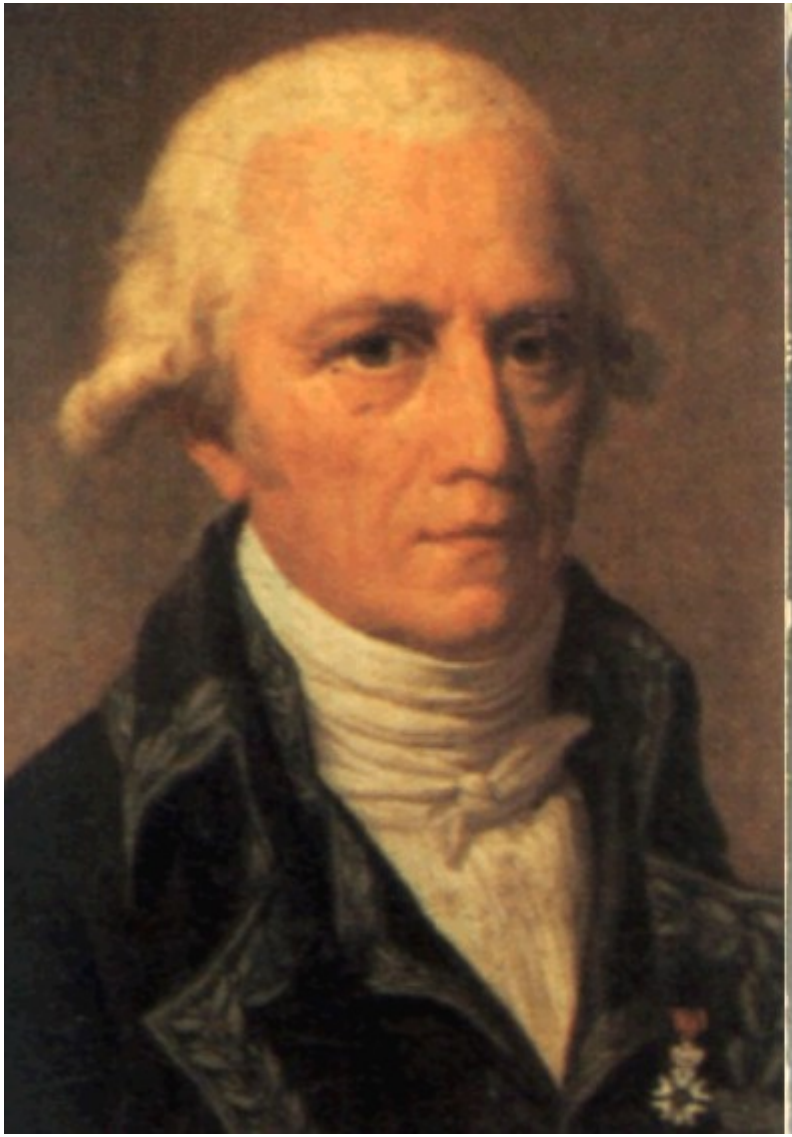

Being
God
Realm of BEING
Angels
Demons
Man
Animals
Realm of BECOMING
Plants
Minerals
Non-being

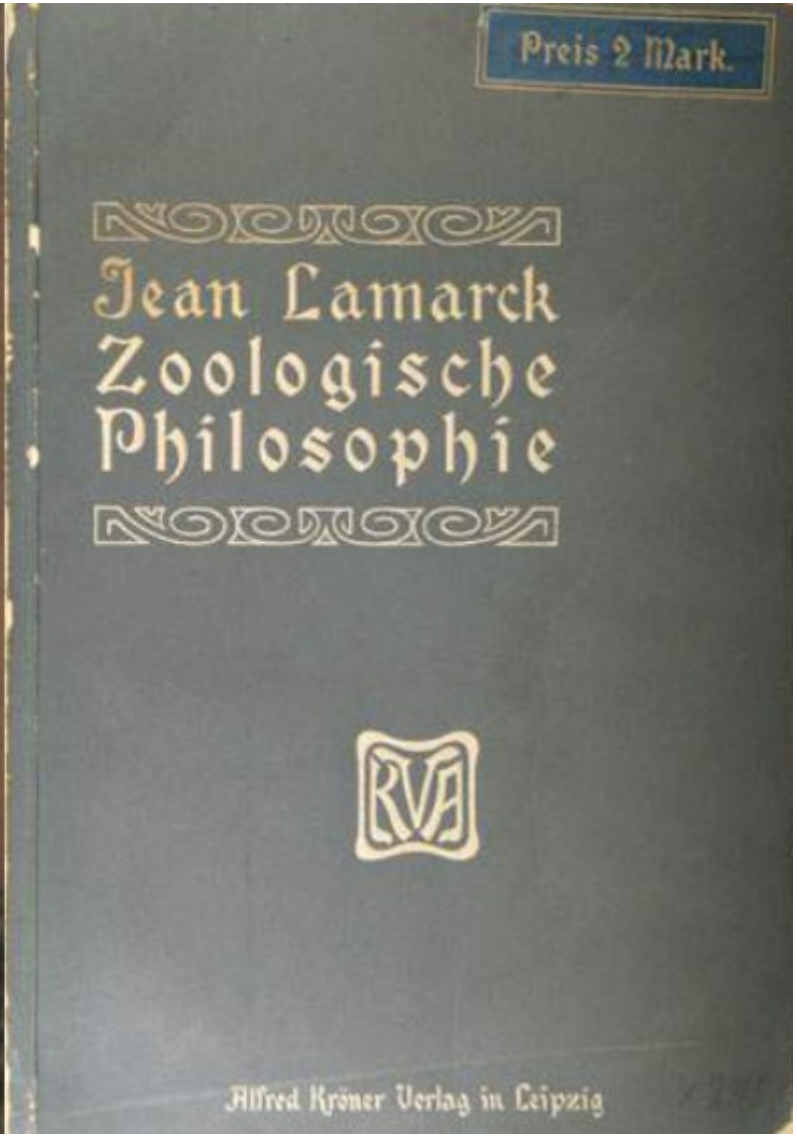






C. Linnaeus (1707-1778)





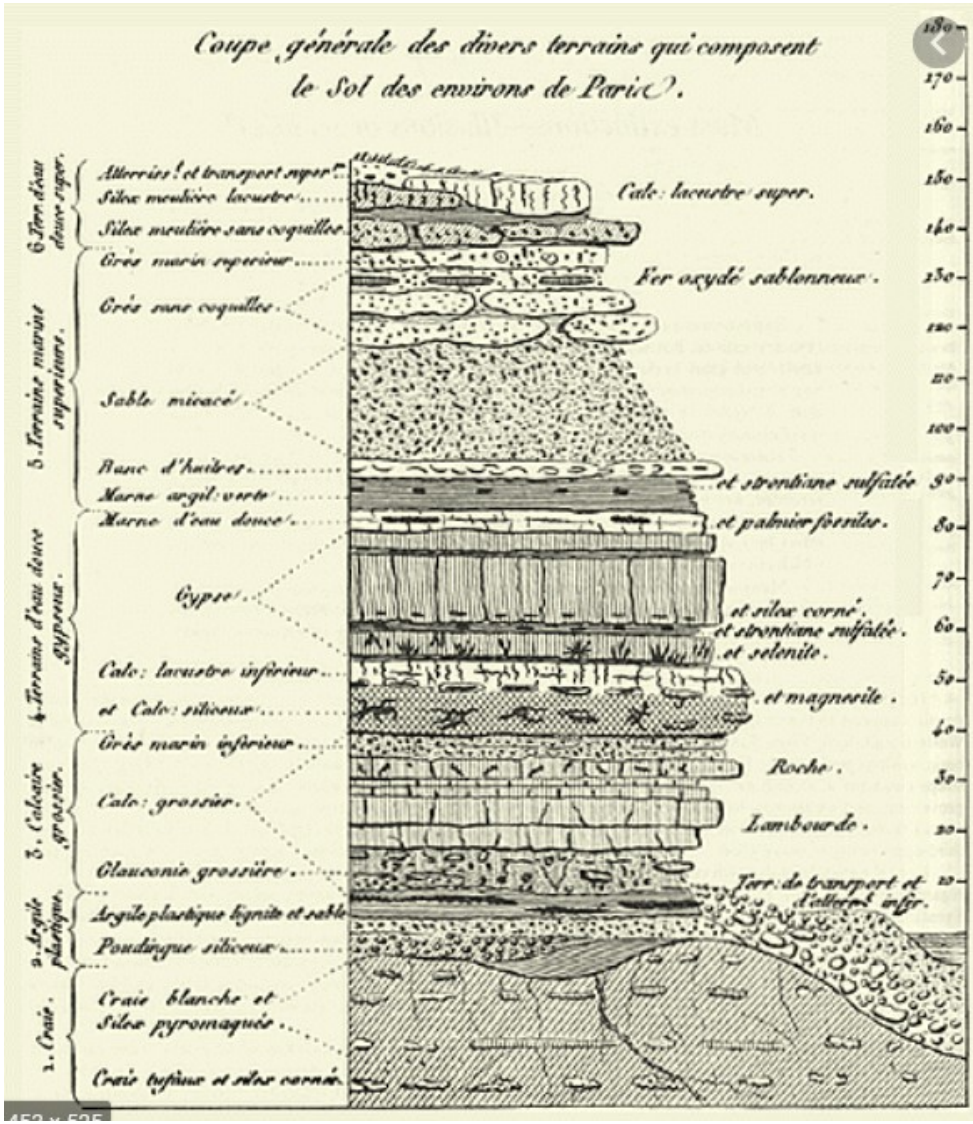
Jean Baptiste Lamarck (1744-1829)

1. Les Mammifères.
2. Les Oiseaux.
3. Les Reptiles.
4. Les Poissons.

} Animaux vertébrés.

5. Les Mollusques.
6. Les Cirrhipèdes.
7. Les Annelides.
8. Les Crustacés.
9. Les Arachnides.
10. Les Insectes.
11. Les Vers.
12. Les Radiaires.
13. Les Polypes.
14. Les Infusoires.

} Animaux invertébrés.



Georges Cuvier (1769-1832)

PIER LUIGI NIMIS

JOHANN WOLFGANG GOETHE E LA BIOLOGIA DEL PERIODO ROMANTICO

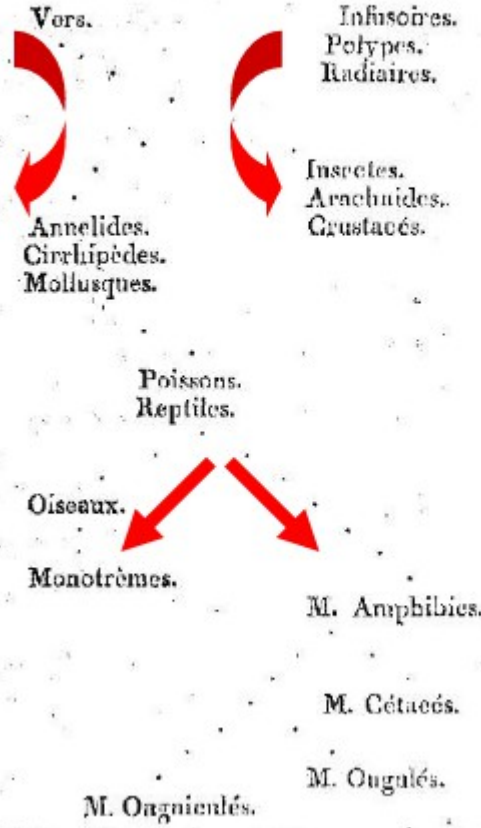
Introduzione

La Biologia, come scienza indipendente il cui campo di applicazione è lo studio degli organismi viventi, appare per la prima volta verso la fine del Settecento, nel momento stesso in cui questi vengono interpretati come entità qualitativamente diverse da quelle del mondo inorganico. Il

1830: Dibattito pubblico tra Lamarck e Cuvier

TABLEAU

Servant à montrer l'origine des différens animaux.

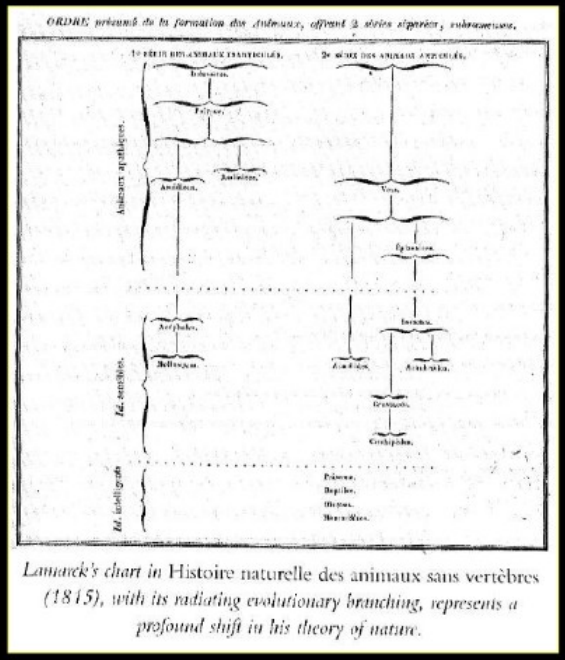


Cette série d'animaux commençant par deux

Appended table in 1809 (vol. 2 of *Philosophie Zoologique*)

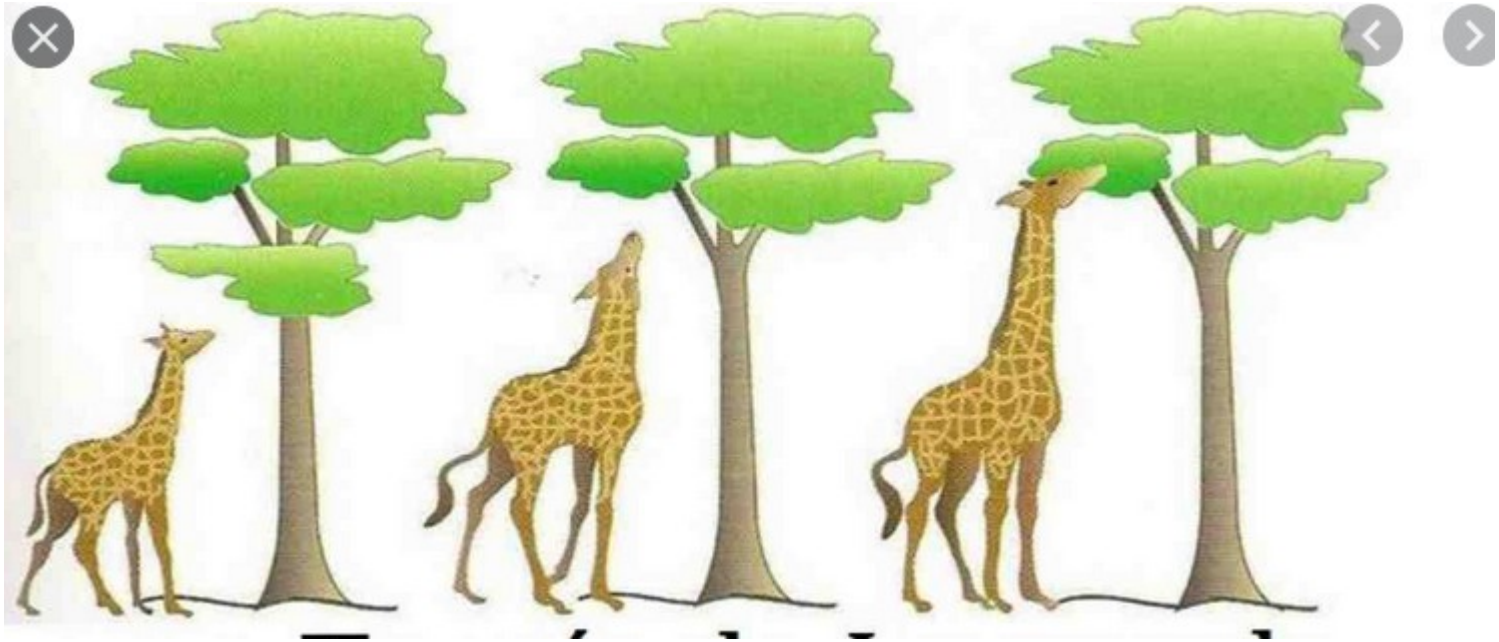
Lamarck's later "Tree"

- By 1815 Lamarck announced his conversion to branching as the fundamental pattern of "evolution"
- "*In its production of the different animals, nature has not fashioned a single and simple series*"

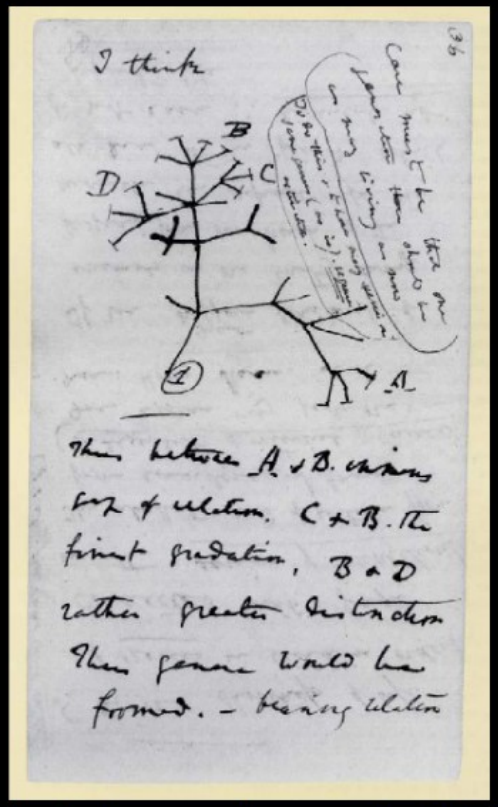


Lamarck's chart in Histoire naturelle des animaux sans vertèbres *(1815), with its radiating evolutionary branching, represents a profound shift in his theory of nature.*

Lamarck's 1815 "tree"

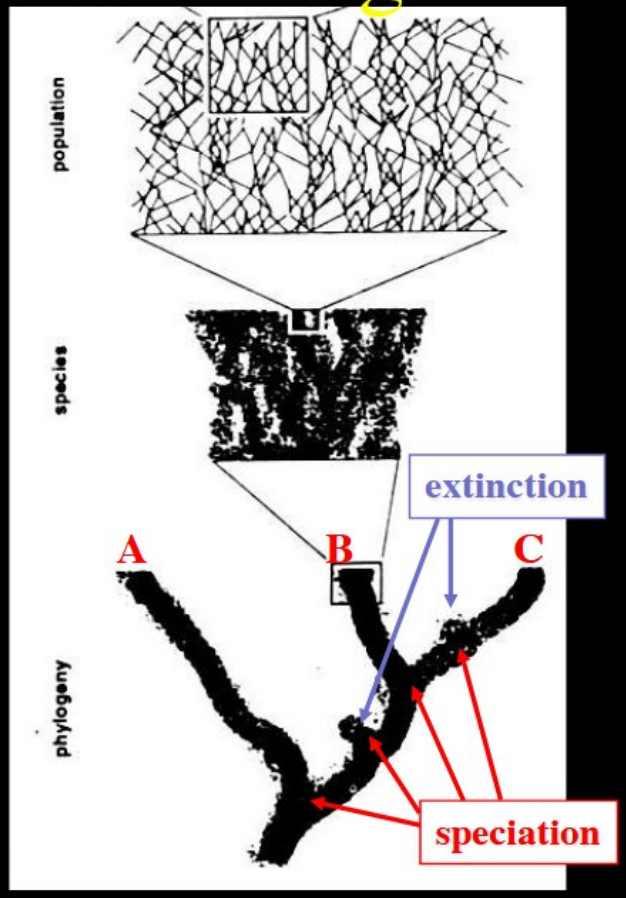


Darwin's "Tree Thinking"

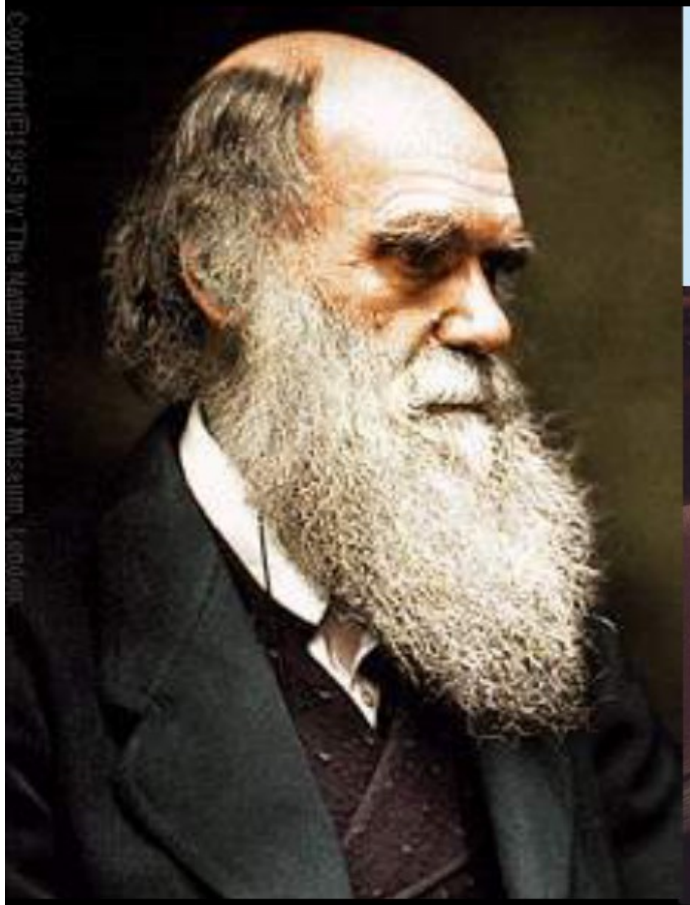


Darwin's 1st species notebook (1837)

back in time



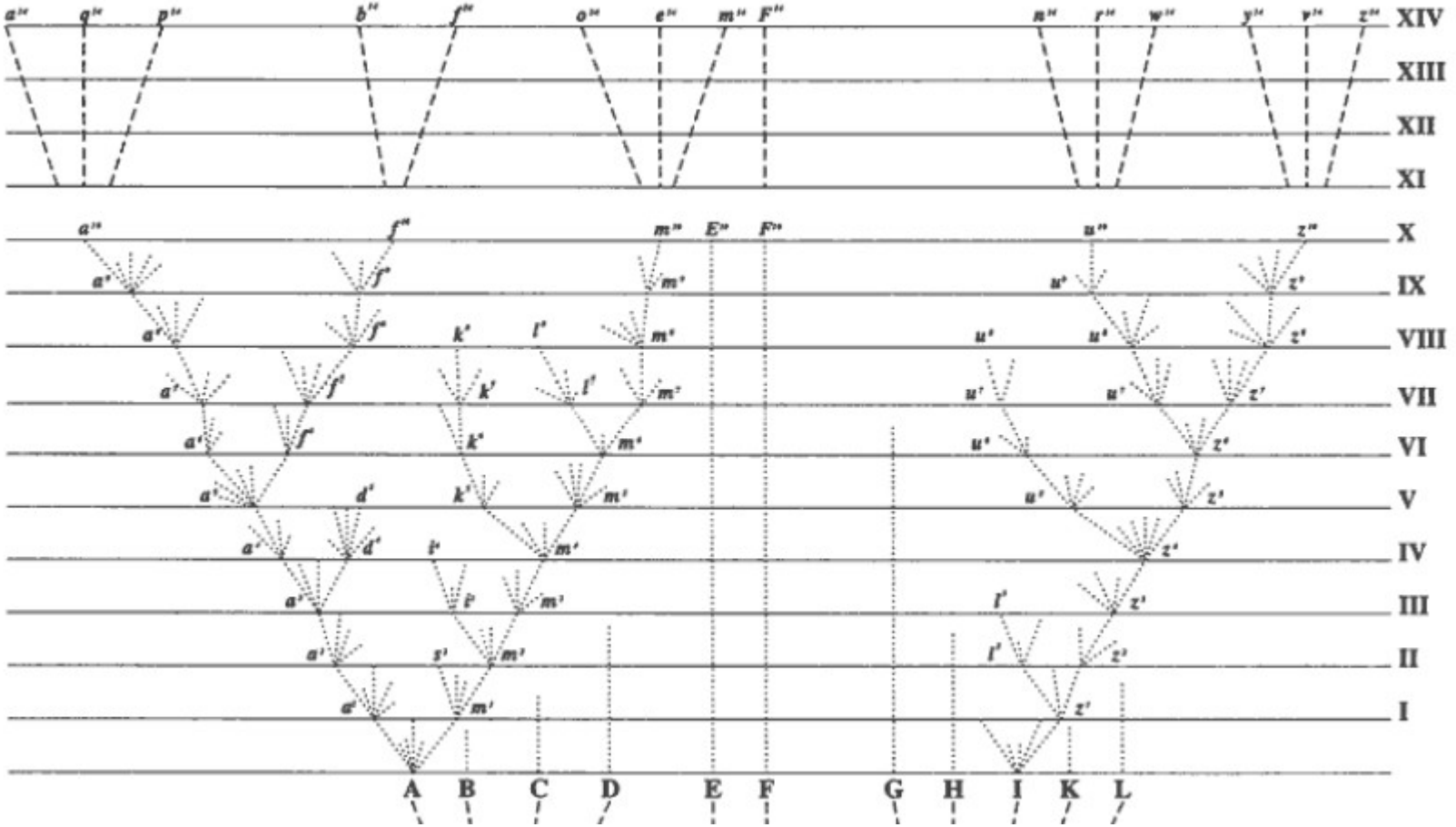
Charles Darwin (1859)



Darwin himself never uses the word "evolution" in *Origin of Species*.

He calls the process

"descent with modification".



La sola figura di “Origin of the species” di Darwin

1) i caratteri (morfologici, fisiologici, comportamentali) variano tra gli individui (variazione fenotipica),

2) caratteri diversi conferiscono tassi diversi di sopravvivenza e riproduzione (idoneità differenziale)

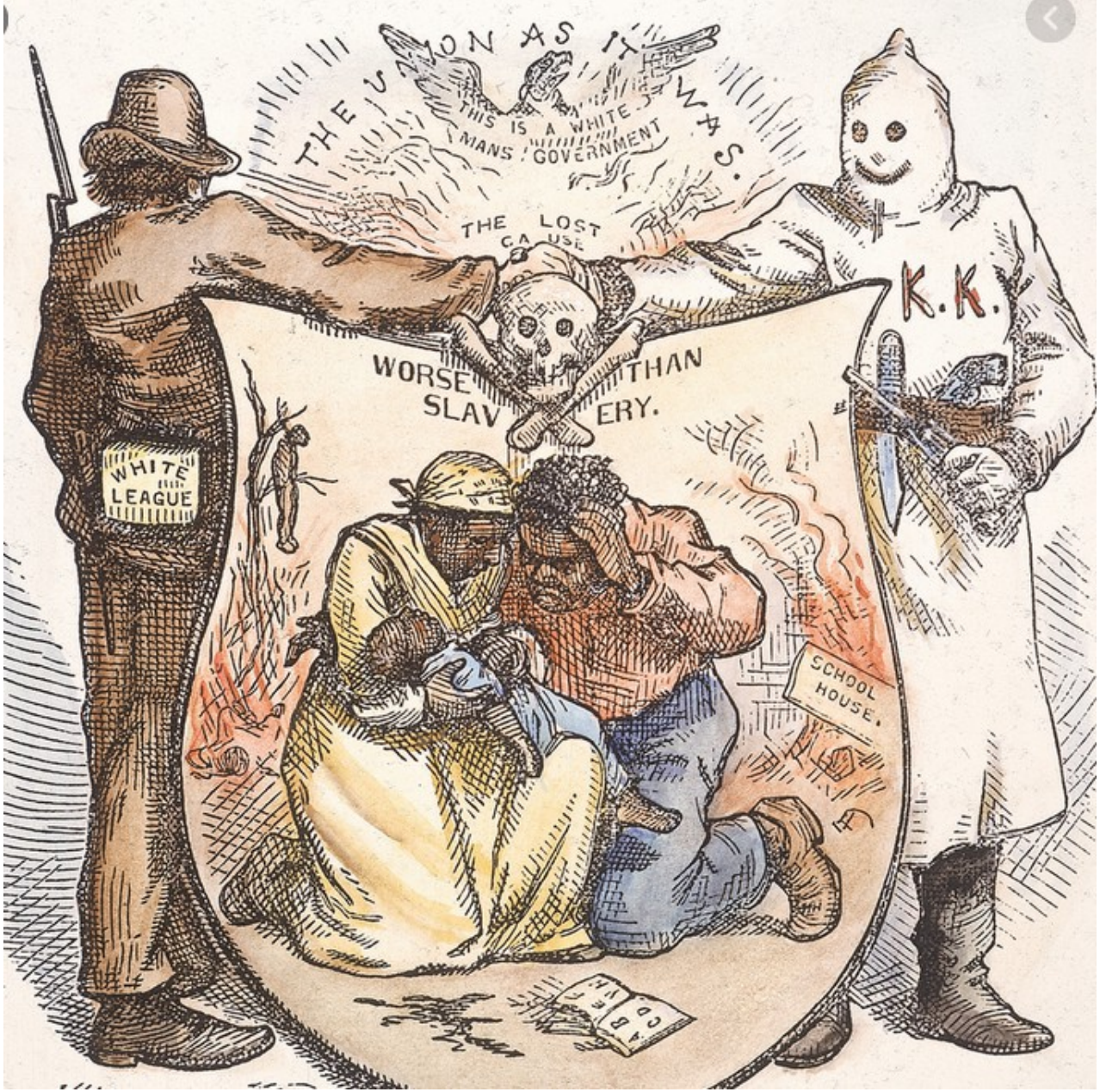
3) i caratteri possono essere passati di generazione in generazione (ereditabilità dei caratteri adattativi)

Le tre principali affermazioni dell'evoluzione darwiniana

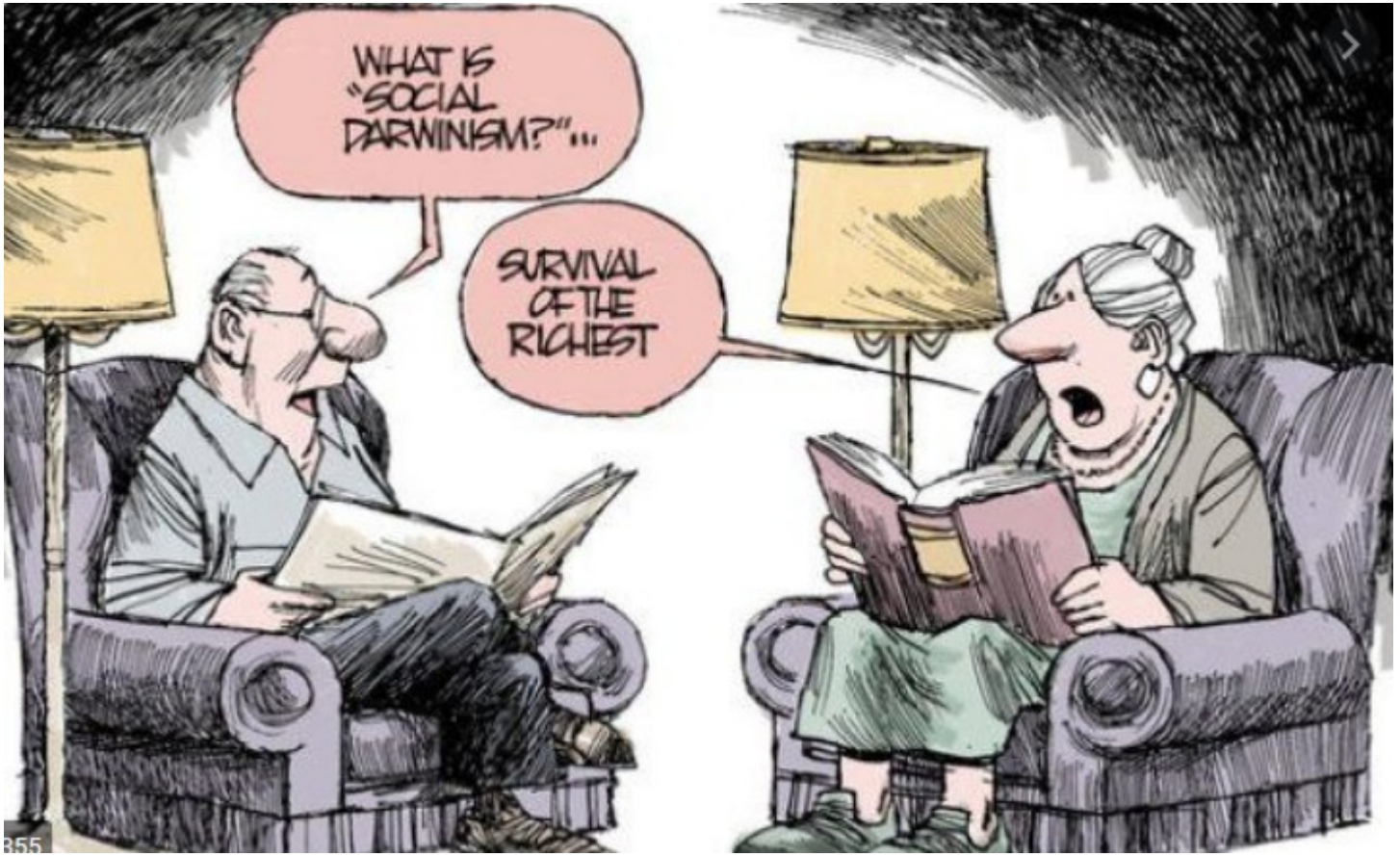
1 Le specie sono correlate da **origini comuni** [discendenza]

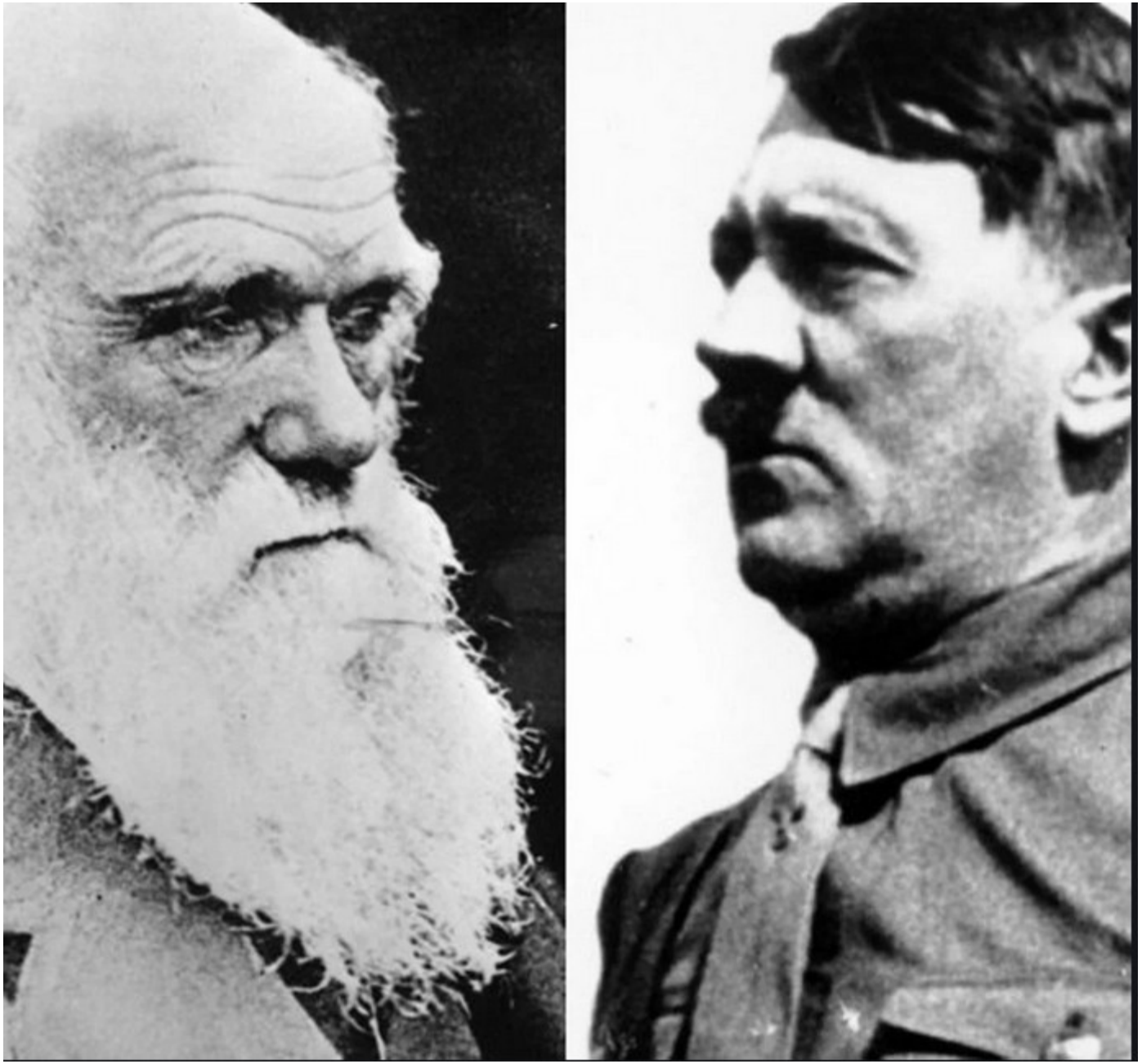
2 I cambiamenti nel tempo non si verificano a livello di organismo
ma a livello di **popolazione**

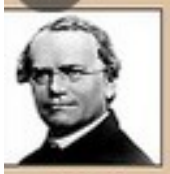
3 La causa principale dell'evoluzione adattativa è la **selezione naturale**



Il “Darwinismo Sociale”


WHAT IS "SOCIAL DARWINISM?"...
SURVIVAL OF THE RICHEST





1865 **Mendel** documents patterns of heredity in pea plants

1902 **Sutton and Boveri** propose chromosome theory of heredity

1927 **Muller** shows that X-rays induce mutations

1930s **Hämmerling** shows that hereditary information is contained in the nuclei of eukaryotic cells

1931 **McClintock** demonstrates genetic recombination in corn

1944 **Avery, McLeod, and McCarty** show that DNA is the "transforming principle" responsible for heredity

1952 **Hershey and Chase** use radioactive labeling to prove that DNA is responsible for heredity

1990s **Genome** sequencing projects begin

1869 **Miescher** first identifies DNA ("nuclein")

1915 **Morgan** and his "Fly Room" colleagues confirm the chromosome theory of heredity

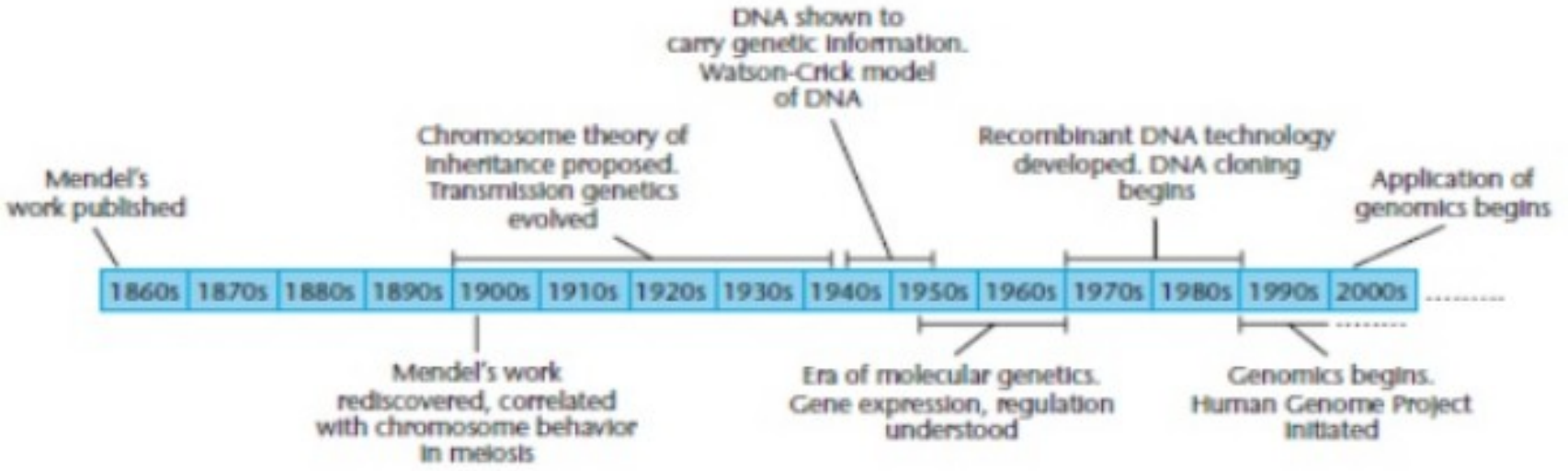
1928 **Griffith's** "transformation experiments" transform non-pathogenic bacteria strains to pathogenic

1941 **Beadle and Tatum** describe the "one gene–one enzyme" hypothesis

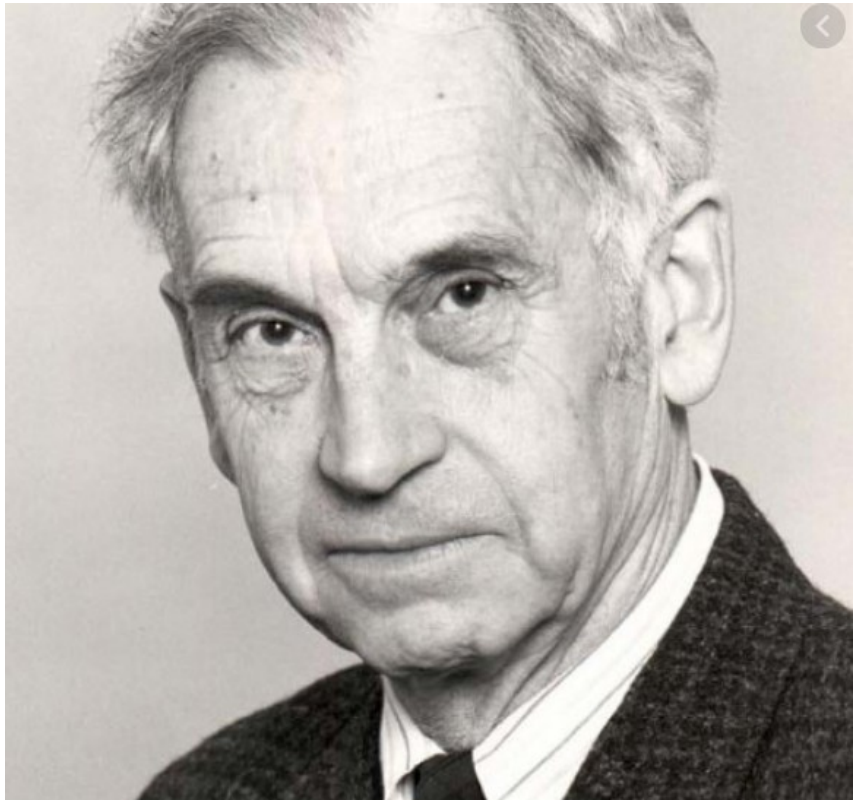
1950 **Chargaff** discovers that A = T and C = G (Chargaff's rules)

1953 **Watson and Crick** propose the double helix structure of DNA

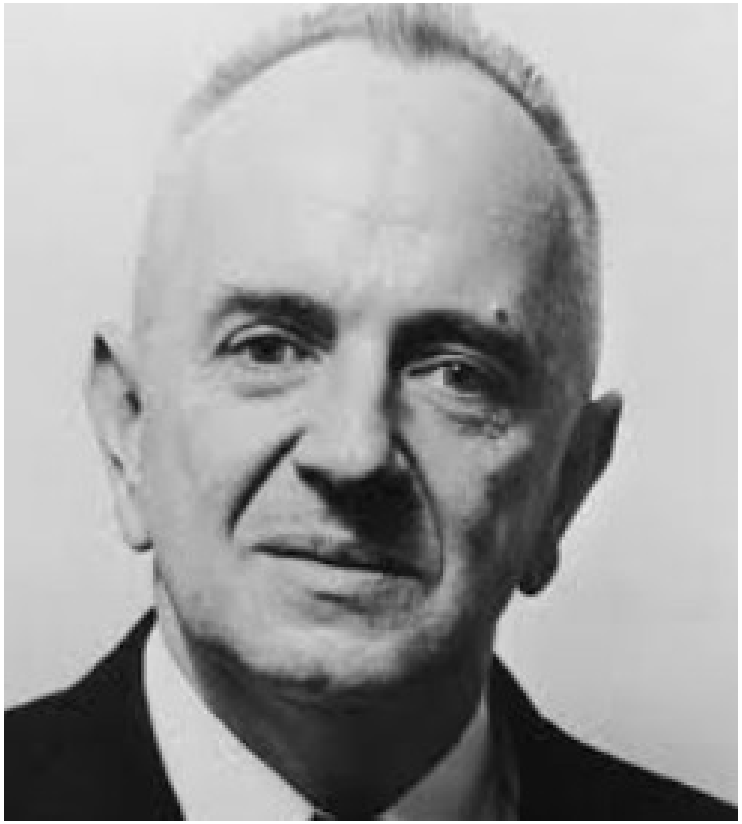
1961 **Jacob and Monod** propose the existence of mRNA



timeline showing the development of genetics from Gregor Mendel's work on pea plants to the current era of genomics and its many applications in research, medicine, and society.



Ernst Mayr (1904-2005)



Theodosius Dobzhansky (1900-1975)

Teoria sintetica dell'evoluzione

ERNST MAYR

L'EVOLUZIONE DELLE SPECIE ANIMALI

TRADUZIONE DI SILVIA E ALDO SERAFINI

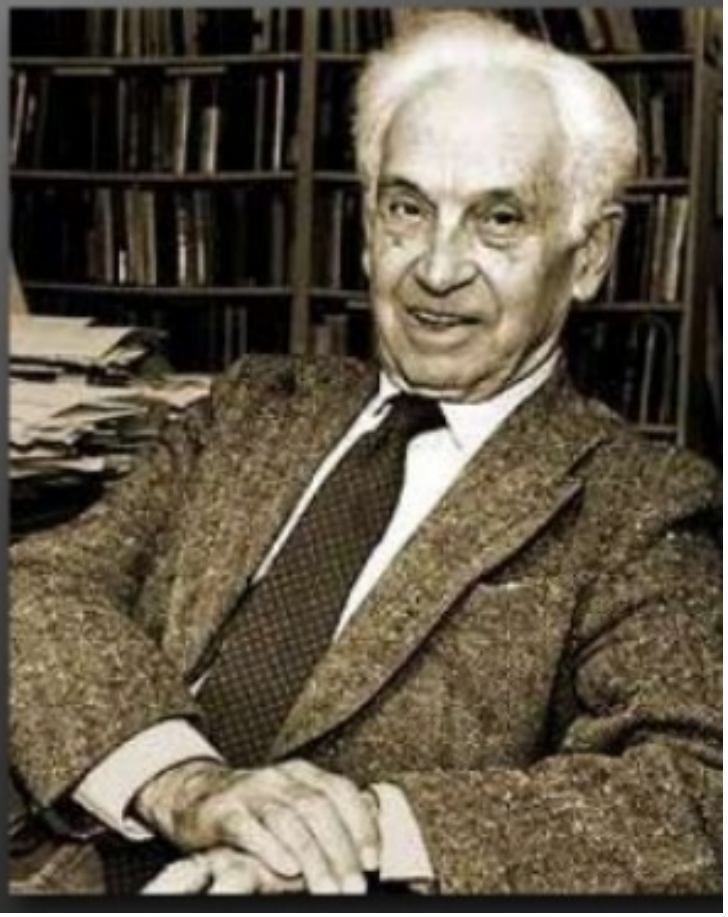
VOLUME PRIMO

GIULIO EINAUDI EDITORE

Ernst Mayr

Ernst Mayr definì le specie come "*gruppi di popolazioni naturali realmente esistenti o potenzialmente interfeconde e isolate riproduttivamente da altri gruppi simili*". Da questo enunciato si evince la chiara importanza raggiunta dalla genetica all'interno della biologia. La selezione naturale trova il suo naturale completamento: non è più semplicemente una lotta per la sopravvivenza, che vede uscire vincitore chi meglio si adatta all'ambiente, ma l'importanza si sposta dal più forte al più prolifico, in quanto riesce ad influenzare maggiormente il **pool genetico** della popolazione di cui fa parte.

Il focus passa quindi dagli individui ai geni



DEFINIZIONE BIOLOGICA DI SPECIE

Una specie è una **popolazione** di organismi che

1) condividono un patrimonio genetico,
2) sono in grado di incrociarsi
3) creano prole fertile

P.W. Bridgman (1882-1961)

EVOLUZIONE - una definizione:

Il cambiamento di materiali genetici (DNA, geni, cromosomi = **genotipo**) e quindi attributi fisici (morfologia, fisiologia = **fenotipo**) **all'interno e tra le popolazioni** e le specie attraverso il **tempo e lo spazio**

(1) L'evoluzione è il **cambiamento delle frequenze alleliche** nel pool genico di una popolazione per molte generazioni.

(2) I pool genici di specie diverse sono isolati l'uno dall'altro, mentre il **pool genico di una specie** è messo in comune dal flusso genico.

(3) Ogni individuo di una specie sessualmente riproduttiva ha solo una parte degli alleli del pool genico della specie.

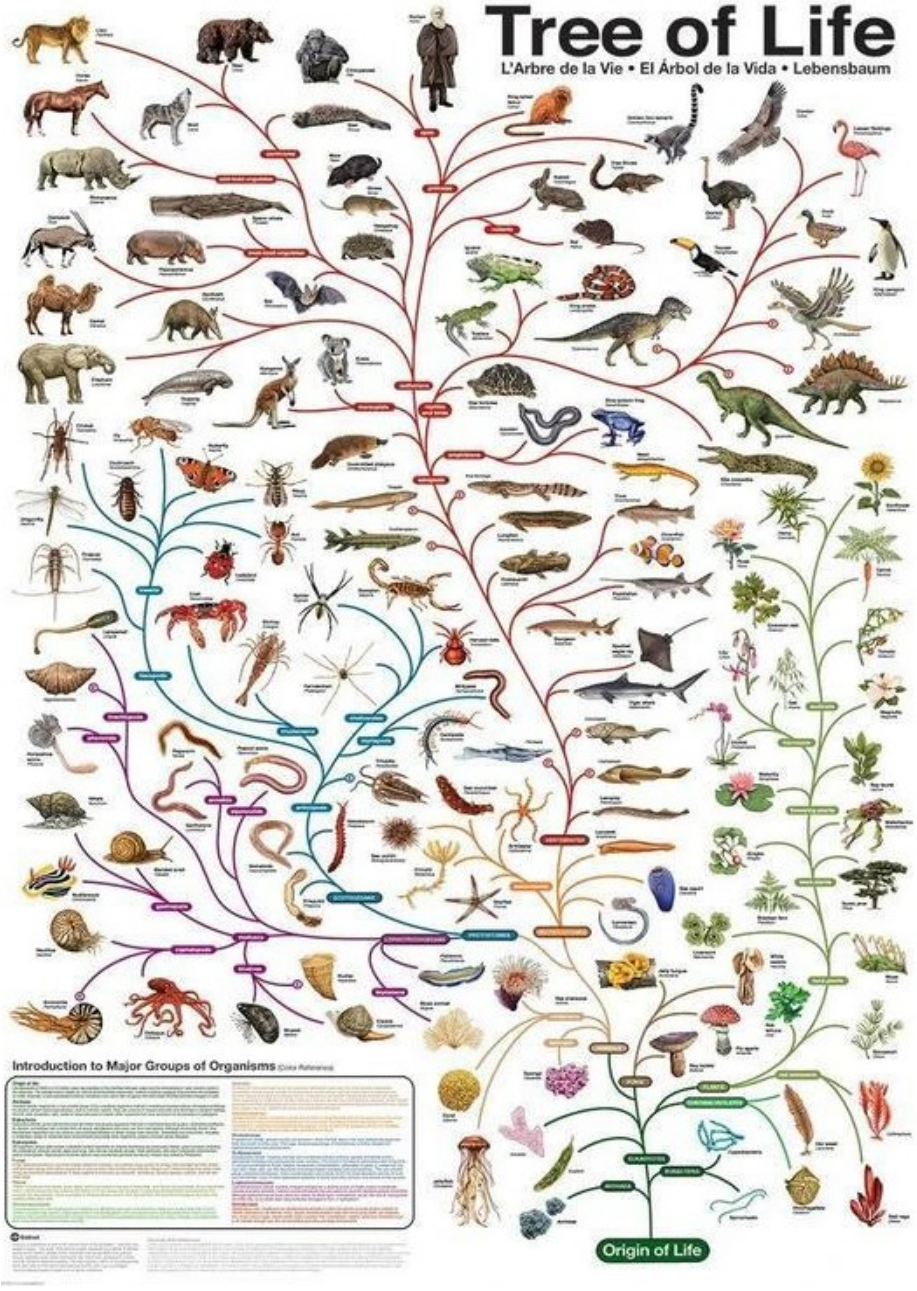
(4) Gli alleli e le combinazioni alleliche dell'individuo sono forniti da due genitori e possono essere modificati da **mutazioni** cromosomiche e/o geniche. Le mutazioni sono la fonte ultima di nuovi alleli e geni.

(5) Gli individui favoriti dalla **selezione naturale** contribuiranno con porzioni più ampie di loro geni o combinazioni di geni al pool genetico della prossima generazione.

(6) I cambiamenti nelle frequenze alleliche **nelle popolazioni** avvengono principalmente per mezzo di selezione naturale, anche se si verificano spesso mutazioni casuali.

(7) **Barriere** che limitano o eliminano il flusso genico tra sottopopolazioni sono essenziali per la divergenza genetica e fenotipica delle sottopopolazioni di una specie.

(8) La **speciazione** è completa quando il flusso genico non si verifica tra una popolazione divergente e la popolazione originaria.

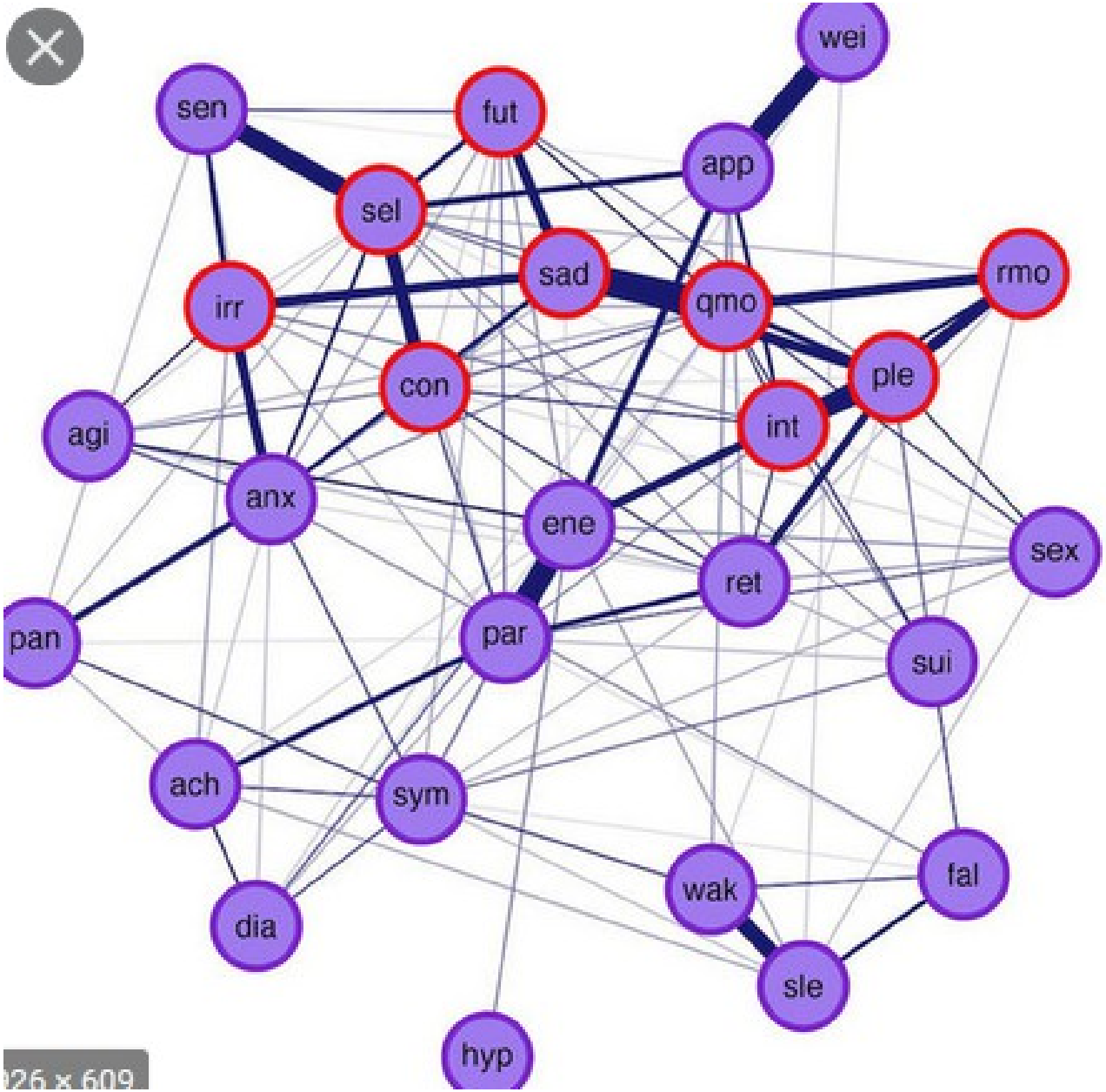

Tree of Life
L'Arbre de la Vie • El Árbol de la Vida • Lebensbaum
Introduction to Major Groups of Organisms
Origin of Life

Jacques Monod (1910-1976)

Ludwig von Bertalanffy
(1901-1972)

SISTEMA

- E’ un insieme di elementi interagenti tra loro (von Bertalanffy 1956).
- L’esistenza di *relazioni tra le parti* riveste un’importanza fondamentale poiché in loro assenza un sistema di elementi non costituisce un sistema ma un agglomerato.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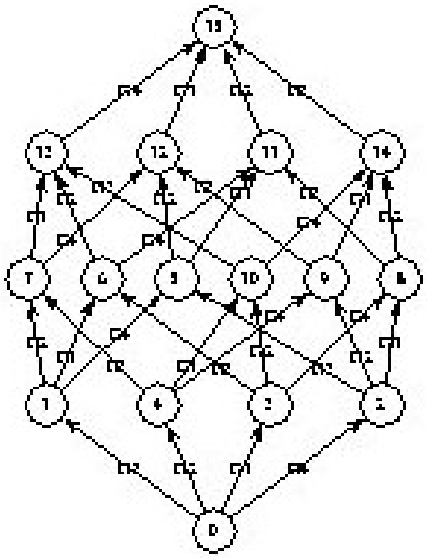

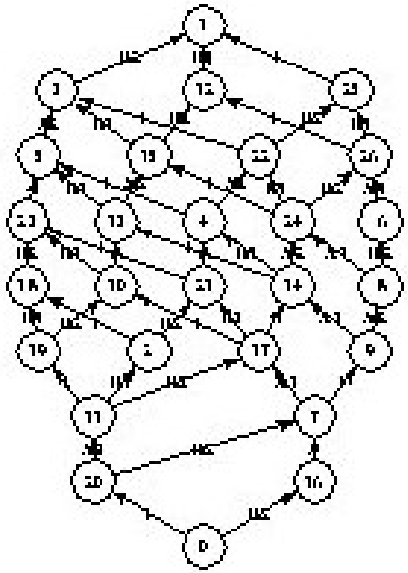

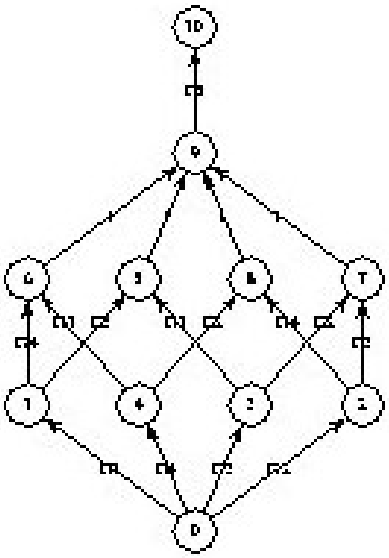

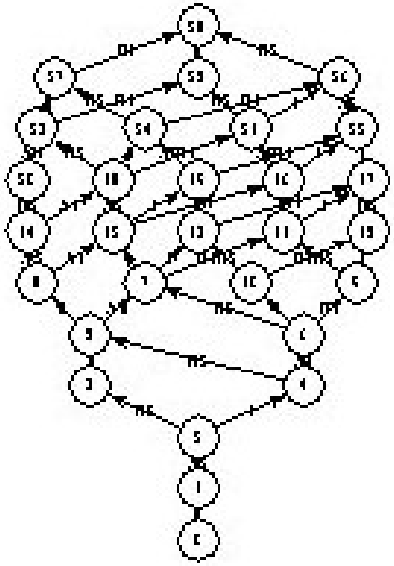

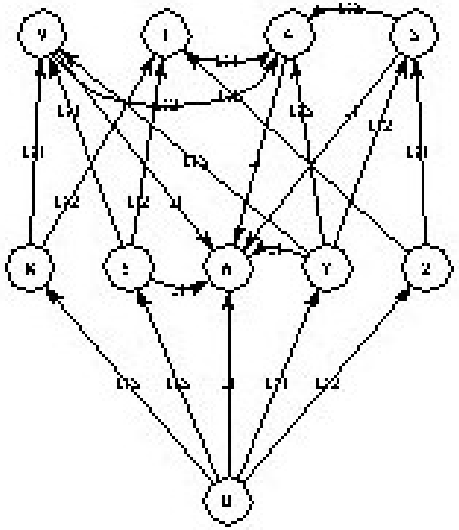

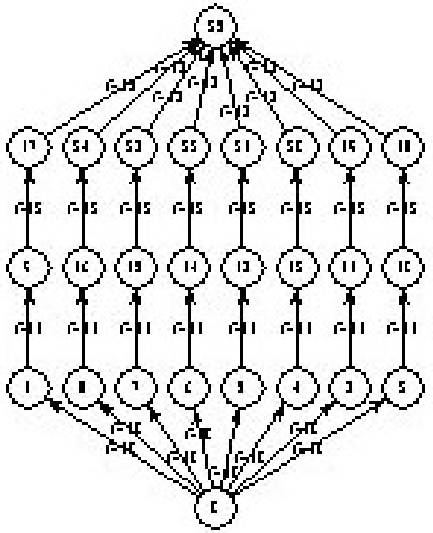

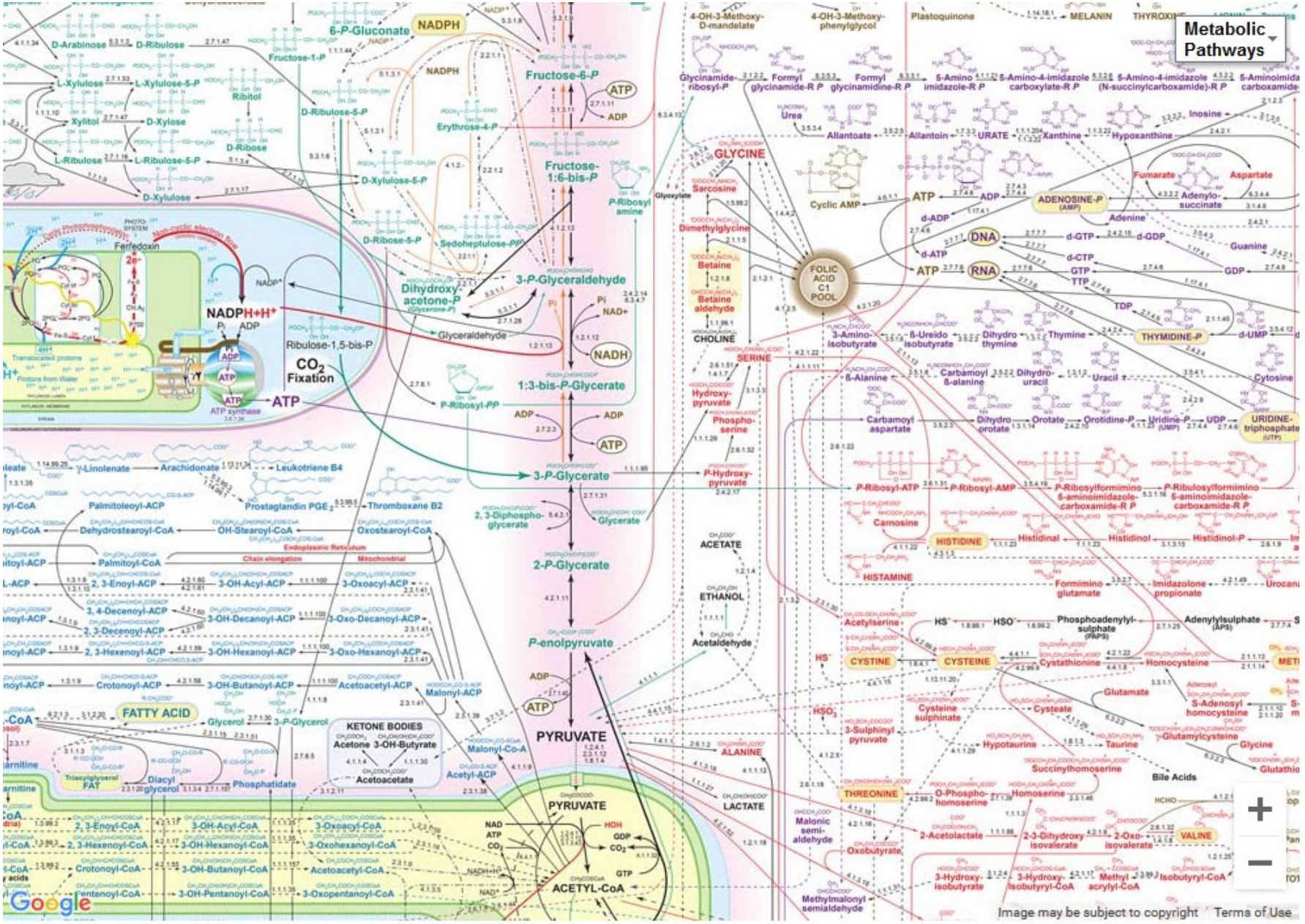
Metabolic Pathways
6-P-Gluconate
NADPH
Fructose-6-P
Fructose-1,6-bis-P
3-P-Glyceraldehyde
Dihydroxy-acetone-P
Glyceraldehyde
1:3-bis-P-Glycerate
3-P-Glycerate
2-P-Glycerate
P-enolpyruvate
PYRUVATE
ACETYL-CoA
ATP
ADP
NADH
NADPH+H+
CO2 Fixation
Ribulose-1,5-bis-P
Ferredoxin
Translocated protons
Protons from Water
ATP synthase
FOLIC ACID C1 POOL
GLYCINE
SERINE
CHOLINE
ACETATE
ETHANOL
ALANINE
LACTATE
FATTY ACID
KETONE BODIES
Acetone
3-OH-Butyrate
Acetoacetate
Glycerol
3-P-Glycerol
Phosphatidate
Diacyl glycerol
Triacylglycerol FAT
Palmitoyl-CoA
Palmitoyl-ACP
Stearoyl-CoA
Oleoyl-CoA
Linolenate
Arachidonate
Leukotriene B4
Prostaglandin PGE2
Thromboxane B2
Chain elongation
Endoplasmic Reticulum
Mitochondrial
Ribitol
Xylitol
D-Xylose
D-Ribose
D-Arabinose
D-Ribulose
L-Xylulose
L-Ribulose
Fructose-1-P
Erythrose-4-P
Sedoheptulose-PP
P-Ribosyl amine
P-Ribosyl-PP
Glycerate
2,3-Diphospho-glycerate
Hydroxy-pyruvate
Phospho-serine
P-Hydroxy-pyruvate
Sarcosine
Dimethylglycine
Betaine
Betaine aldehyde
Glyoxylate
Cyclic AMP
Urea
Allantoate
Allantoin
URATE
Xanthine
Hypoxanthine
Inosine
Adenine
Guanine
Adenylo-succinate
Fumarate
Aspartate
ADENOSINE-P (AMP)
d-ADP
d-ATP
d-GTP
d-GDP
d-CTP
GTP
GDP
TTP
TDP
DNA
RNA
THYMIDINE-P
d-UMP
URIDINE-triphosphate (UTP)
Thymine
Dihydro thymine
Uracil
Cytosine
3-Amino-isobutyrate
ß-Ureido isobutyrate
ß-Alanine
Carbamoyl ß-alanine
Dihydro-uracil
Carbamoyl aspartate
Dihydro orotate
Orotate
Orotidine-P
Uridine-P (UMP)
UDP
Carnosine
HISTIDINE
Histidinal
Histidinol
Histidinol-P
HISTAMINE
Formimino glutamate
Imidazolone propionate
Urocanic
P-Ribosyl-ATP
P-Ribosyl-AMP
P-Ribosylformimino 5-aminoimidazole-carboxamide-R P
P-Ribulosylformimino 5-aminoimidazole-carboxamide-R P
4-OH-3-Methoxy-D-mandelate
4-OH-3-Methoxy-phenylglycol
Plastoquinone
MELANIN
THYROXINE
Glycinamide-ribosyl-P
Formyl glycinamide-R P
Formyl glycinamidine-R P
5-Amino imidazole-R P
5-Amino-4-imidazole carboxylate-R P
5-Amino-4-imidazole (N-succinylcarboxamide)-R P
5-Aminoimida carboxamide
Acetylserine
Phosphoadenylyl-sulphate (PAPS)
Adenylylsulphate (APS)
CYSTINE
CYSTEINE
Cystathionine
Homocysteine
Cysteine sulphinate
Cysteate
3-Sulphinyl pyruvate
Hypotaurine
Taurine
Glutamate
S-Adenosyl homocysteine
Glutamylcysteine
Glycine
Glutathio
Bile Acids
Succinylhomoserine
THREONINE
O-Phospho-homoserine
Homoserine
Malonic semi-aldehyde
Oxobutyrate
2-Acetolactate
2-3-Dihydroxy isovalerate
2-Oxo-isovalerate
VALINE
3-Hydroxy-isobutyrate
3-Hydroxy-isobutyryl-CoA
Methyl acrylyl-CoA
Isobutyryl-CoA
Methylmalonyl semialdehyde
Malonyl-Co-A
Malonyl-ACP
Acetyl-ACP
Acetoacetyl-ACP
3-OH-Butanoyl-ACP
Crotonoyl-ACP
3-OH-Hexanoyl-ACP
2, 3-Hexenoyl-ACP
3-OH-Decanoyl-ACP
2, 3-Decenoyl-ACP
3-OH-Acyl-ACP
2, 3-Enoyl-ACP
3-Oxoacyl-ACP
Dehydrostearoyl-CoA
OH-Stearoyl-CoA
Oxostearoyl-CoA
Palmitoleoyl-ACP
3-Oxo-Butanoyl-ACP
3-Oxo-Hexanoyl-ACP
3-Oxo-Decanoyl-ACP
3-Oxohexanoyl-CoA
3-Oxopentanoyl-CoA
3-OH-Pentanoyl-CoA
Pentenoyl-CoA
Non-cyclic electron flow
PHOTO-SYSTEM
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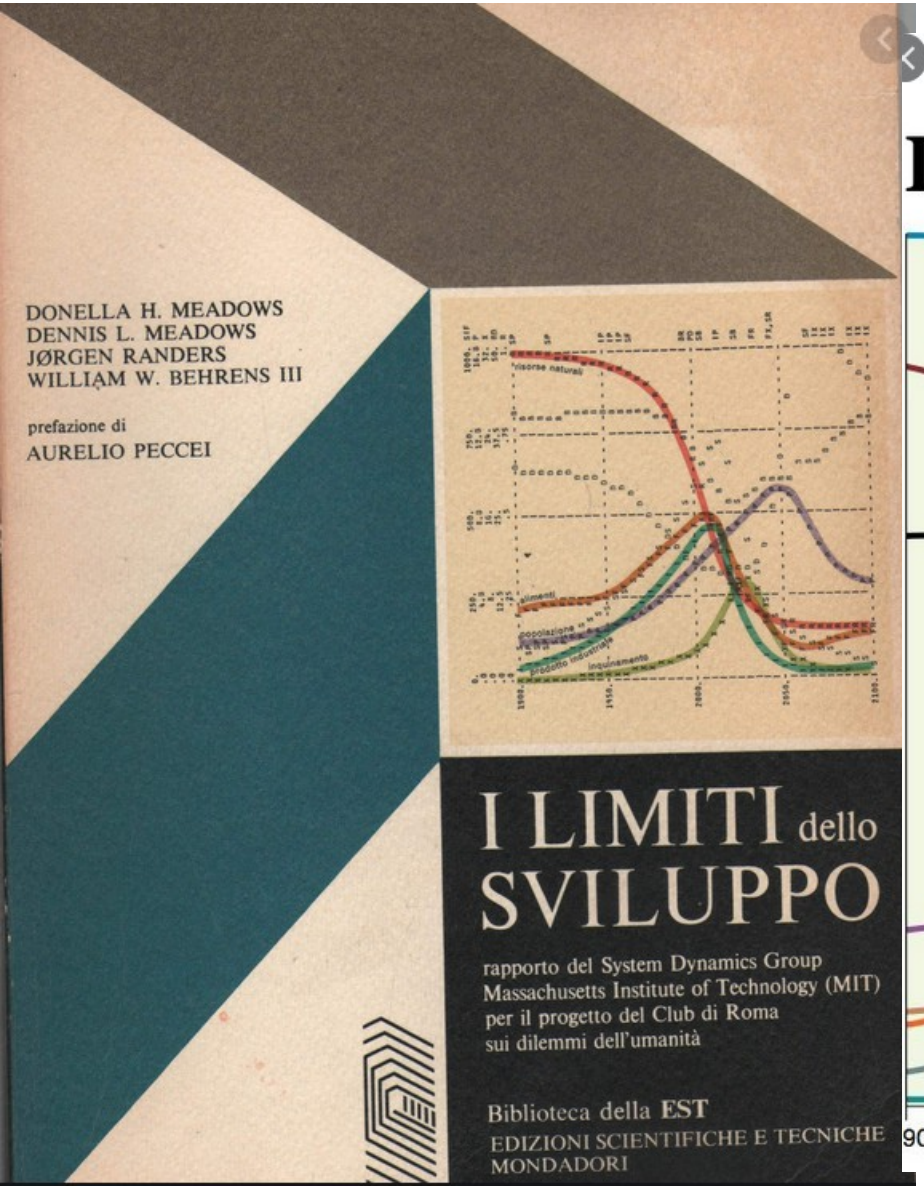
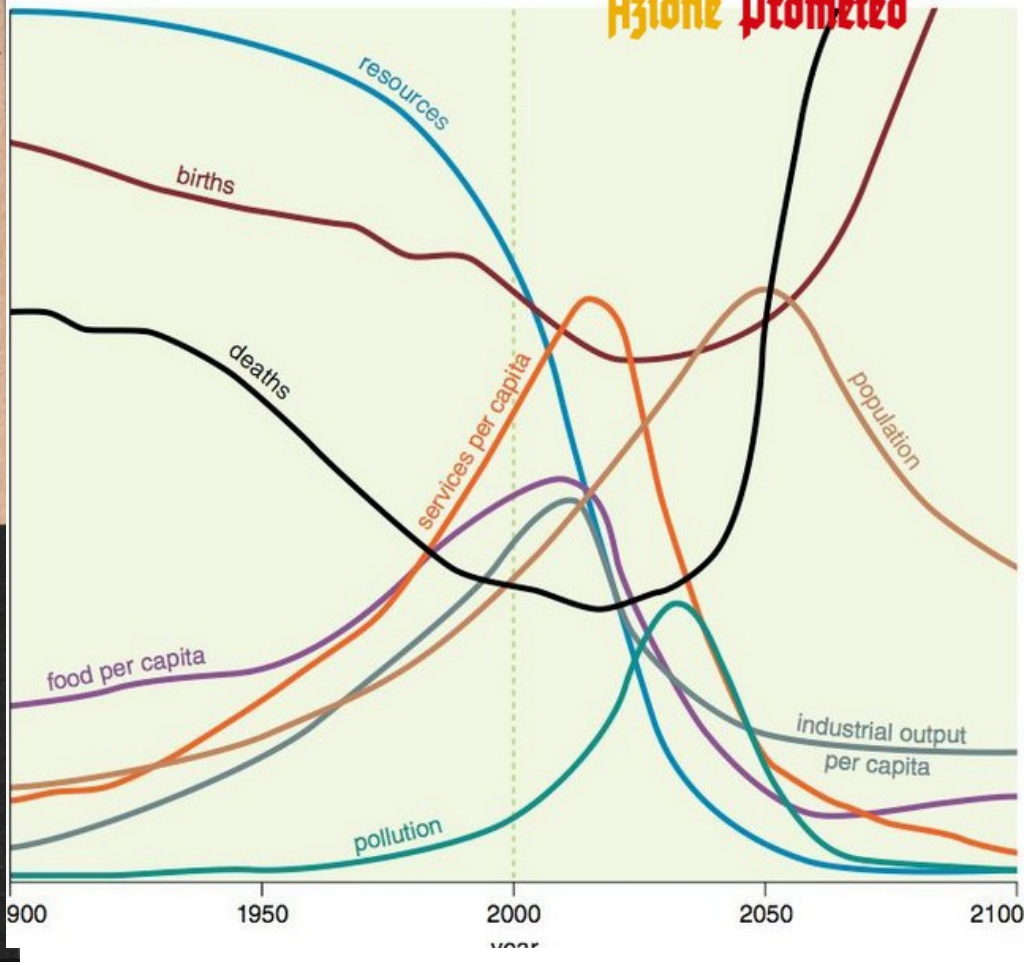
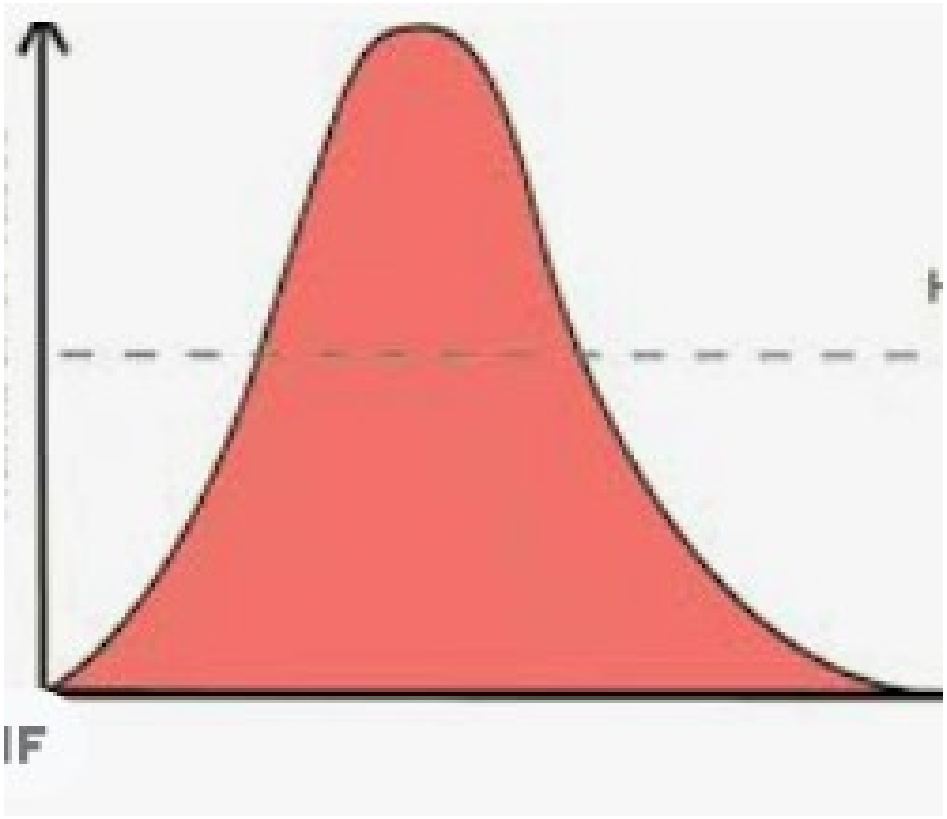
Complex systems are counterintuitive. That is, they give indications that suggest corrective action which will often be ineffective or even adverse in its results.

- Jay Wright Forrester -

“I limiti dello sviluppo”
Lo studio del M.I.T. del 1972



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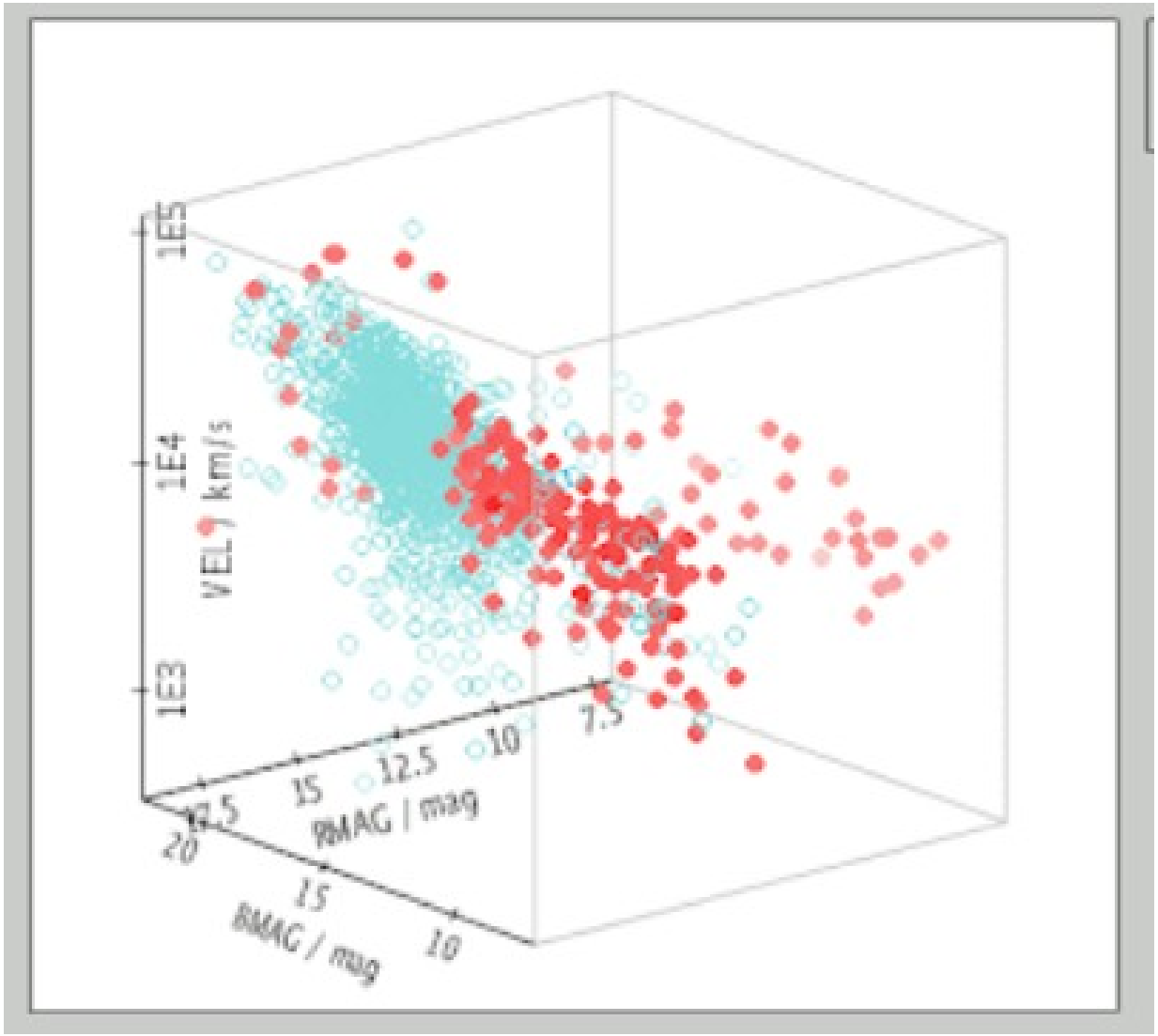
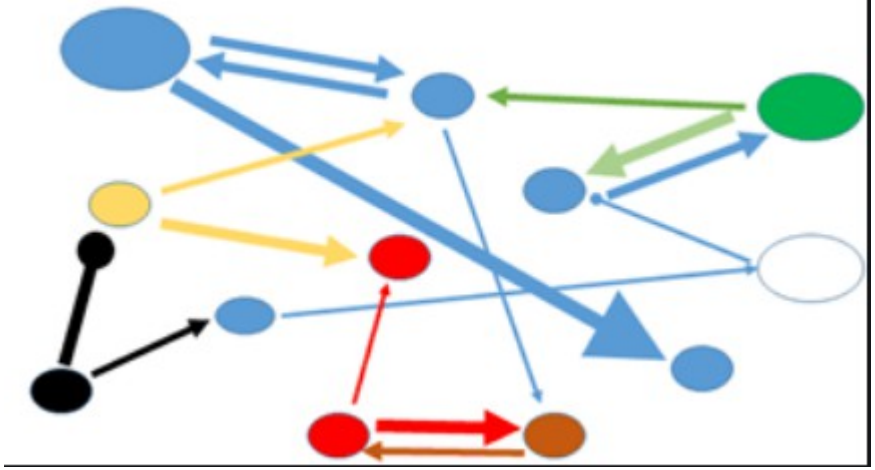
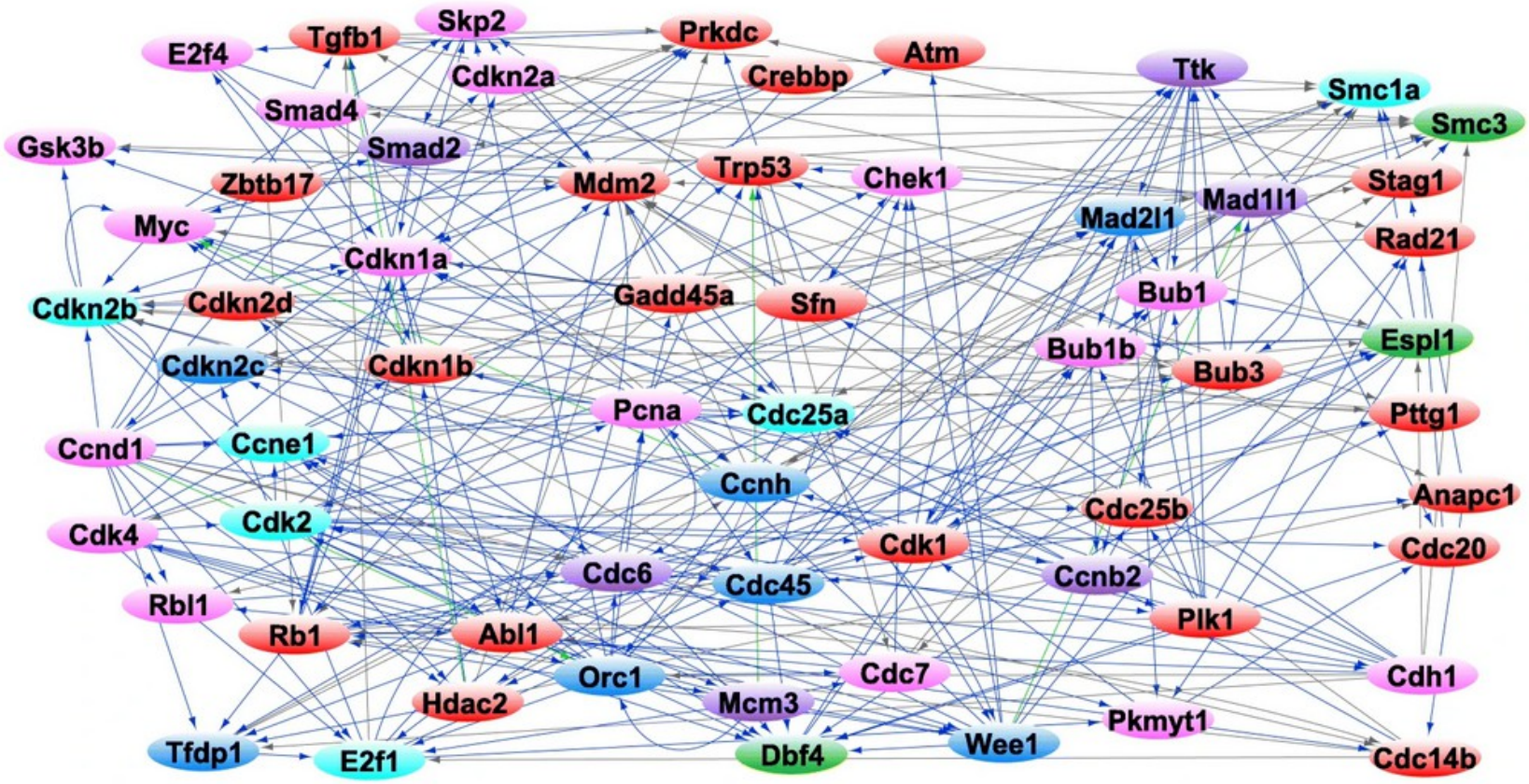
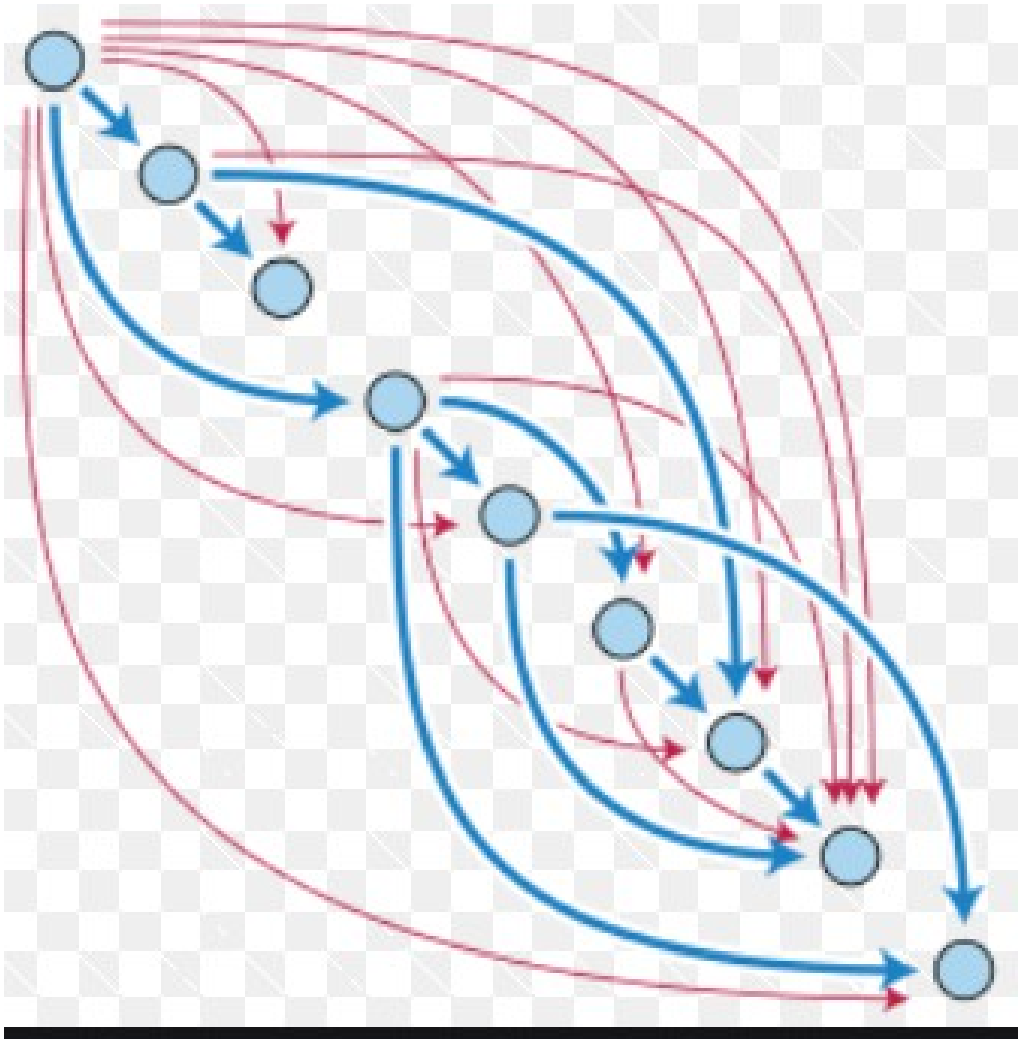

1E5
1E4
1E3
VEL / km/s
7.5
10
12.5
15
17.5
20
RMAG / mag
10
15
BMAG / mag

LINEAR CAUSALITY

NETWORK CAUSALITY




Skp2
Tgfb1
Prkdc
E2f4
Atm
Ttk
Smc1a
Cdkn2a
Crebbp
Smad4
Smc3
Gsk3b
Smad2
Trp53
Chek1
Stag1
Zbtb17
Mdm2
Mad1l1
Myc
Mad2l1
Rad21
Cdkn1a
Cdkn2b
Cdkn2d
Gadd45a
Sfn
Bub1
Espl1
Bub1b
Cdkn2c
Cdkn1b
Bub3
Pcna
Cdc25a
Pttg1
Ccnd1
Ccne1
Ccnh
Anapc1
Cdc25b
Cdk2
Cdk4
Cdk1
Cdc20
Cdc6
Cdc45
Ccnb2
Rbl1
Plk1
Rb1
Abl1
Cdh1
Orc1
Cdc7
Hdac2
Mcm3
Pkmyt1
Tfdp1
E2f1
Dbf4
Wee1
Cdc14b



Lo stato di un sistema condiziona la sua futura evoluzione

1. Hierarchical Classification

Characters are "fossil" footprints indicating ancestry

- but rather each inherited it from a *common ancestor* who first derived it — *a "fossil" footprint*

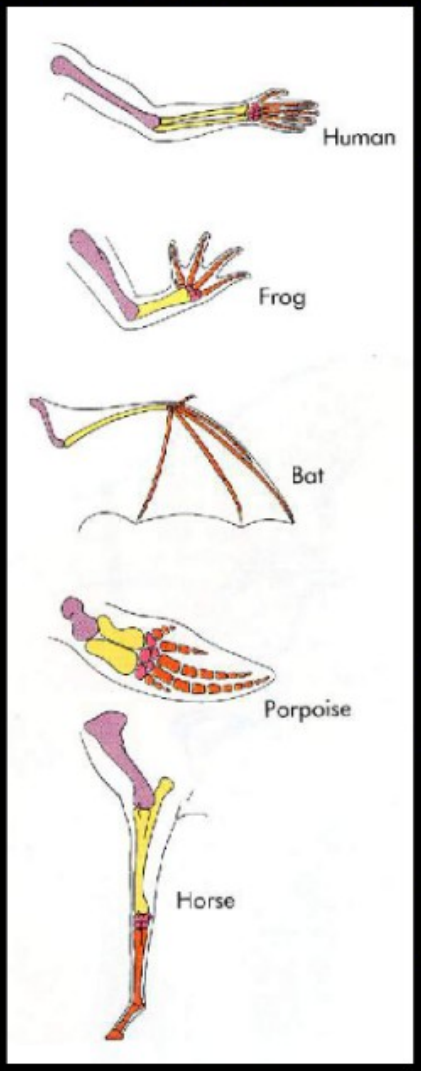
2. Evidence through Homology

Character modification — homologous parts

Evolution thus predicts that species descended from a common ancestor should share homologous characters - derived from the same structure(s) - but that they will show divergence in these characters through time

The forelimb of all these vertebrates are homologous but modified:

Unrelated species (different ancestors) will show convergence in similar niche



grasping

leaping

flying

swimming

running