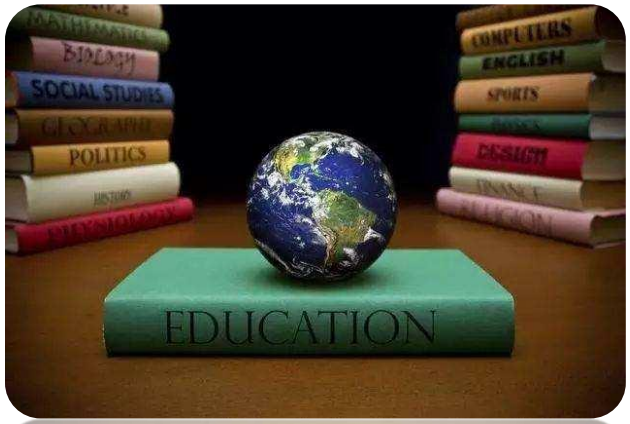
知性的科学

—— 科技创新介导自然观、价值观、伦理观重塑

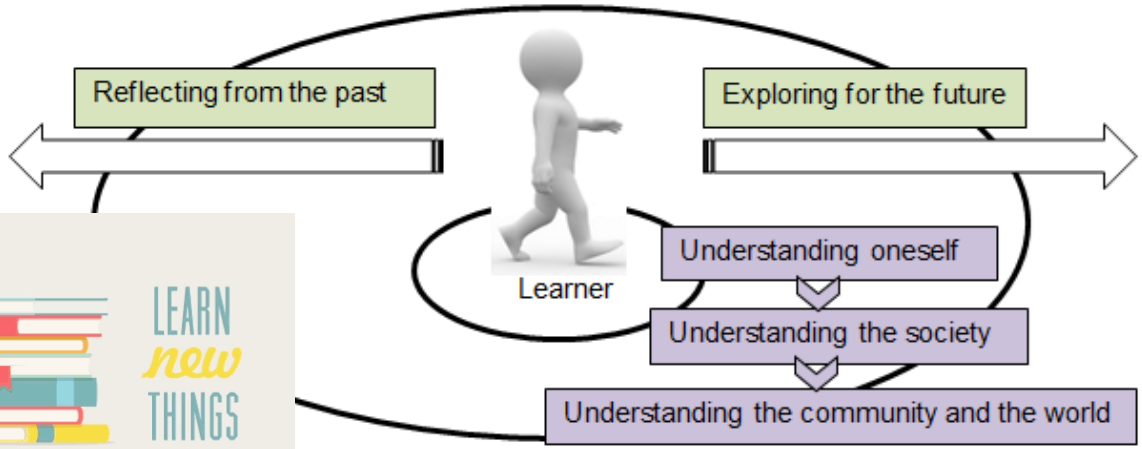
复旦大学　杨 继

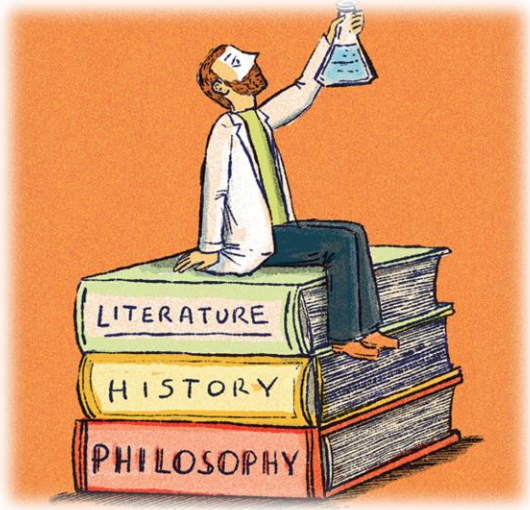

EDUCATION
BIOLOGY
SOCIAL STUDIES
POLITICS
COMPUTERS
ENGLISH
SPORTS
DESIGN


通识教育


全人
Whole Man
好人
Good Man
有用之人
Useful Man
正直的公民
Good Citizen

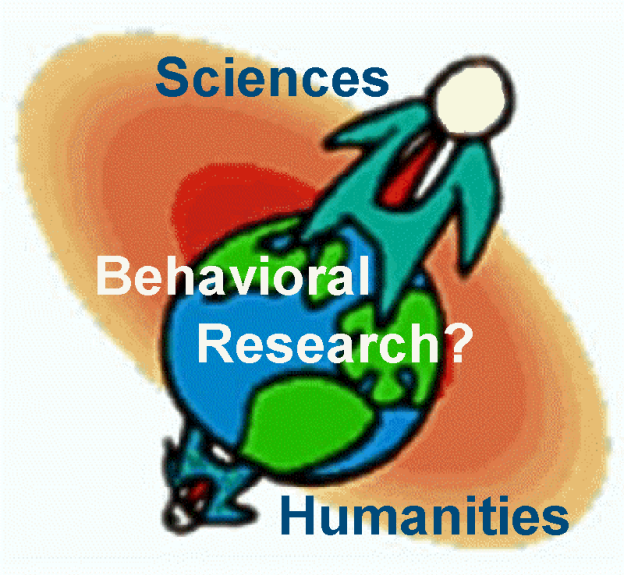

LEARN
new
THINGS

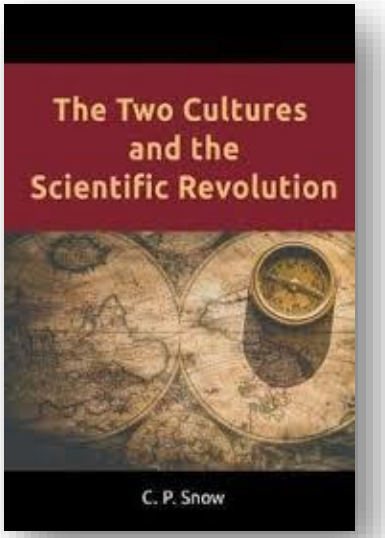

Reflecting from the past
Exploring for the future
Learner
Understanding oneself
Understanding the society
Understanding the community and the world



The values and ethical principles of a society are shaped by literature, history, philosophy, art, …… and of course by SCIENCE.

科学与人文的融合





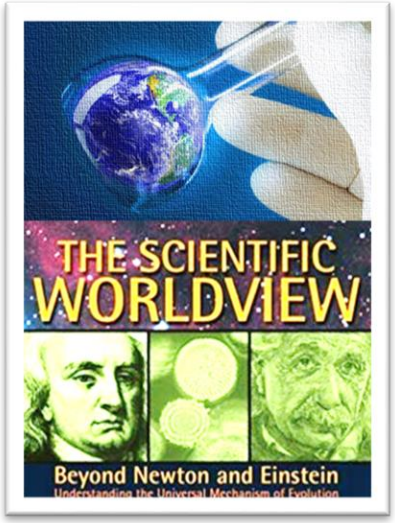
Today, in a more technological society than ever, it seems essential to overcome this barrier between the two cultures (scientific and humanistic) and propose an education that integrates both branches of knowledge.

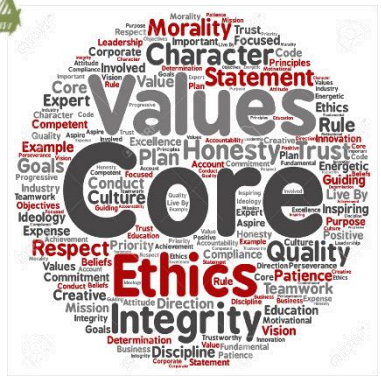
科学与知性

The intellectual implications of science

Science contributes to our culture in many ways, as a creative intellectual activity in its own right, as the light which has served to illuminate man's place in the universe, and as the source of understanding of man's own nature.

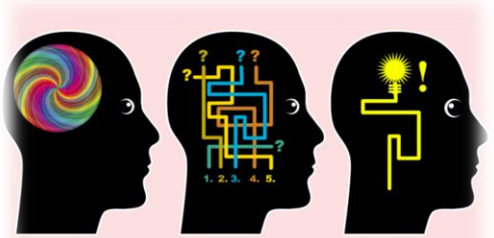
~ John F. Kennedy

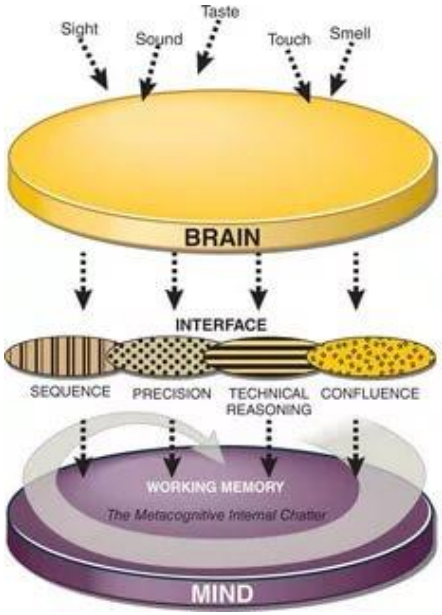


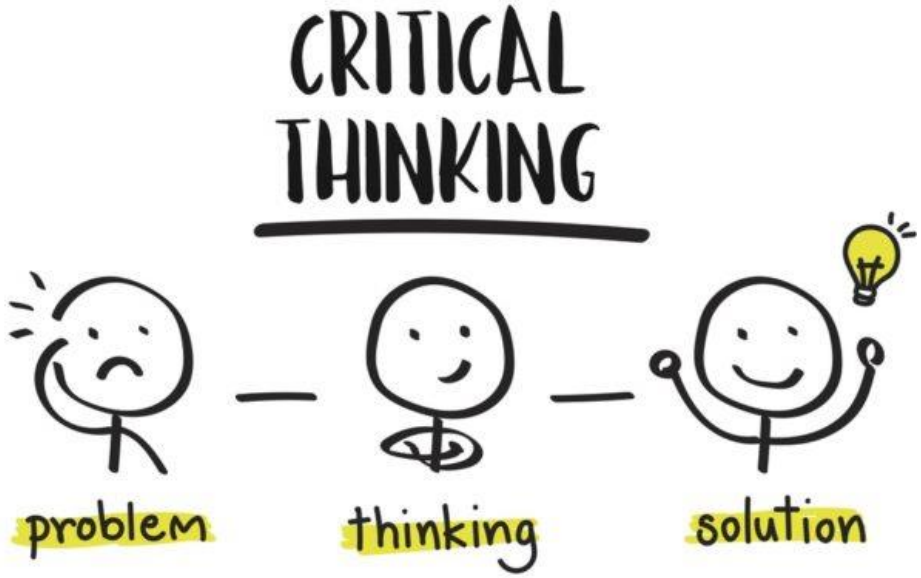


康德：感性 — 知性 — 理性

Kant divided cognitive activity on senses (чувства), intellect and reason. **Intellect** is an ability to construct logic conclusions.

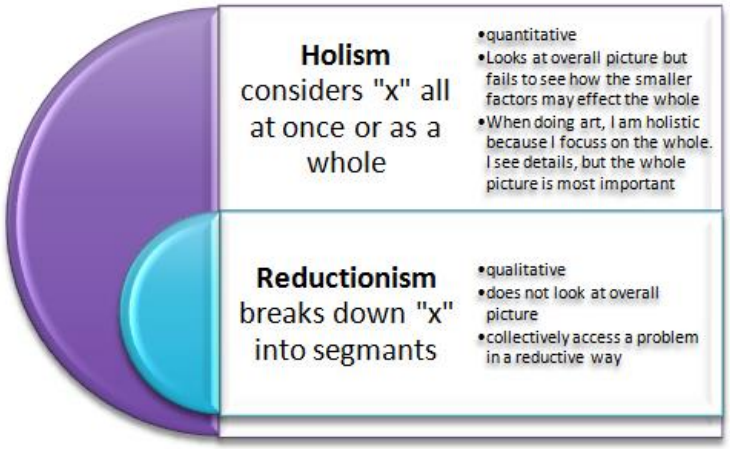


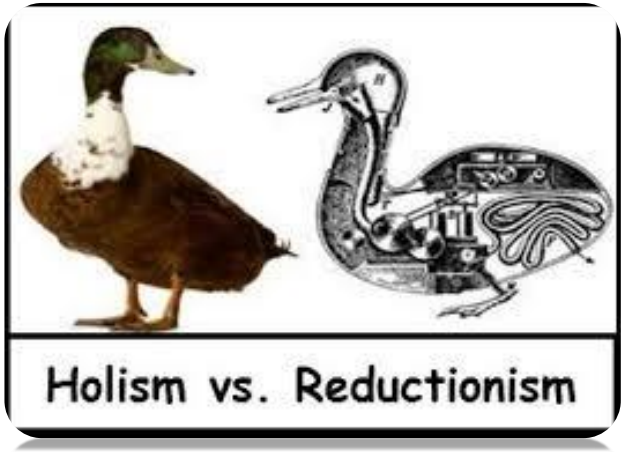


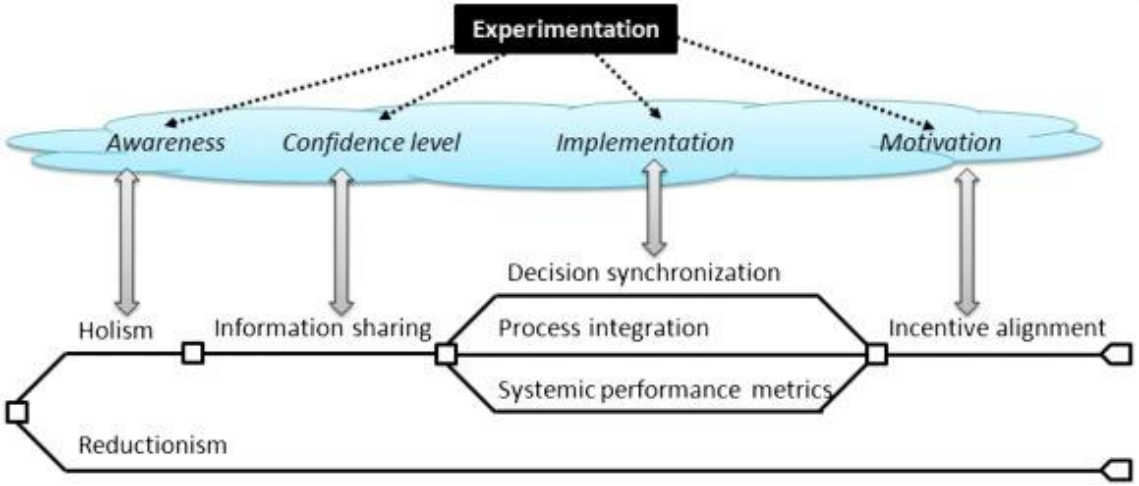


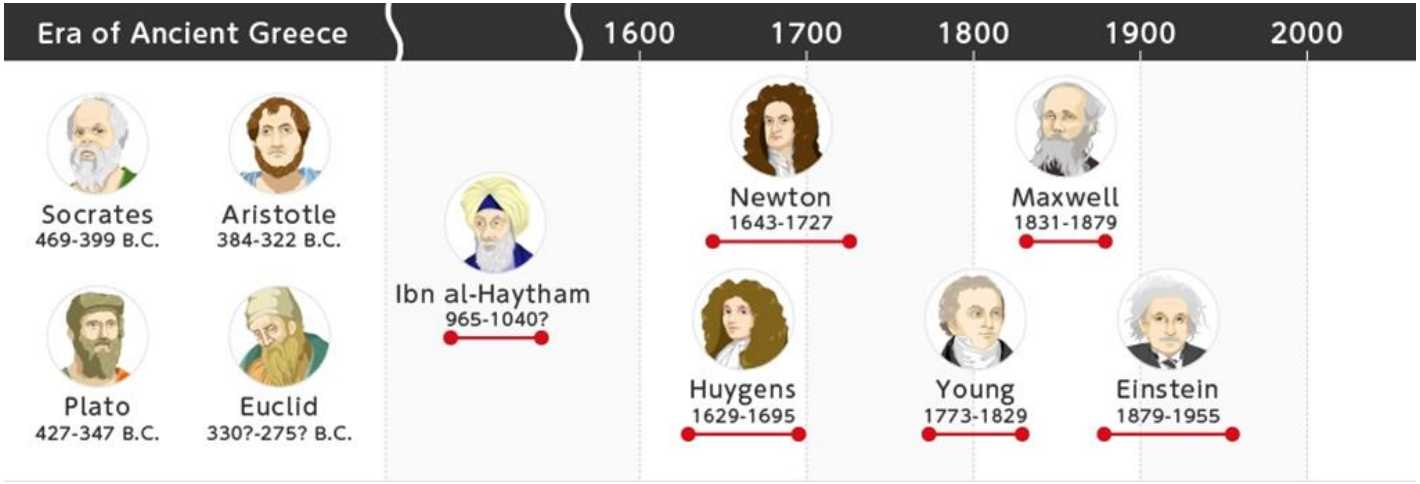
Root Causes: What Are the Problems Behind the Problem?

东西方思维和认知模式的差异







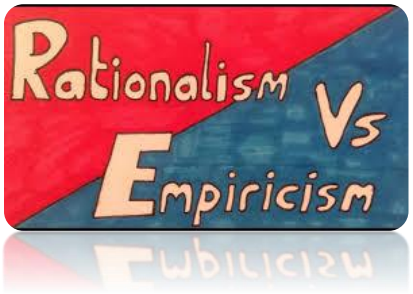


Rationalism

Knowledge is derived from reason and logic.

Mathematics is the paradigm of knowledge.

Genuine knowledge is certain because it is rational, not empirical.

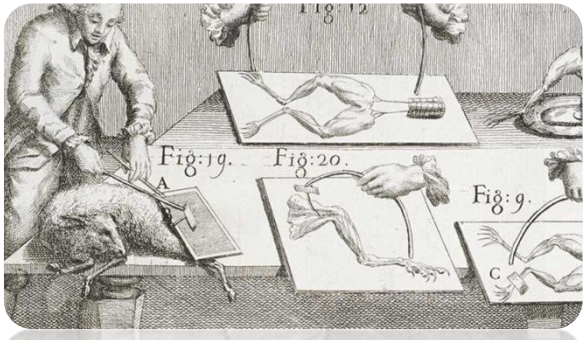


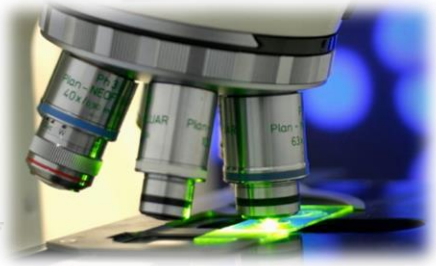
Empiricism

Knowledge is derived from experience/experimentation.

Experimental science is the paradigm of knowledge.

Experimental science cannot produce certainty.



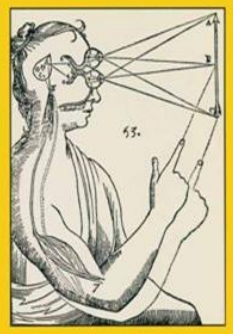


The Roots of Modern Science

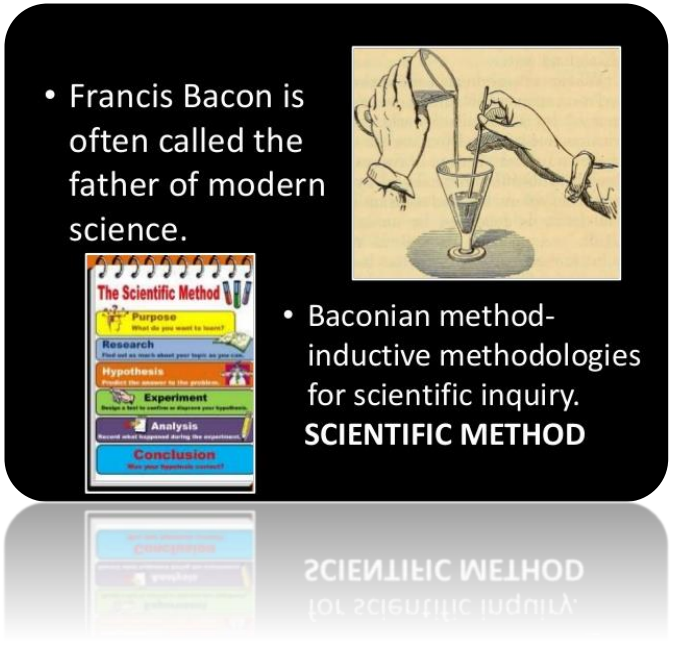
- The Renaissance and Reformation inspired the Scientific Revolution
- Since the Middle Ages, European scholars unquestioningly accepted ancient ideas
- The earth-centered view of the universe, the "geocentric theory" symbolized Europe's out-dated scientific assumptions

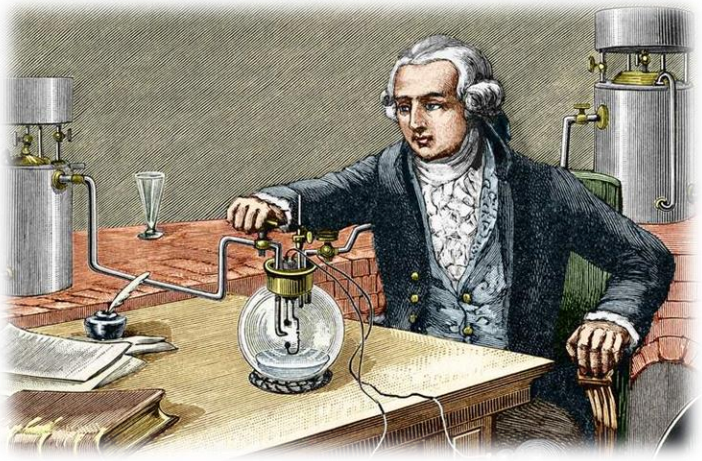
The Scientific Revolution

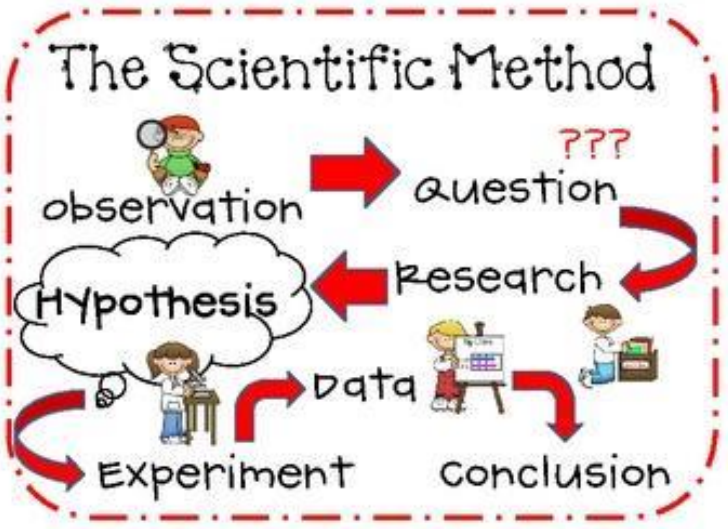
THE SCIENTIFIC REVOLUTION AND THE ORIGINS OF MODERN SCIENCE



科学不是单纯的观察，不是不声不响、不露声色的呆在一边静止的旁观，而是把事物抓起来，放到可以人为控制条件的实验室里，按照我们的意志和目标，对它进行反复的拷问。它不回答怎么办？就给它点颜色看看：高温、高压、高浓度或者低压、低温、低浓度。总而言之，在一种非自然的状态下，让它吐露奥秘，告诉你他的规律。

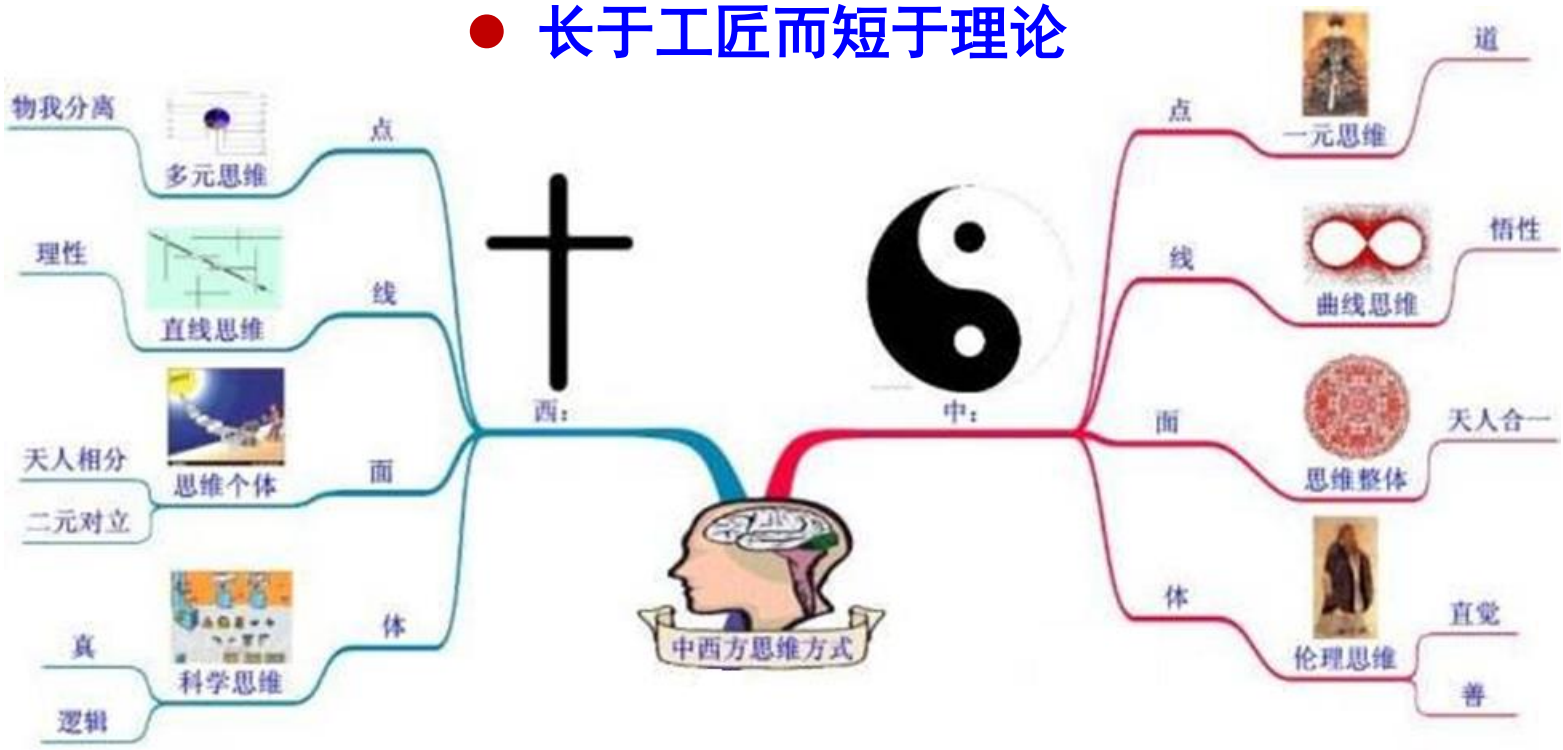






中国文化以和谐为核心，强调整体思维，推崇“中庸之道”

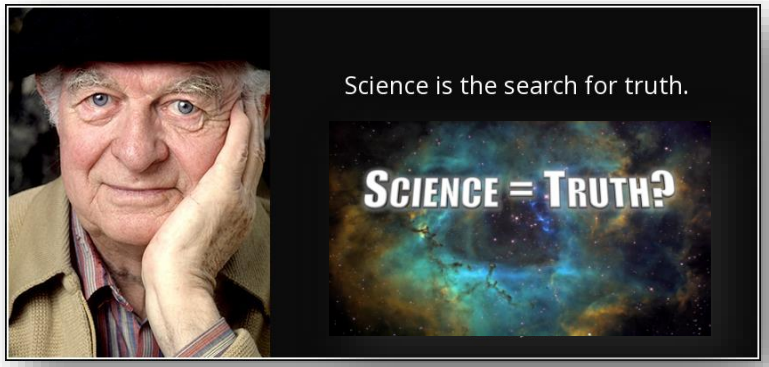
- 长于直觉而短于抽象
- 长于综合而短于分析
- 长于工匠而短于理论

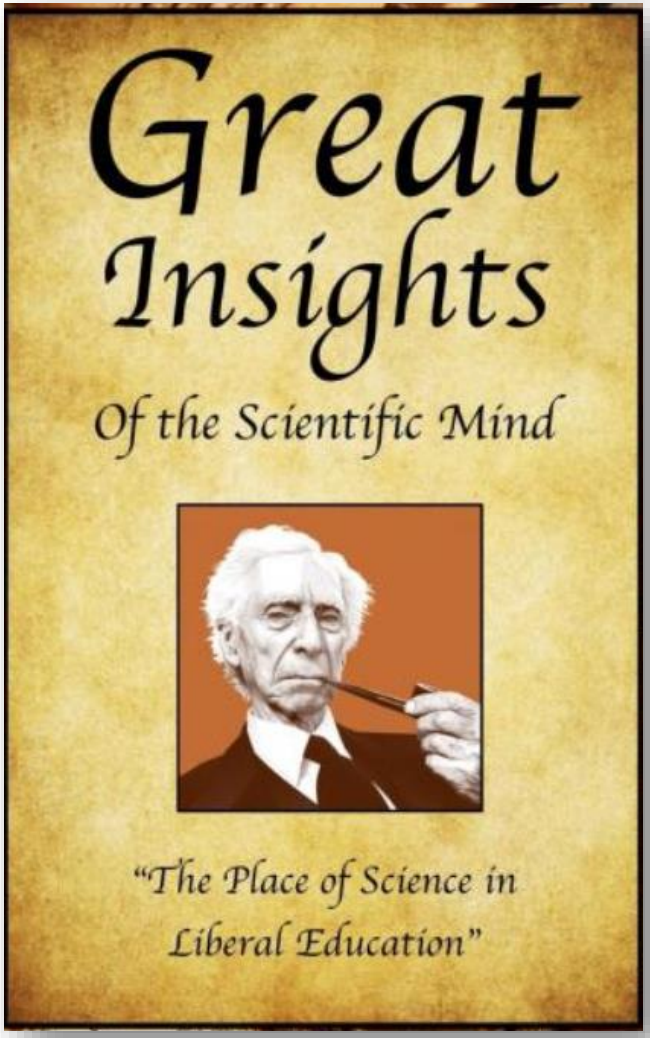


求真科学
(Science for truth)

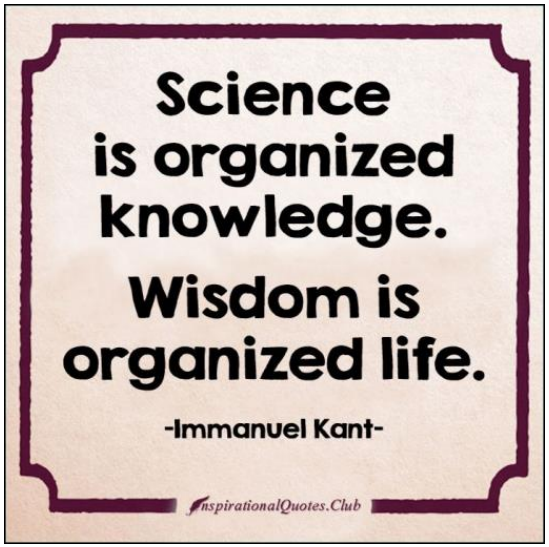
vs

求力科学
(Science for power)



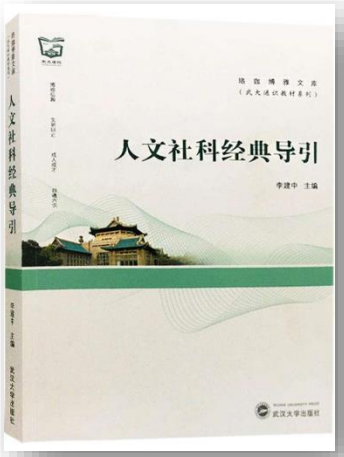

Great
Insights
Of the Scientific Mind
"The Place of Science in
Liberal Education"

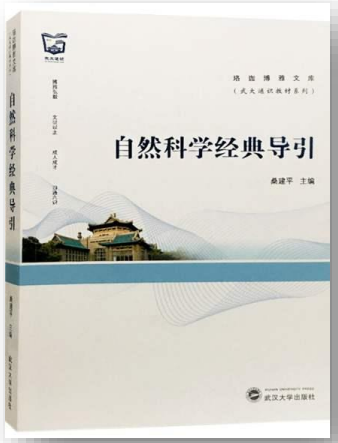

Intellectual
Spiritual
Emotional
Physical
2x8=16


Science
is organized
knowledge.
Wisdom is
organized life.
-Immanuel Kant-
InspirationalQuotes.Club

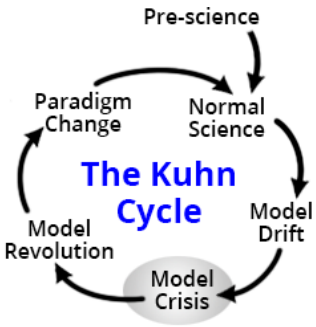
通识教育 ⊄ “经典教育”

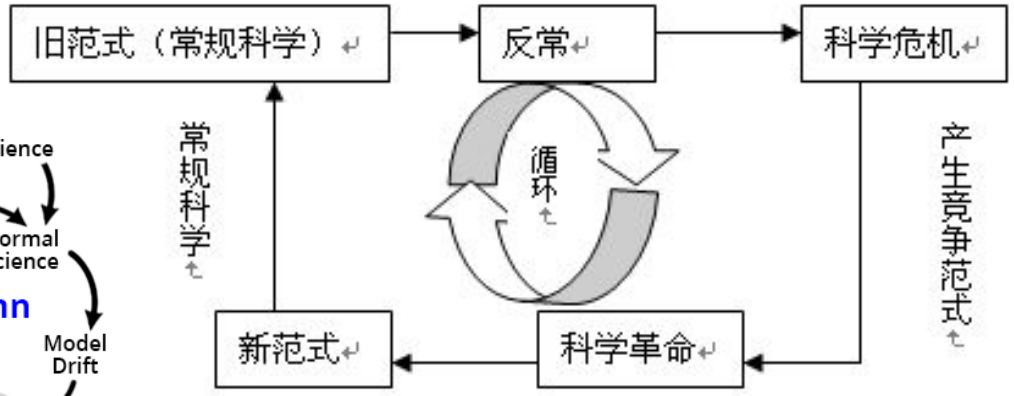

中西古典
对于大学通识教育的意义
無竟寓


人文社科经典导引

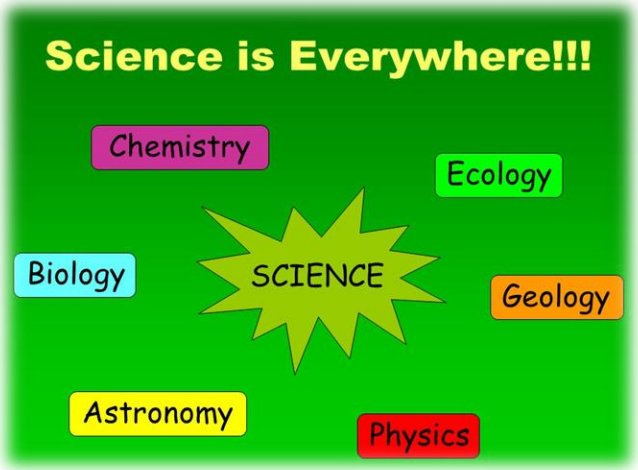

自然科学经典导引

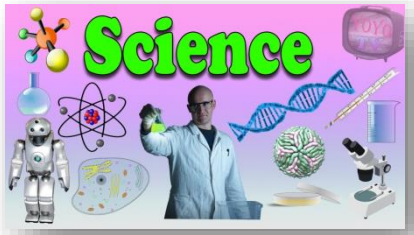

科学中的革命
（新译本）

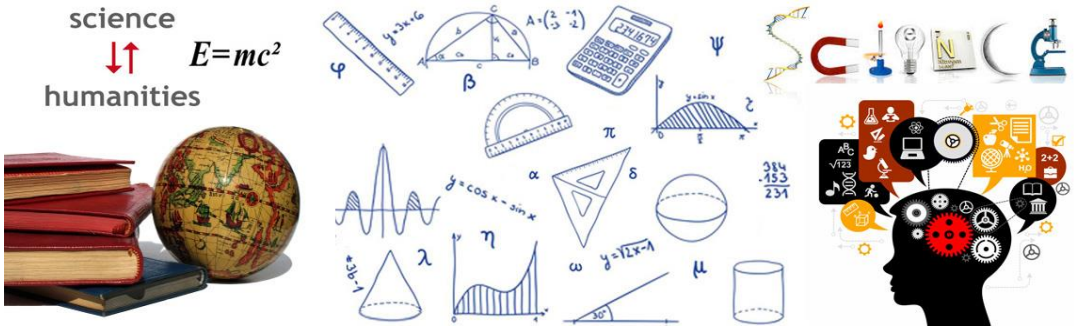

Pre-science
Normal Science
Model Drift
Model Crisis
Model Revolution
Paradigm Change
The Kuhn Cycle


旧范式（常规科学）
反常
科学危机
科学革命
新范式
常规科学
循环
产生竞争范式

KNOWLEDGE SOCIETY

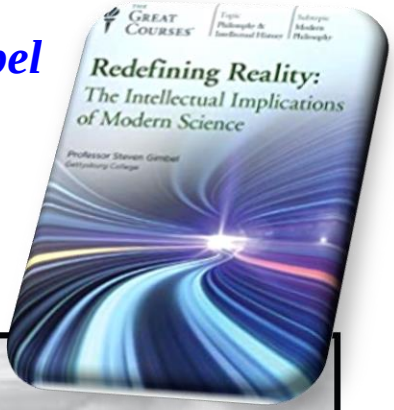






We are living exciting times where knowledge flows and gets shared like never before. We are flooded everyday with awesome technological scientific novelties that are almost immediately incorporated to our lives.

Steven Gimbel



Redefining Reality:

—— The Intellectual Implications of Modern Science

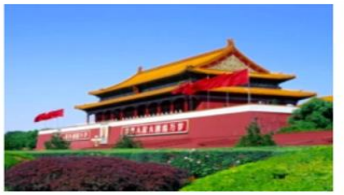
In Newton's conception, time was absolute, fixed, and immutable, but after Einstein, time became softer, able to be stretched and contracted; surrealist artists attempted to capture this revision of our notion of time.

通识教育课程的基本内涵与学科特色

文史经典与文化传承

哲学智慧与批判性思维

文明对话与世界视野



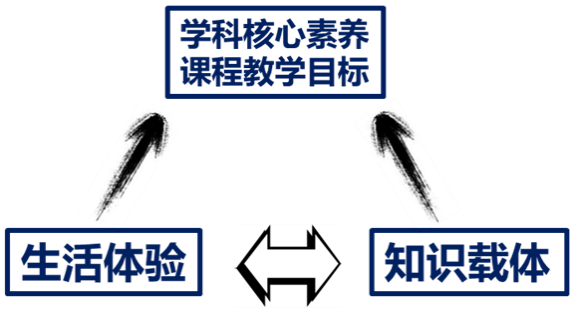
社会研究与当代中国

科学探索与技术创新

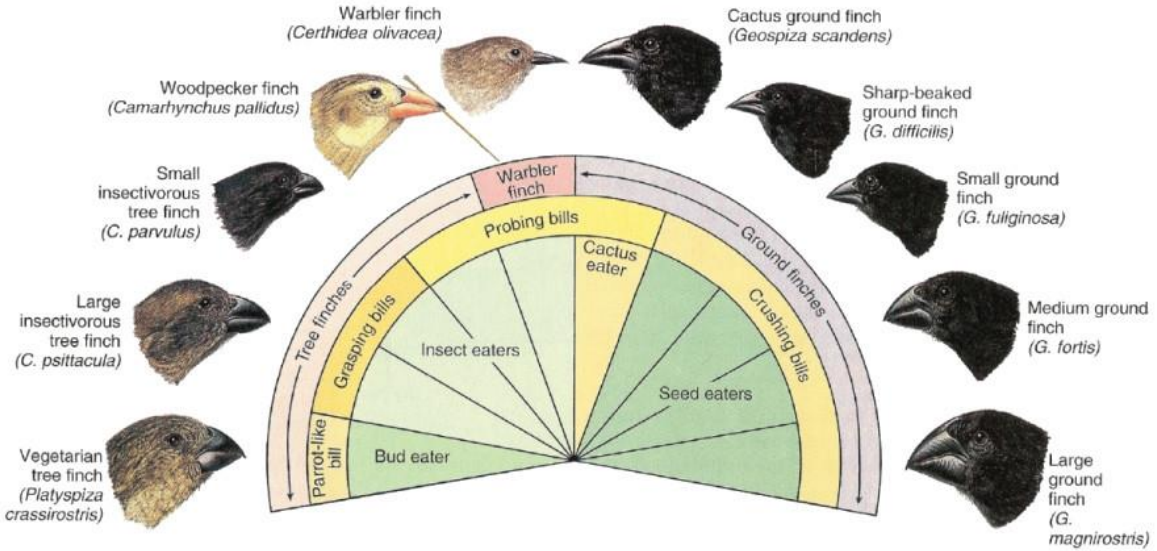
生态环境与生命关怀

艺术创作与审美体验

复旦通识
Fudan General Education




MYTHS OF EVOLUTION

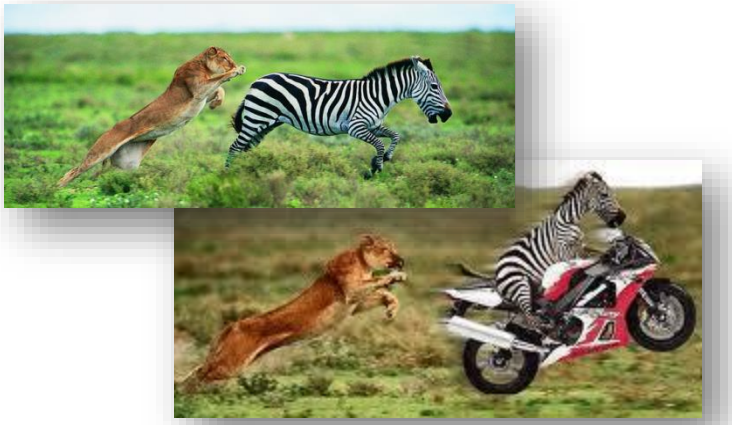

Warbler finch
(Certhidea olivacea)
Cactus ground finch
(Geospiza scandens)
Woodpecker finch
(Camarhynchus pallidus)
Sharp-beaked
ground finch
(G. difficilis)
Small
insectivorous
tree finch
(C. parvulus)
Small ground
finch
(G. fuliginosa)
Large
insectivorous
tree finch
(C. psittacula)
Medium ground
finch
(G. fortis)
Vegetarian
tree finch
(Platyspiza
crassirostris)
Large
ground
finch
(G.
magnirostris)
Warbler finch
Probing bills
Cactus eater
Ground finches
Tree finches
Grasping bills
Crushing bills
Insect eaters
Seed eaters
Parrot-like bill
Bud eater

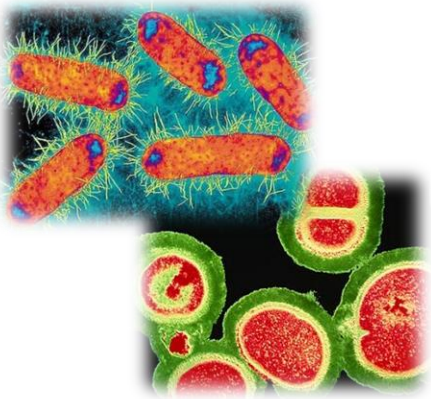

Selection
选择
Inheritance
遗传
Variation
变异

- 生物所繁殖的后代不能全数存活
- 即使是同一物种的不同个体也各不相同
- 这些差异至少有一部分遗传给下一代

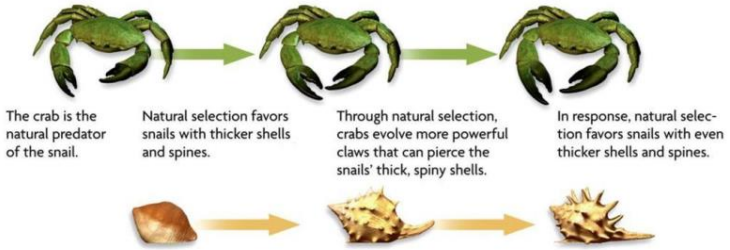
自然选择学说：谁活下来，谁死了；存活者都是适应环境的幸运儿

进化军备竞赛 Evolutionary Arms Race





Coevolution Continued…



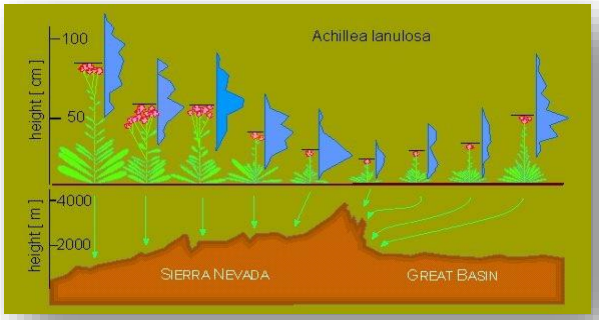
- Coevolution can occur in competitive relationships, sometimes called an **evolutionary arms race**.

红皇后假说

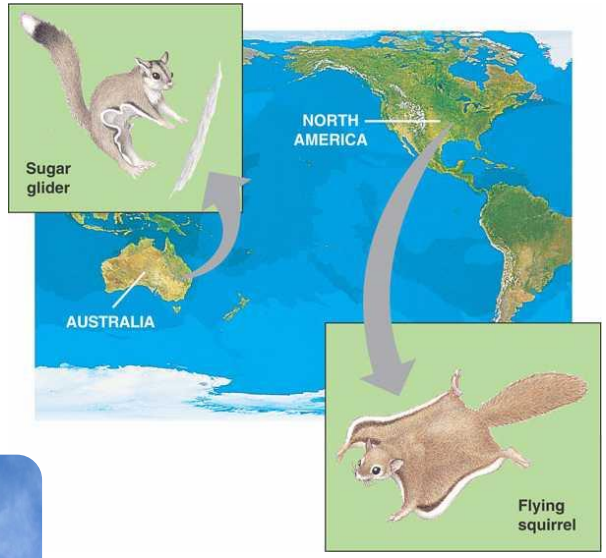
以不变应万变

以万变求不变

蒈草



蜜袋鼯（澳洲鼠）



Divergent evolution

仙人柱

水毛茛

Convergent evolution

鼯鼠（飞鼠）

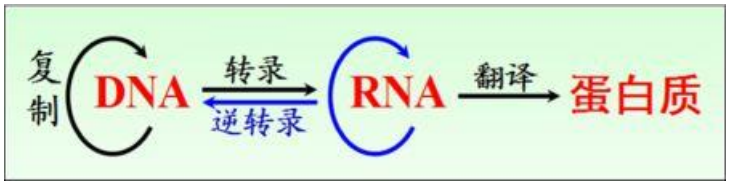
猴面包树

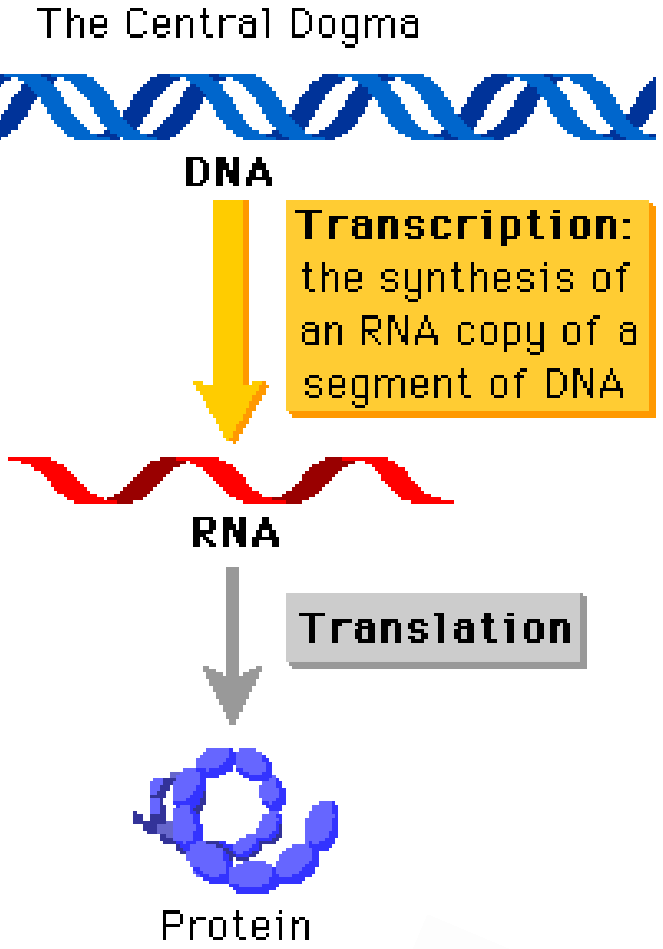
数学思维与逻辑推理能力

事物发展的精准性

中心法则

(genetic central dogma)

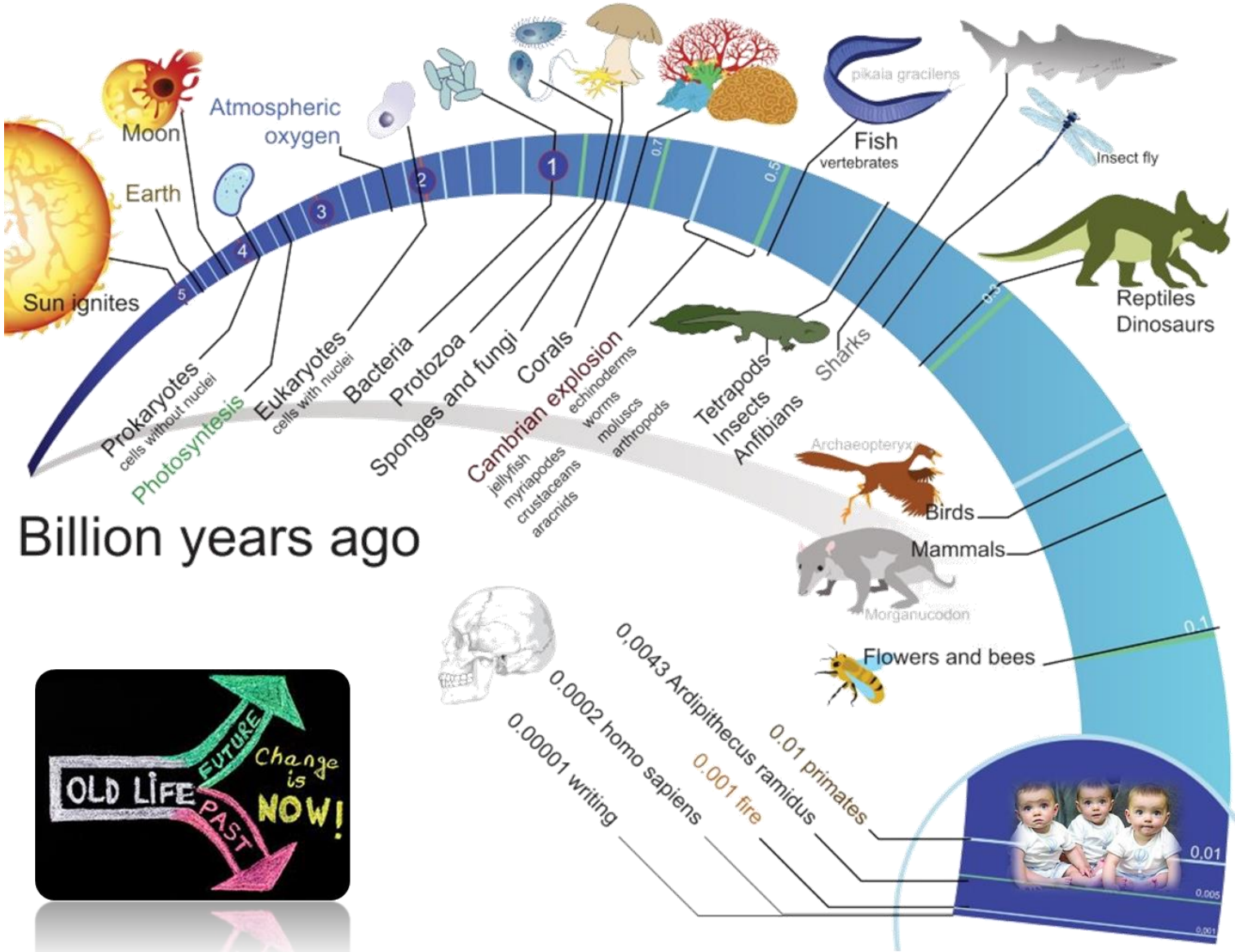




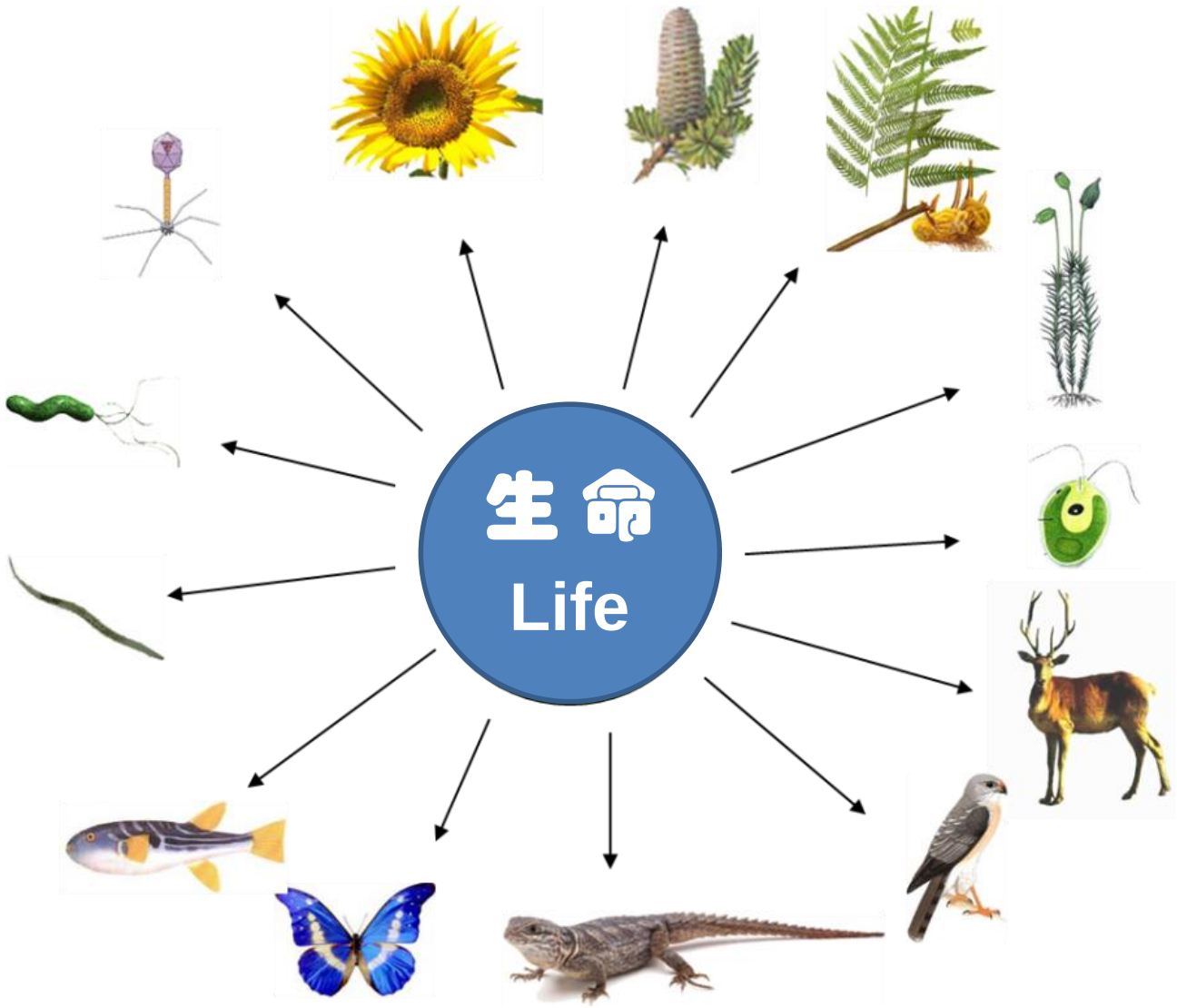
生物学中只有一条普遍适用的法则，就是没有一条法则是普遍适用的

事物发展的精准性

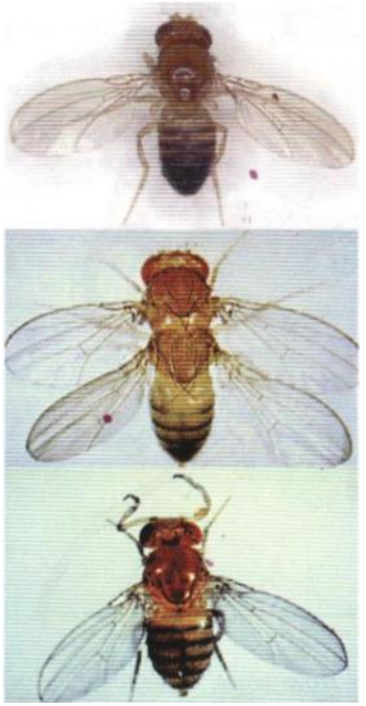
不确定性

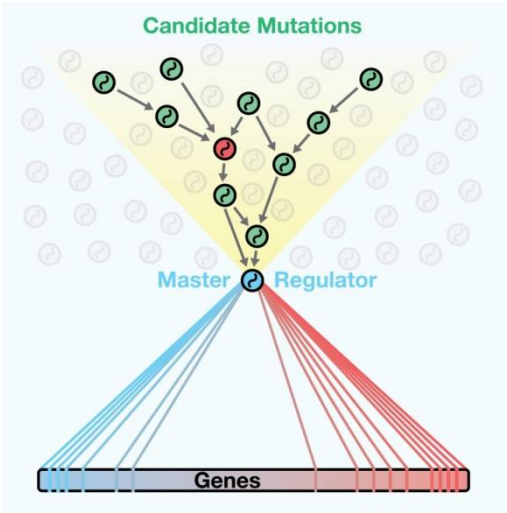

Moon
Atmospheric oxygen
Earth
Sun ignites
Prokaryotes
cells without nuclei
Photosyntesis
Eukaryotes
cells with nuclei
Bacteria
Protozoa
Sponges and fungi
Corals
Cambrian explosion
jellyfish
myriapodes
crustaceans
aracnids
echinoderms
worms
moluscs
arthropods
Tetrapods
Insects
Anfibians
Sharks
pikaia gracilens
Fish
vertebrates
Insect fly
Reptiles
Dinosaurs
Archaeopteryx
Birds
Mammals
Morganucodon
Flowers and bees
0,0043 Ardipithecus ramidus
0.0002 homo sapiens
0.00001 writing
0.01 primates
0.001 fire
0,01
0.005
0.001
Billion years ago

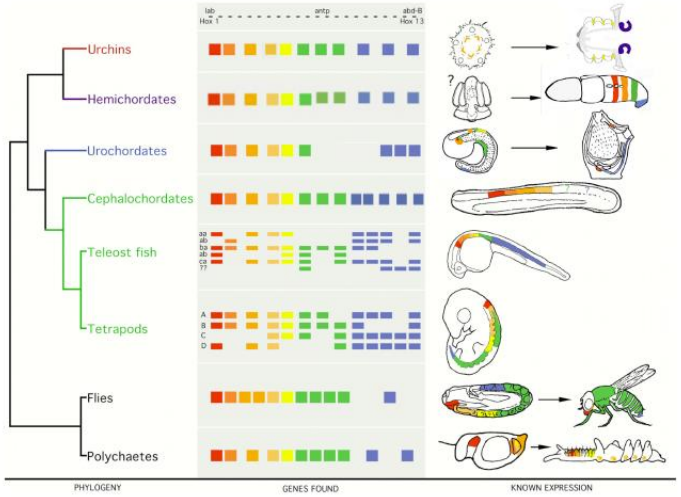
OLD LIFE
FUTURE
PAST
Change is NOW!


生命
Life

进化发育生物学 (Evo – Devo)

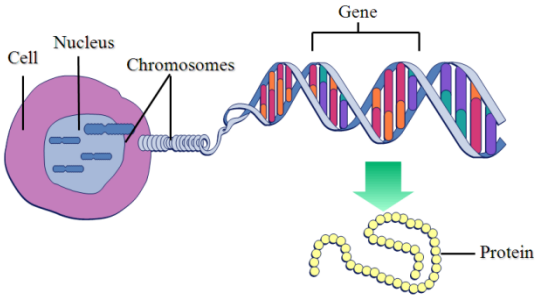


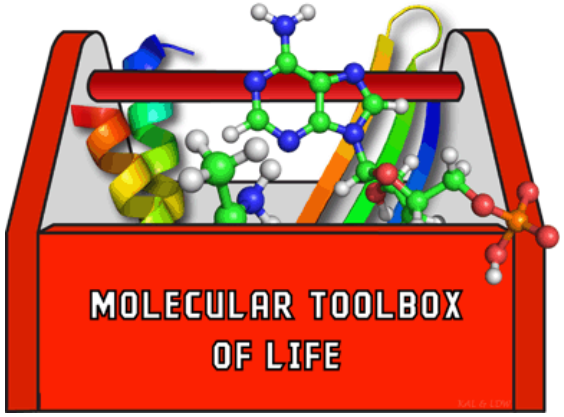


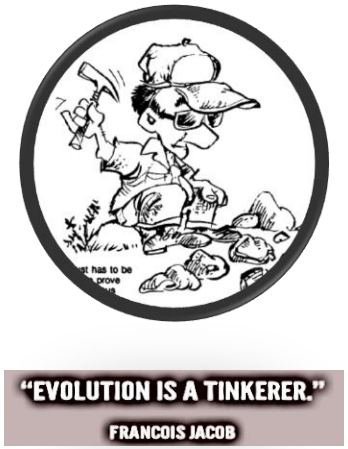


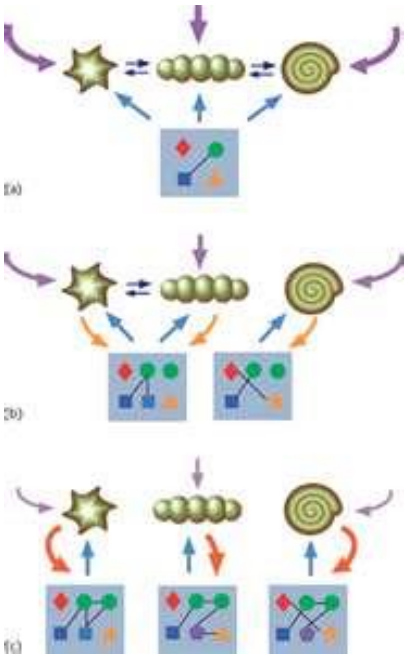
同源异型转换基因（homeotic gene）

—— 控制器官发育、指导细胞特化和模式建成的主调节基因（master regulatory gene）


Gene
Nucleus
Cell
Chromosomes
Protein

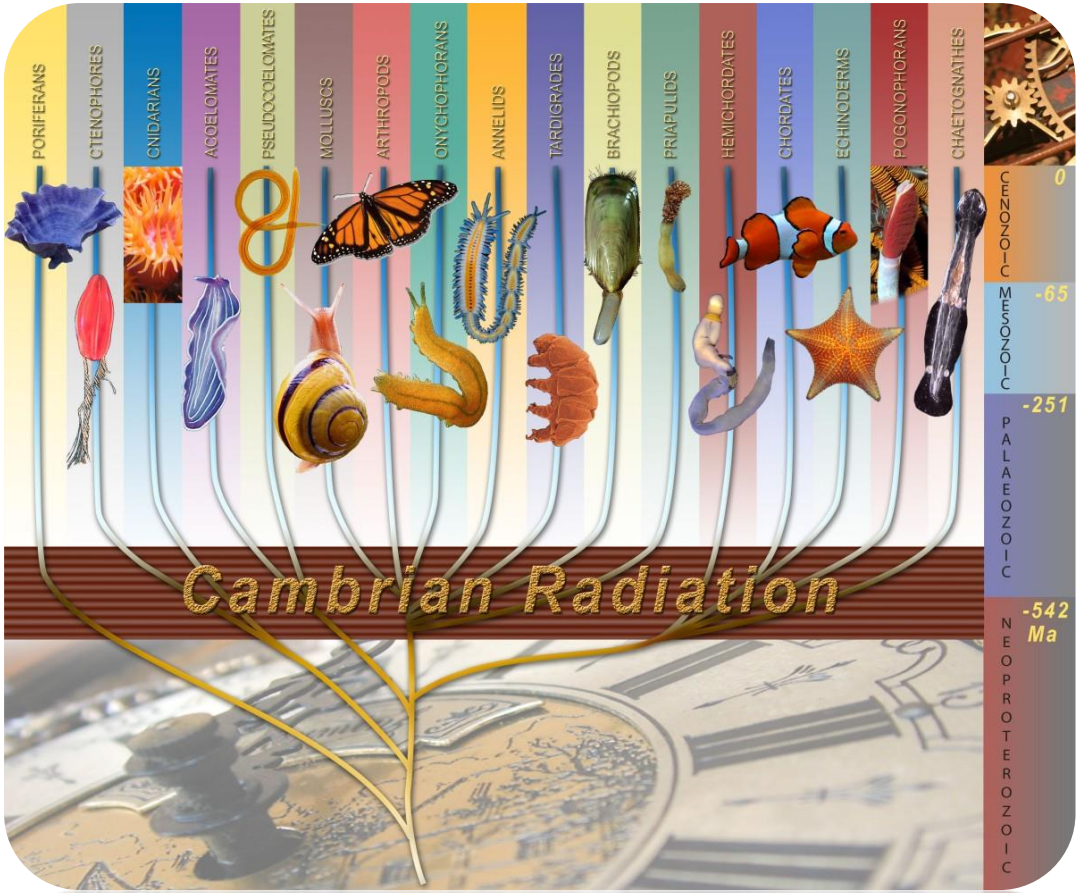

MOLECULAR TOOLBOX
OF LIFE


"EVOLUTION IS A TINKERER."
FRANCOIS JACOB

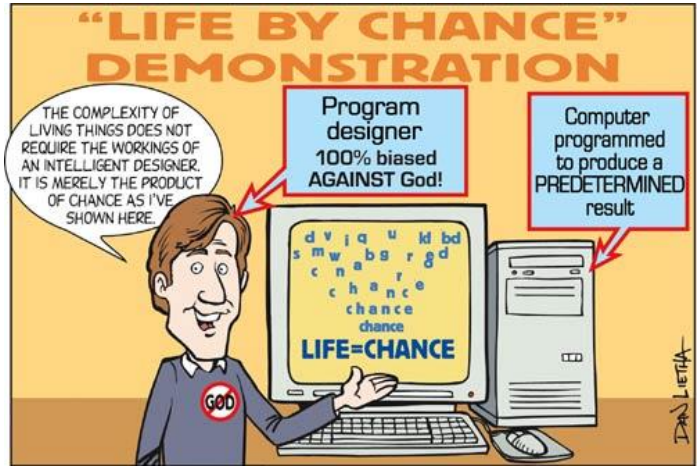


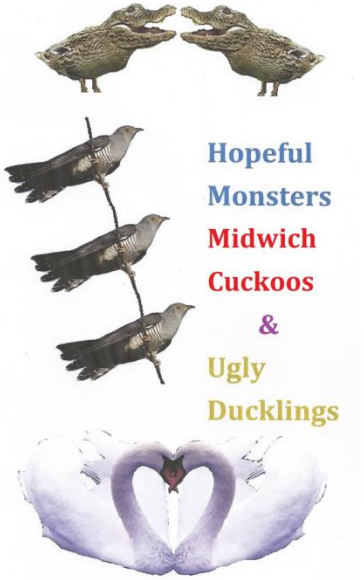

evolution-as-a-grand-tinker

寒武纪生命大爆发

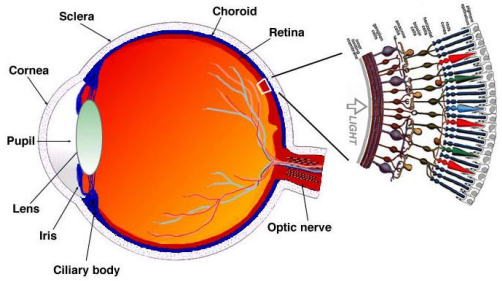

PORIFERANS
CTENOPHORES
CNIDARIANS
ACOELOMATES
PSEUDOCOELOMATES
MOLLUSCS
ARTHROPODS
ONYCHOPHORANS
ANNELIDS
TARDIGRADES
BRACHIOPODS
PRIAPULIDS
HEMICHORDATES
CHORDATES
ECHINODERMS
POGONOPHORANS
CHAETOGNATHES
Cambrian Radiation
CENOZOIC
0
MESOZOIC
-65
PALAEOZOIC
-251
NEOPROTEROZOIC
-542 Ma

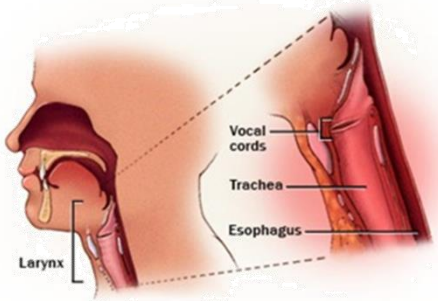
“偶然性”

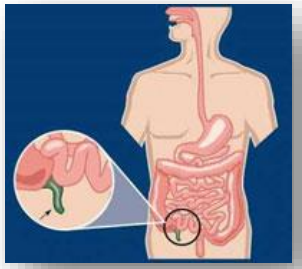


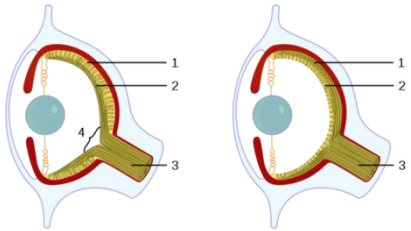


The little things that make big things happen . . .



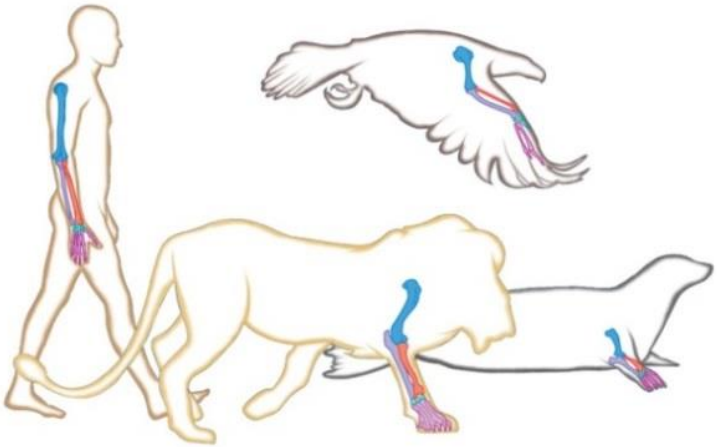


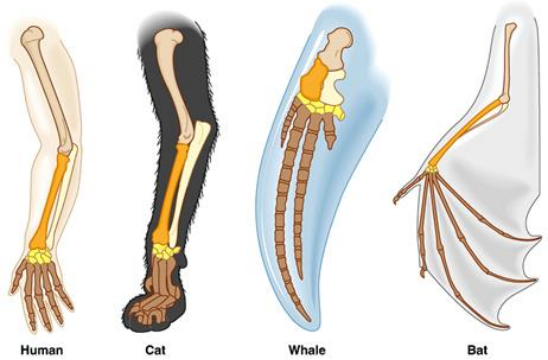


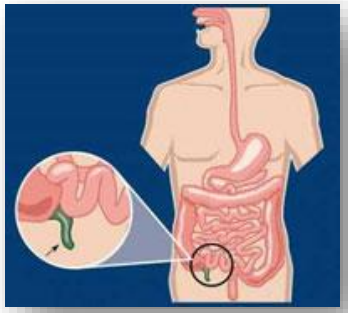


人体器官的“蹩脚设计”

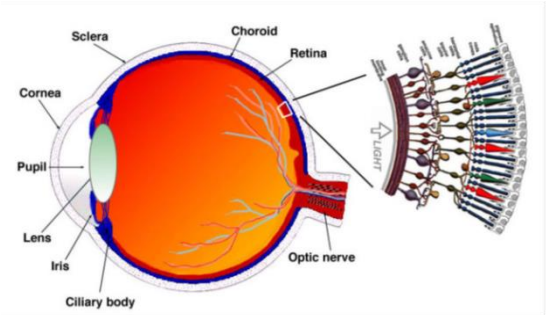
“废物利用”





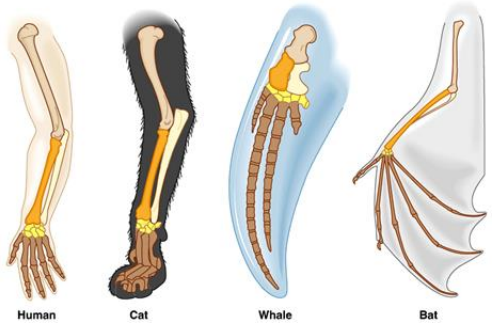



存在即合理！

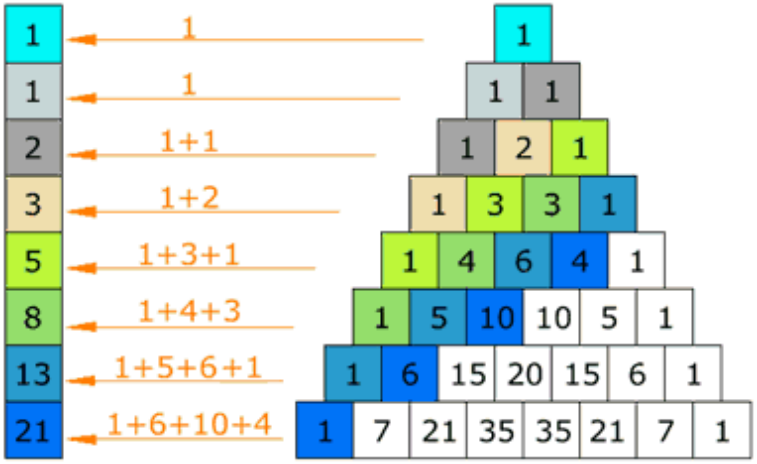

Sclera
Choroid
Retina
Cornea
Pupil
Lens
Iris
Ciliary body
Optic nerve
LIGHT

存在不一定合理

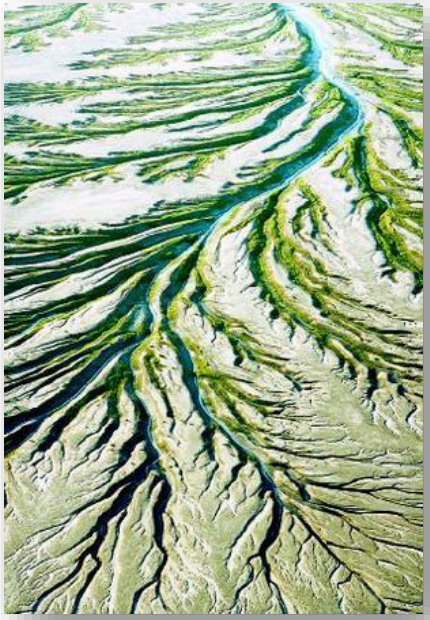

NOTICE
UNREASONABLE
BEYOND THIS
POINT


Human
Cat
Whale
Bat


FIBONACCI

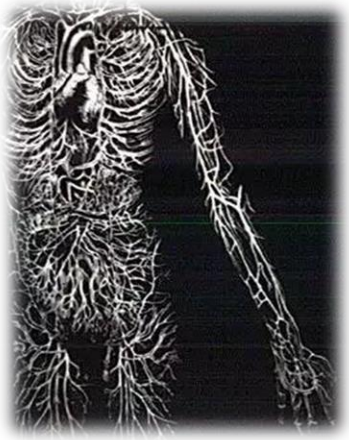

1 1
1 1
2 1+1
3 1+2
5 1+3+1
8 1+4+3
13 1+5+6+1
21 1+6+10+4
1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1

闪电

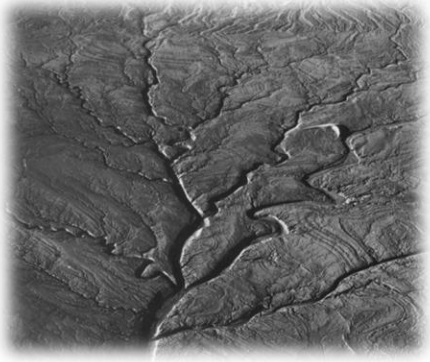


三角洲

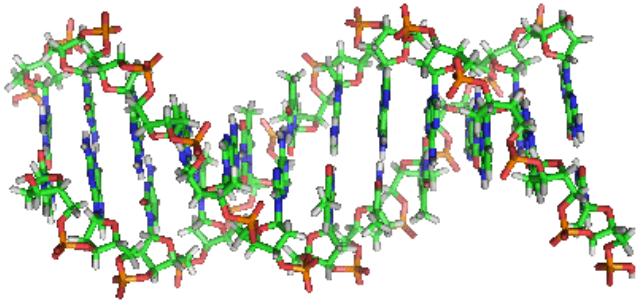
树枝

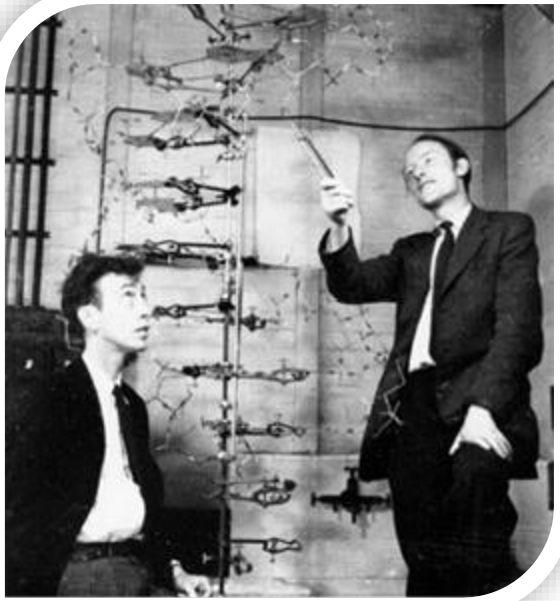


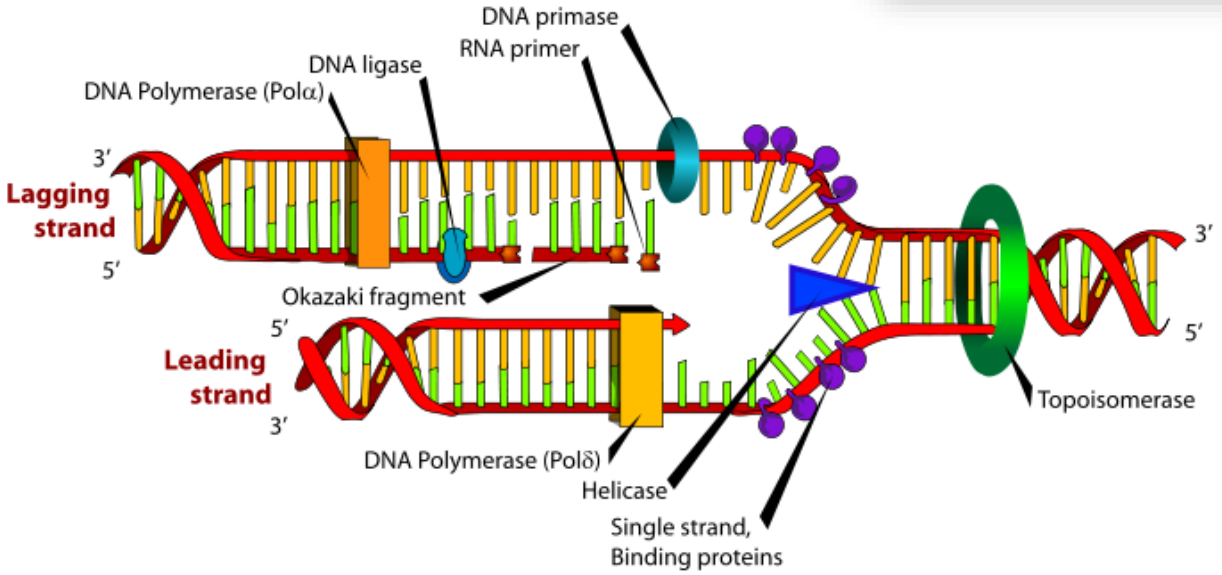
Space-filling,
Hierarchical,
Branching network



为什么大自然不同复杂系统表现相似的变化式样，是因为这些系统都是由流动形成的分形网络填充形成的，从而表现广泛的流量与存量之间的幂律关系。

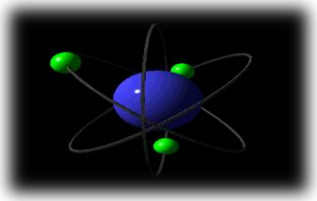


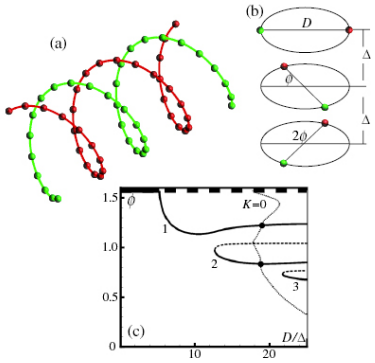


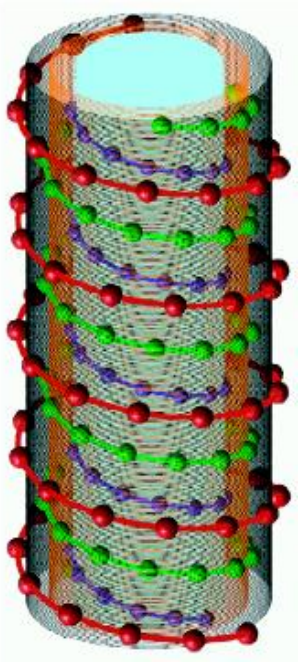

DNA primase
RNA primer
DNA ligase
DNA Polymerase (Polα)
3′
Lagging strand
5′
Okazaki fragment
5′
Leading strand
3′
DNA Polymerase (Polδ)
Helicase
Single strand, Binding proteins
Topoisomerase
3′
5′

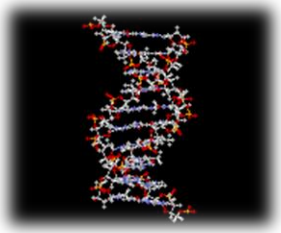
传递遗传密码的双螺旋灰尘

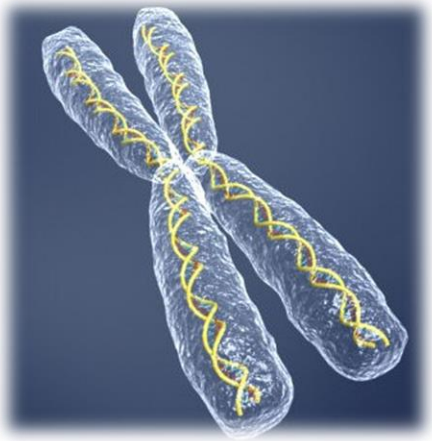
德国马普学会地外物理研究所的高格尔·摩福利及其同事进行的一项模拟实验表明，浸没在等离子中的灰尘能组织成类似脱氧核糖核酸（DNA）的双螺旋形状，并和有机生命体有很多相似之处。 这种系统产生的灰尘阵列叫作等离子体晶格。



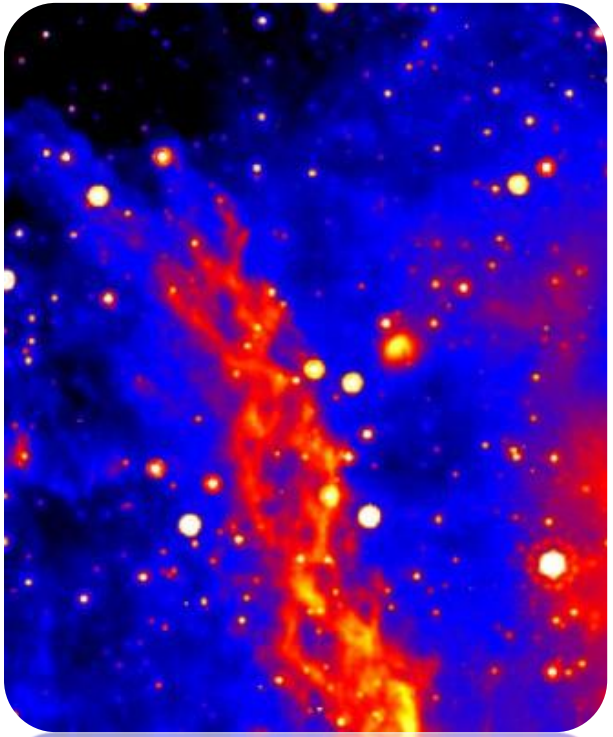




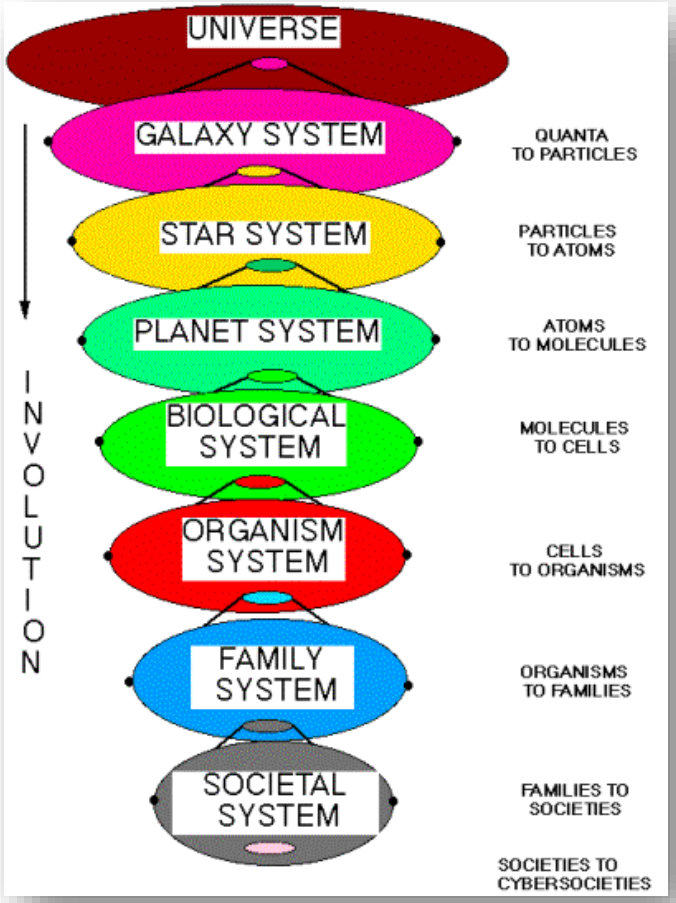




双螺旋结构并不是生命载体DNA所特有的，是在静电力控制的系统中自发形成的一种一般性的稳定结构。

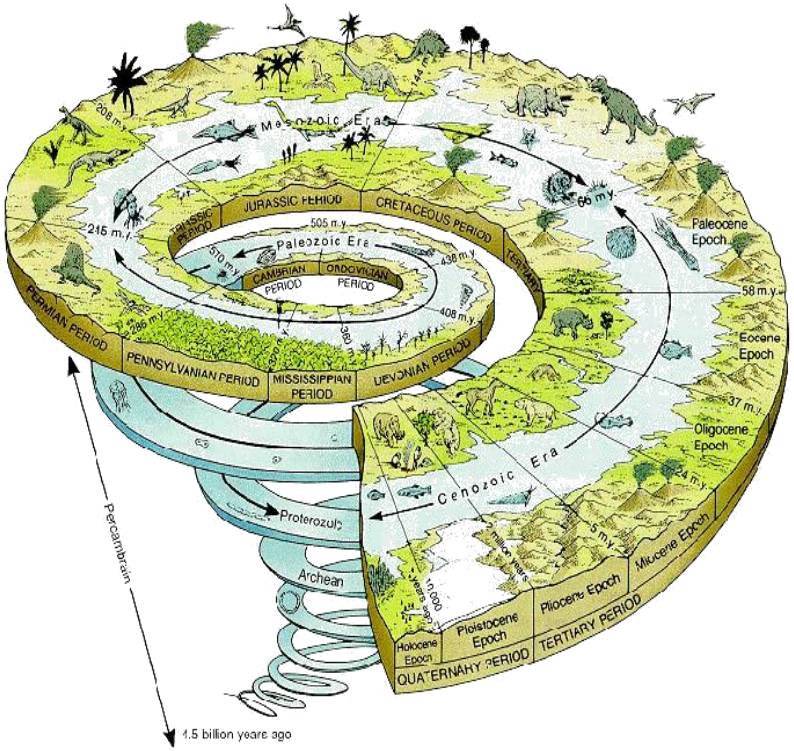


双螺旋星云

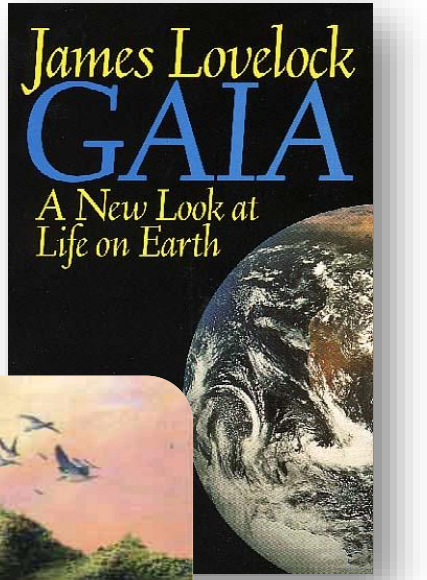


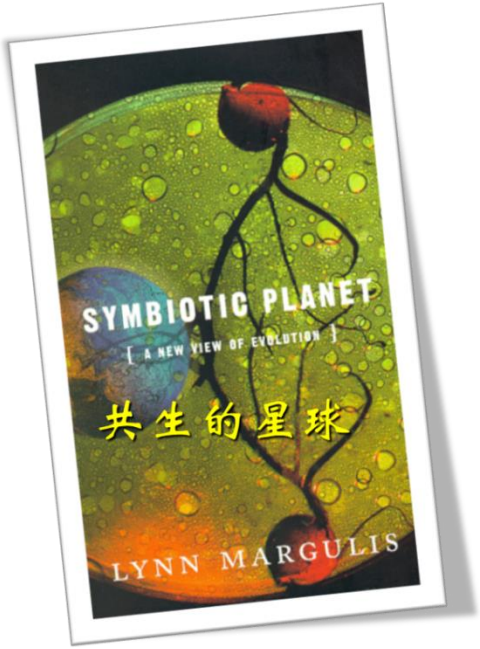
"EVOLUTION, OF COURSE, IS NOT SOMETHING THAT SIMPLY APPLIES TO LIFE HERE ON EARTH; IT APPLIES TO THE WHOLE UNIVERSE."

JOHN POLKINGHORNE




进化
种群
多样性
生产力
提升
组织
均衡性
进化
互利共生
万物生长
万物互联


James Lovelock
GAIA
A New Look at
Life on Earth


SYMBIOTIC PLANET
A NEW VIEW OF EVOLUTION
共生的星球
LYNN MARGULIS


“盖娅”假说

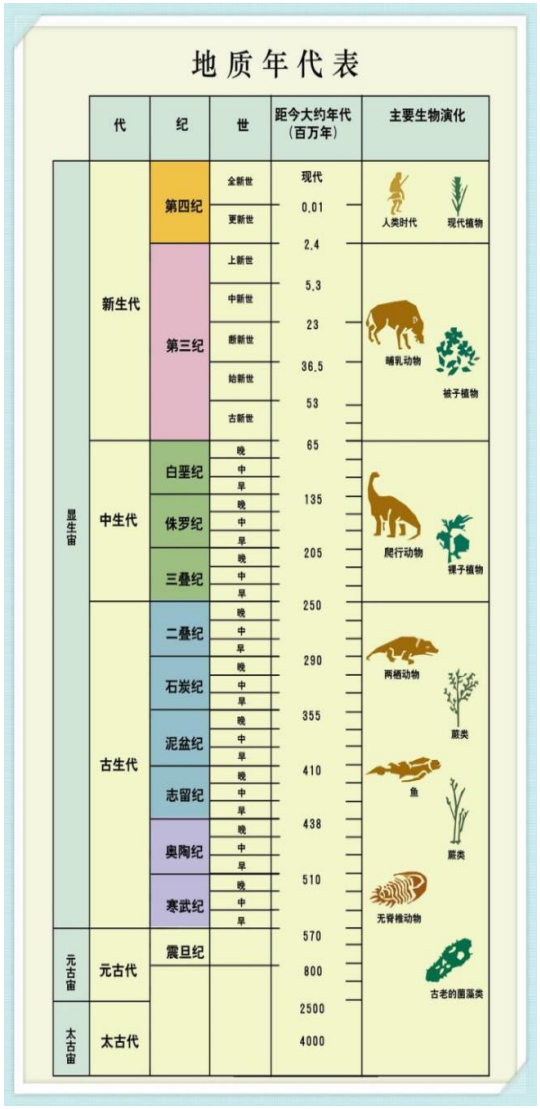
人类中心主义价值观

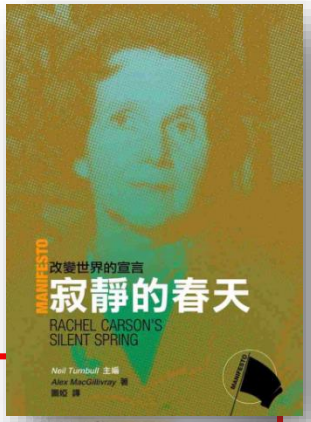
Anthropocentric

Humans are at the centre

Humankind: Masters over Nature ?

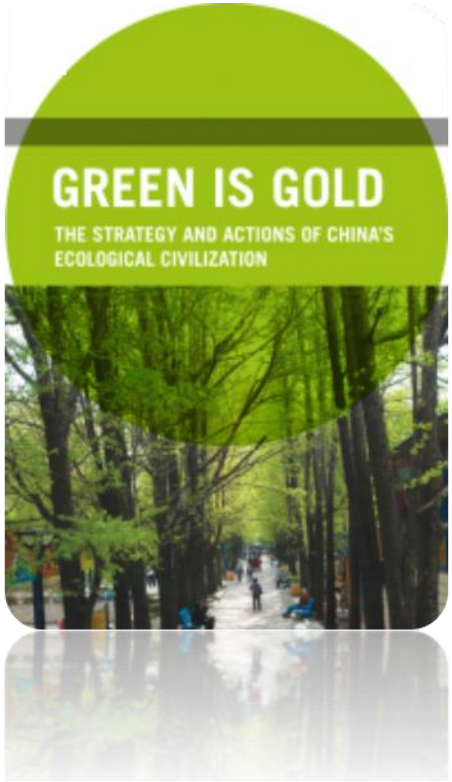
人类纪 Anthropogene






Environmental Ethics
Recognize plant and animal rights.
Realize the intrinsic worth of nature.
Buzzle.com

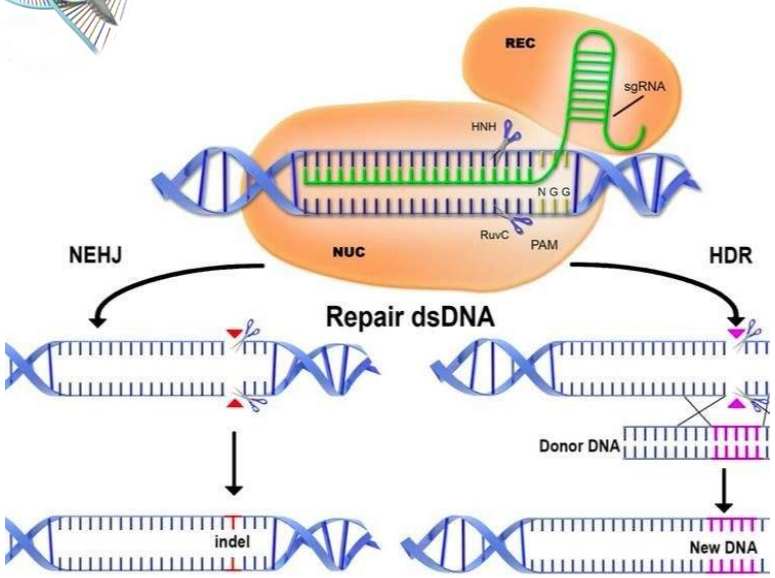

3E
Economical Responsibility
Ethical Responsibility
Ecological Responsibility



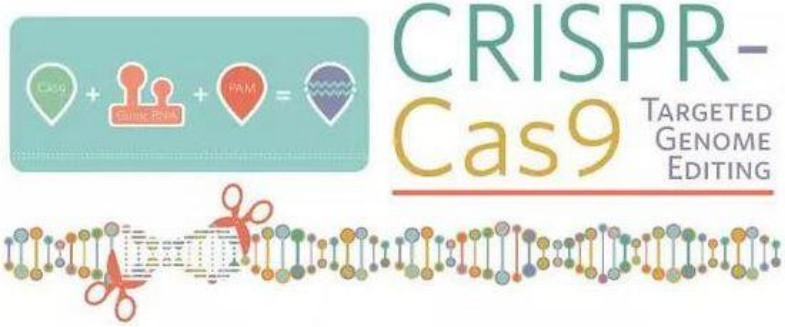
TOWARD ECOLOGICAL CIVILIZATION

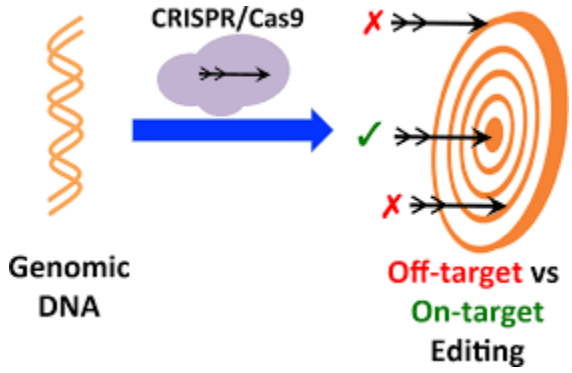
生态文明

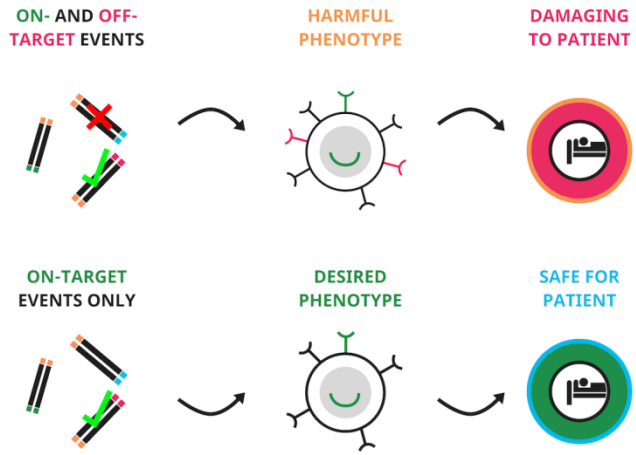
基因编辑技术


REC
sgRNA
HNH
NGG
RuvC
PAM
NUC
NEHJ
HDR
Repair dsDNA
Donor DNA
indel
New DNA

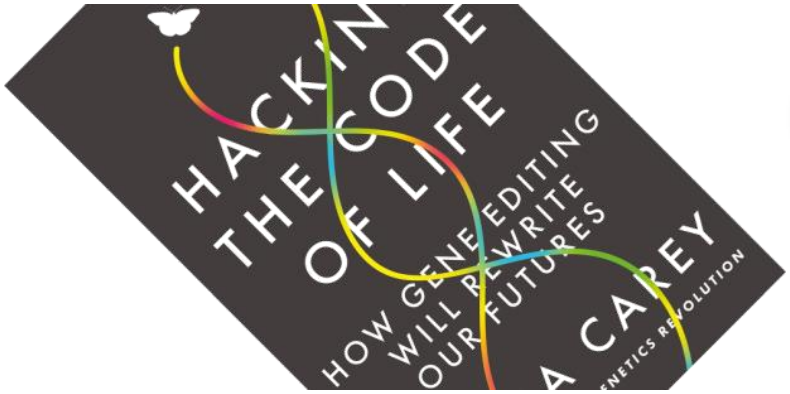

定位
切除
修补

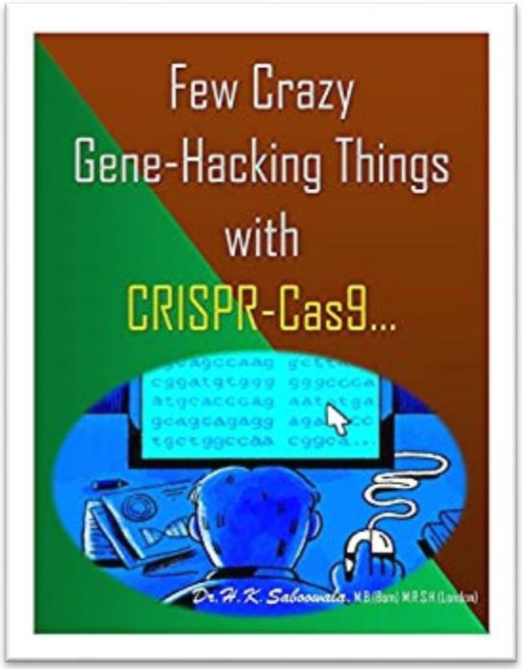

CRISPR-
Cas9
TARGETED
GENOME
EDITING


CRISPR/Cas9
Genomic
DNA
Off-target vs
On-target
Editing

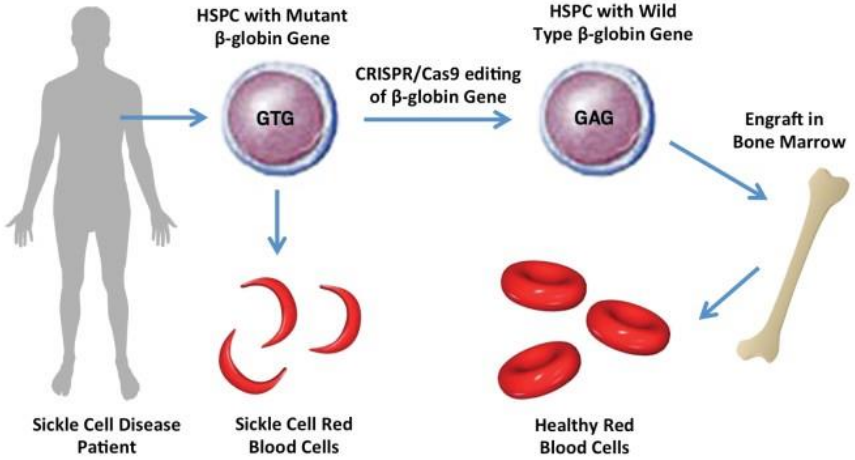

ON- AND OFF-
TARGET EVENTS
HARMFUL
PHENOTYPE
DAMAGING
TO PATIENT
ON-TARGET
EVENTS ONLY
DESIRED
PHENOTYPE
SAFE FOR
PATIENT

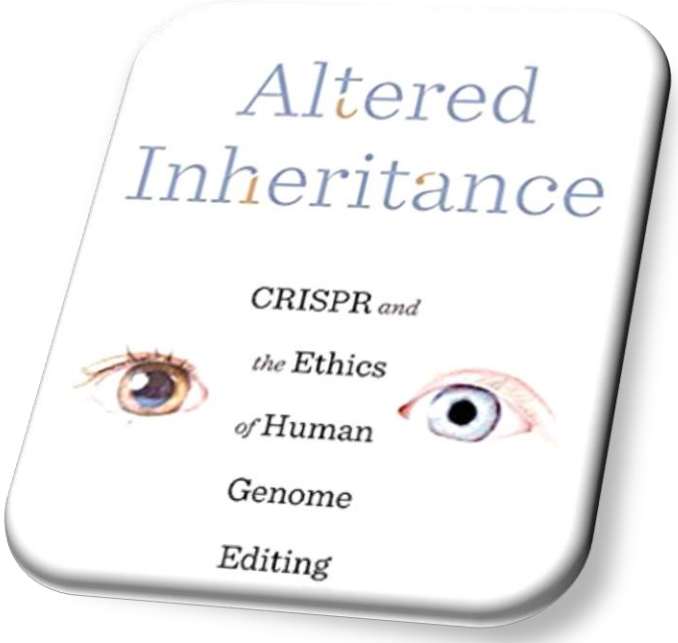
Are Humans Going to Be Hacked?

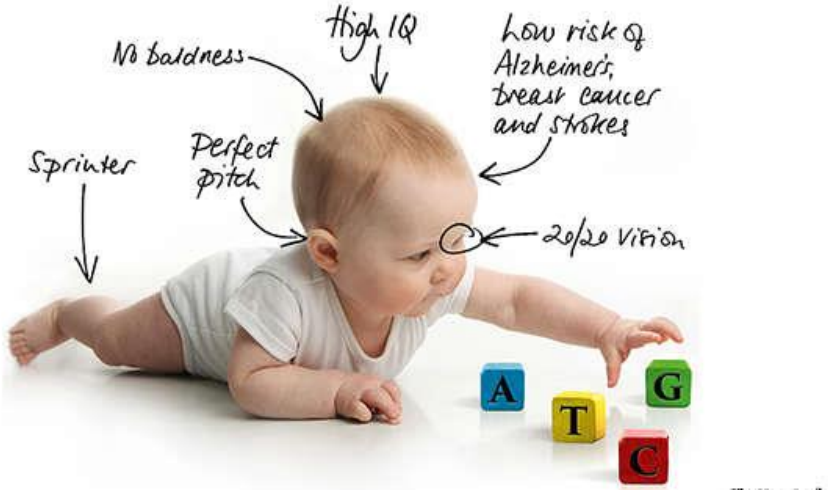




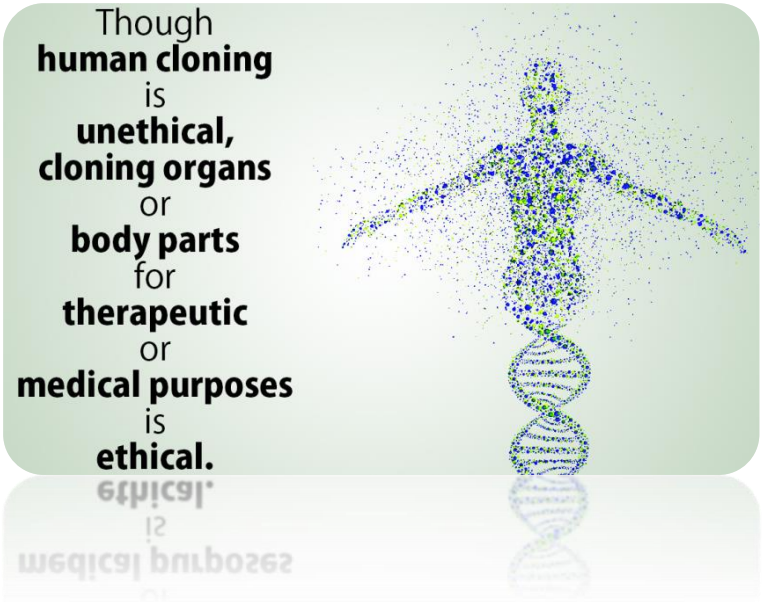
基因编辑技术 ： 一把双刃剑

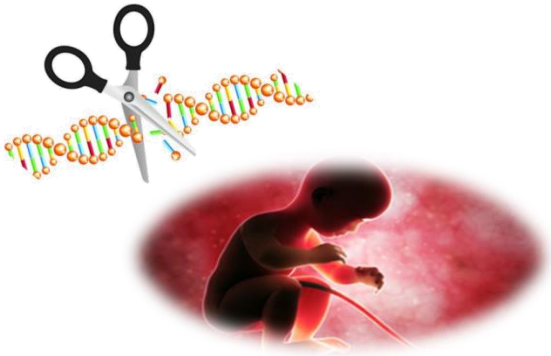


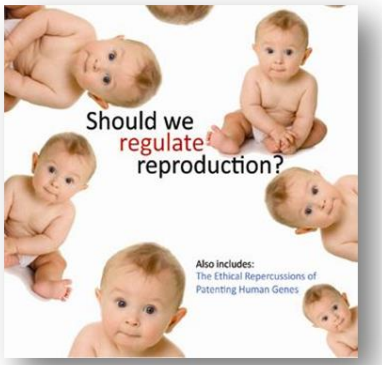




自然人被技术化的限度在哪里？

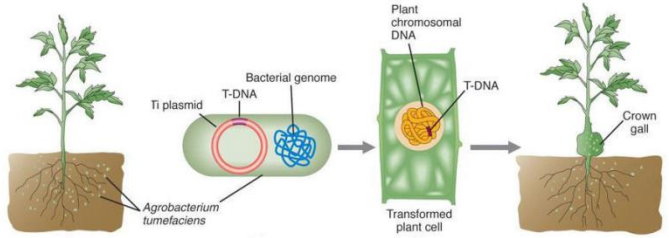


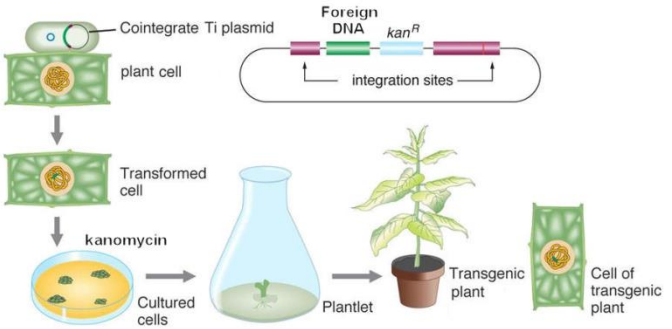


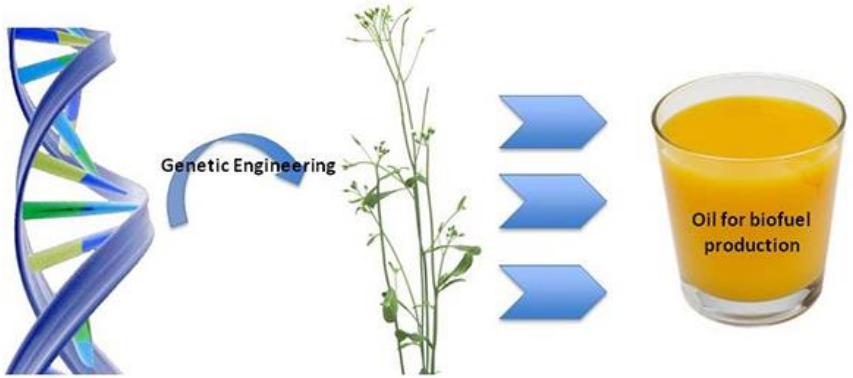


Transgenic Plants

"Transgenic Animals" Research Ethics



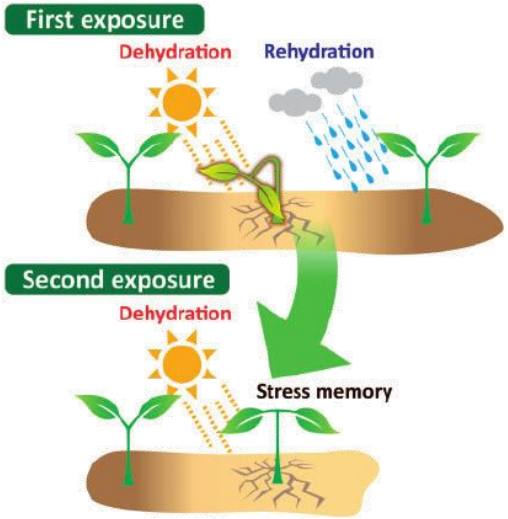




Single copy of transgene

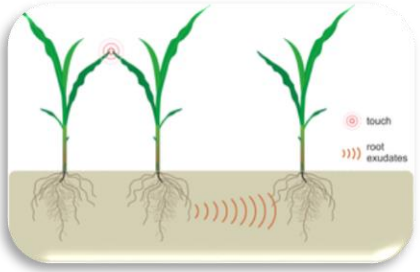
Transgenic *Arabidopsis* plant

A Mind Without A Brain: The Science Of Plant Intelligence

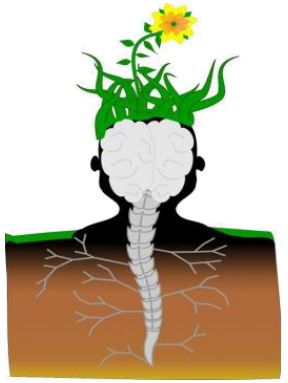


- Can plants think ?
- Can plants talk ?
- Can plants learn ?
- Can plants remember ?

……



植物也用“神经”传递疼痛

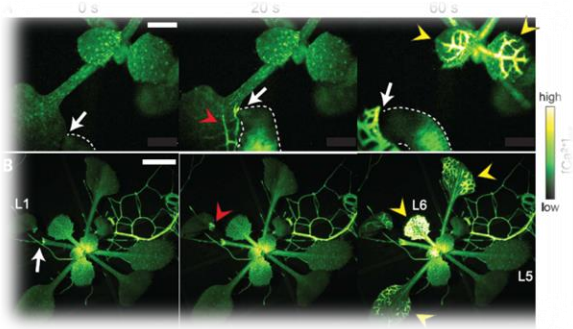


Science **361**, 1112–1115 (2018)

Glutamate triggers long-distance, calcium-based plant defense signaling

Masatsugu Toyota[1,2,3]*, Dirk Spencer[2]†, Satoe Sawai-Toyota[2]‡, Wang Jiaqi[1], Tong Zhang[4,5]§, Abraham J. Koo[4,5], Gregg A. Howe[6,7], Simon Gilroy[2]*

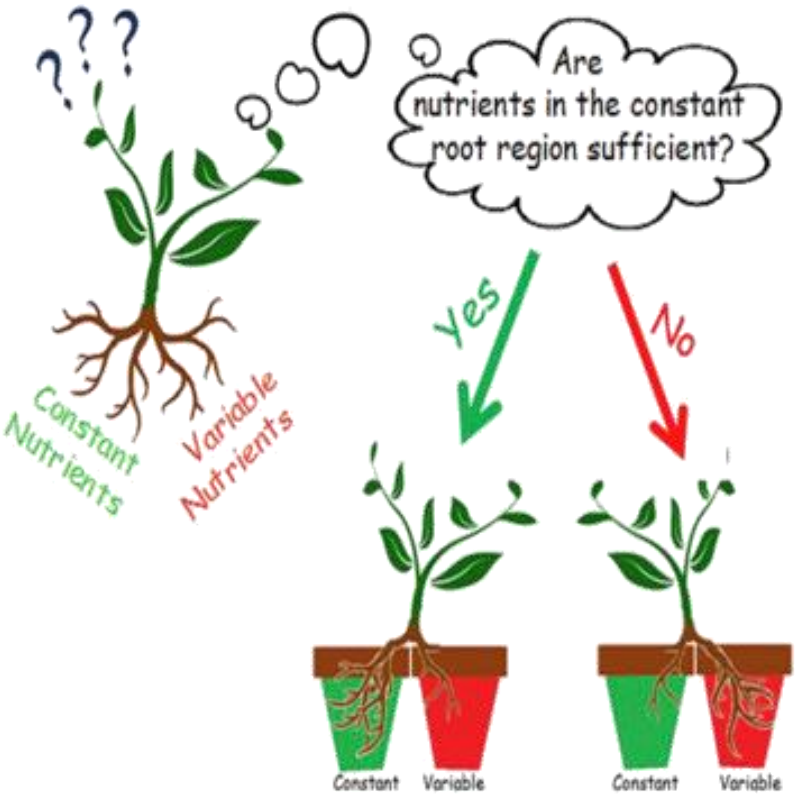
Animals require rapid, long-range molecular signaling networks to integrate sensing and response throughout their bodies. The amino acid glutamate acts as an excitatory neurotransmitter in the vertebrate central nervous system, facilitating long-range information exchange via activation of glutamate receptor channels. Similarly, plants sense local signals, such as herbivore attack, and transmit this information throughout the plant body to rapidly activate defense responses in undamaged parts. Here we show that glutamate is a wound signal in plants. Ion channels of the *GLUTAMATE RECEPTOR–LIKE* family act as sensors that convert this signal into an increase in intracellular calcium ion concentration that propagates to distant organs, where defense responses are then induced.

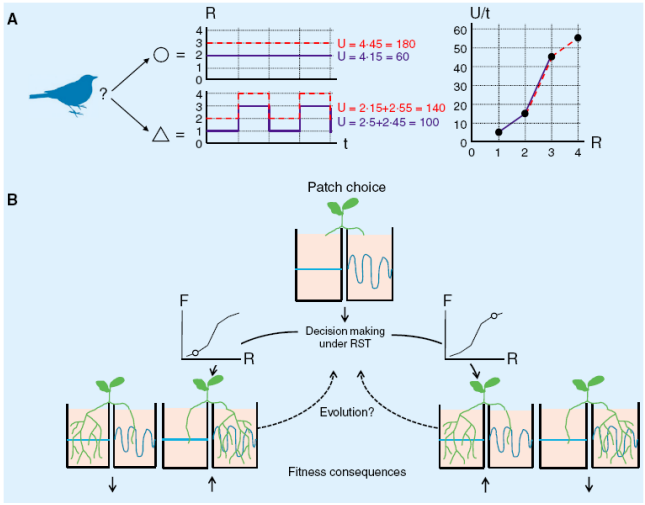


The scent of newly cut grass has been identified as the plant’s way of signaling distress

Grass Sends SOS Signals

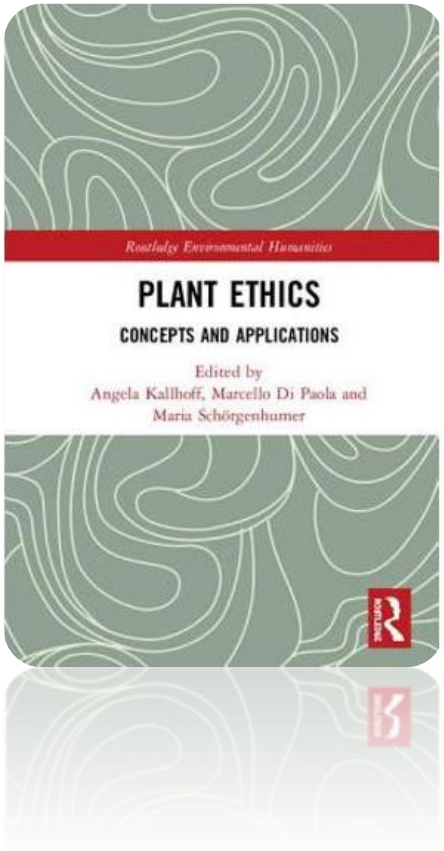
植物与动物一样具有风险预判和决策能力





Current Biology 26:1763–1767

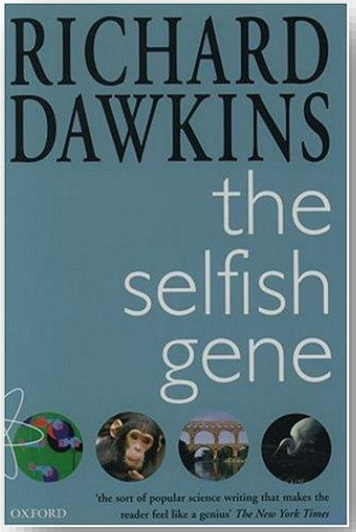
Green plants as intelligent organisms

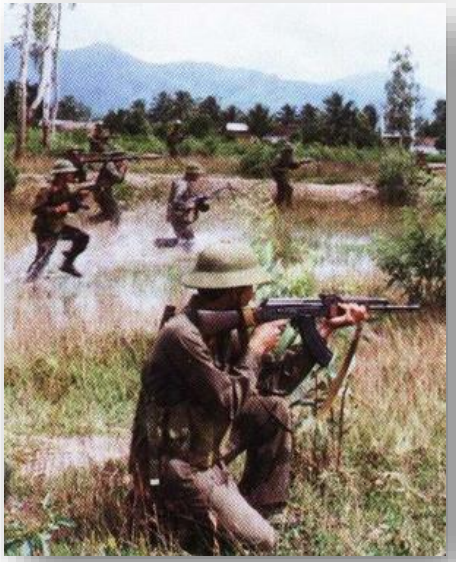


NEW DIRECTIONS IN PLANT ETHICS

New Directions in Plant Ethics explores plant ethics as an emerging field in bioethics. It contributes to developing systematic approaches to the life of plants, highlighting the specific traits of plants as a distinct life-form. Instead of approaching plants as moral patients, it emphasizes and analyzes the relations between plants and persons. In this regard the project focuses on the normative dimensions of cultural practices addressing plant life and practices of exchange among persons and plants.

THE STRUGGLE FOR SURVIVAL

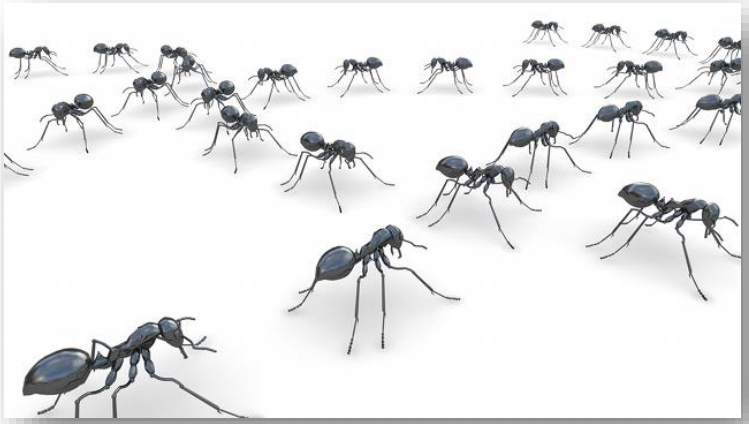




生存

竞争

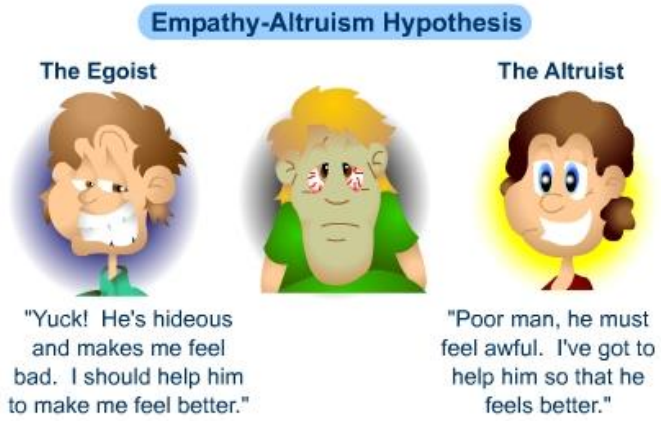
利他行为



人性（humanity）= 人的本性（nature）+ 德性（virtue）

Humanity

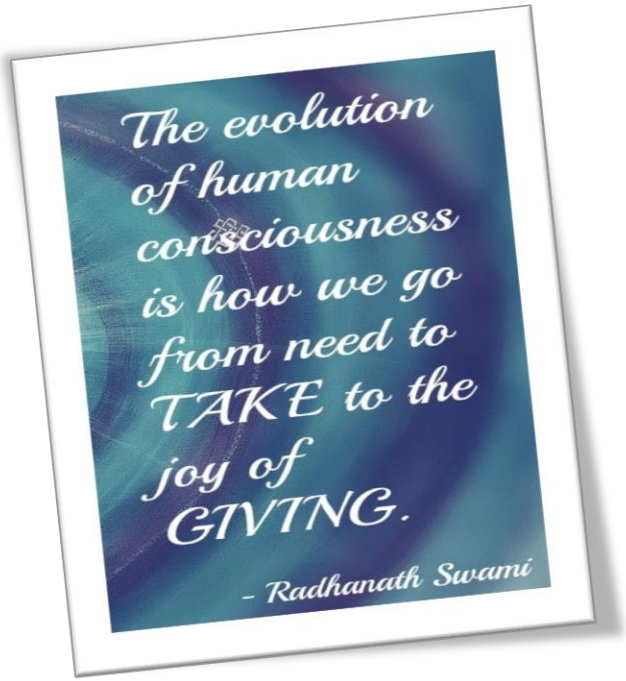
家庭、朋友、社会...



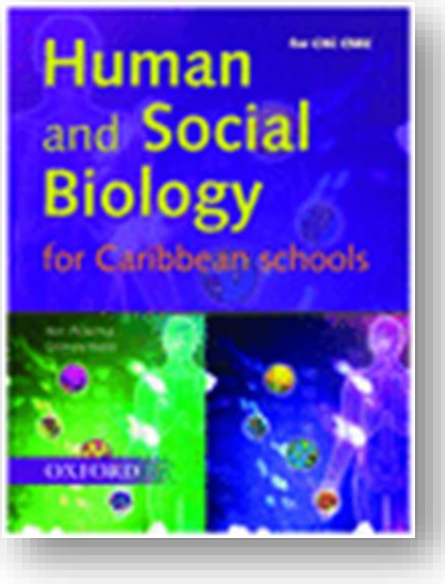
成熟的人类爱分享

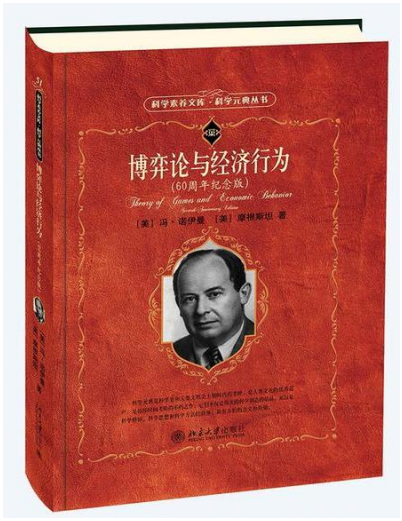
生存竞争

——“大家好才是真的好”



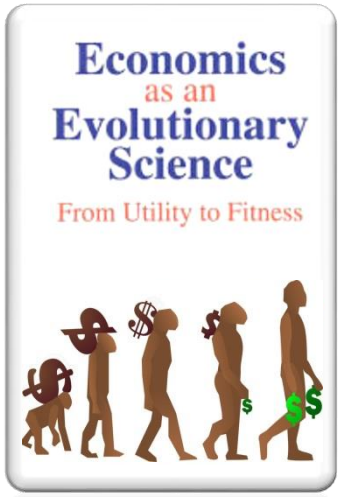
投桃報李




博弈论与经济行为
（60周年纪念版）
Theory of Games and Economic Behavior


$


TIME FOR A REBALANCING!
Bellissimo!
NEIN!
GENTILONI
ABE
MERKEL
HMPF!!
SACRÉ BLEU!
MACRON
MAY
TRUDEAU
AMERICA FIRST


Economics
as an
Evolutionary
Science
From Utility to Fitness

Economics and Society

—— Real Prisoner's Dilemma

囚徒困境

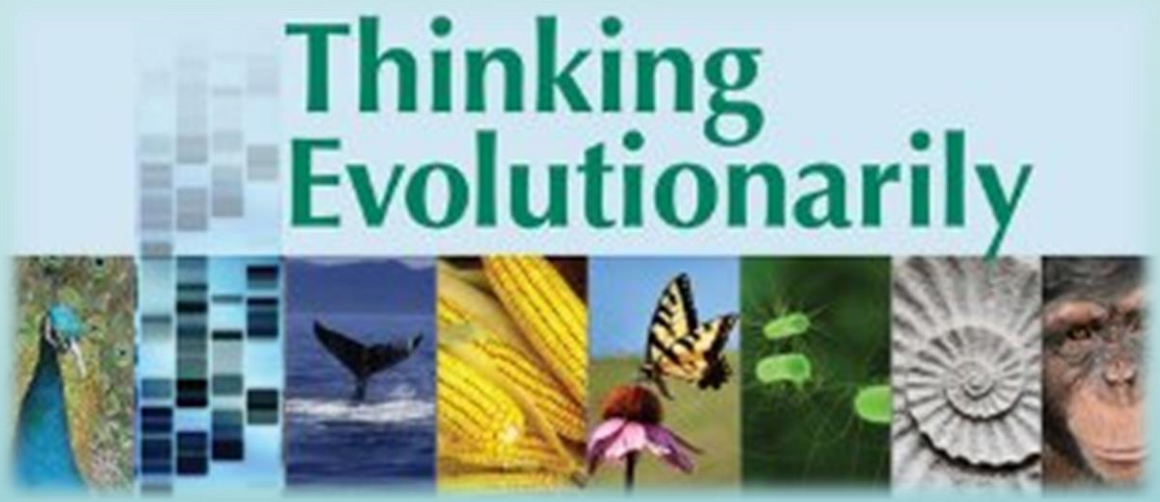
vs

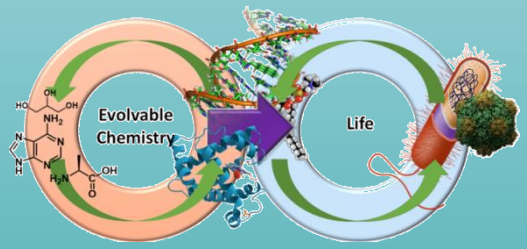
看不见的手

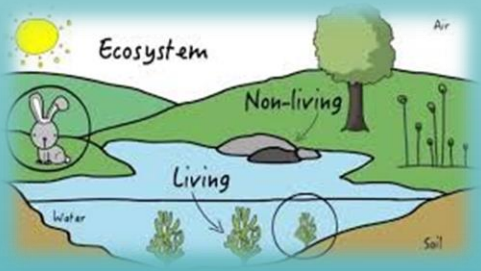
利益最大化

		A	
		Ads	No Ads
B	Ads	A: Same Business, Spend $	A: Less Business
		B: Same Business, Spend $	B: More Business
	No Ads	A: More Business	A: Same Business
		B: Less Business	B: Same Business

进化思维


Thinking
Evolutionarily


Evolvable
Chemistry
Life


Ecosystem
Air
Non-living
Living
Water
Soil

通识课堂
General Education

学科核心素养 → 教学目标 → 凝练教学内容 → 课程标准（教什么？）

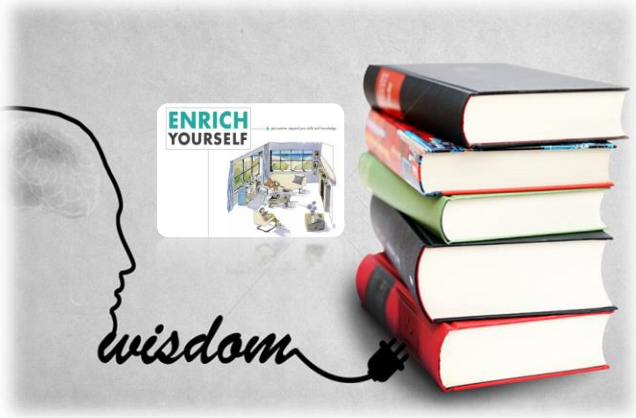
凝练教学内容 → 评价标准（怎么教？）

教材 → 教学大纲 → 教案 → 教学活动

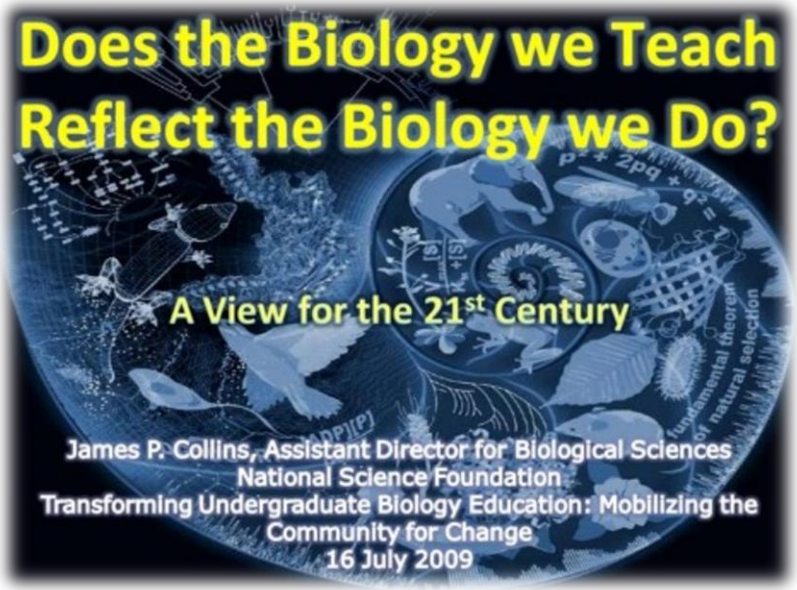
（知识本位 vs 能力本位）

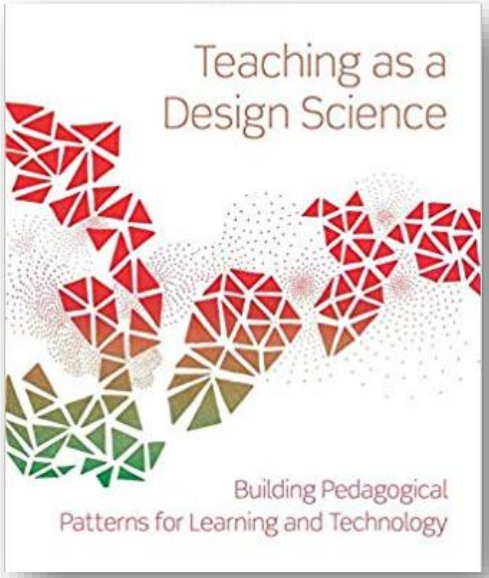

Teacher Knowledge
Update Resources

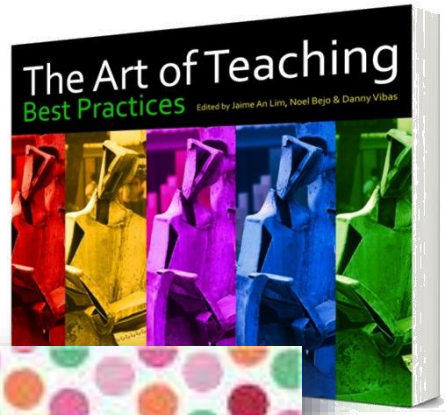

enrich
Education

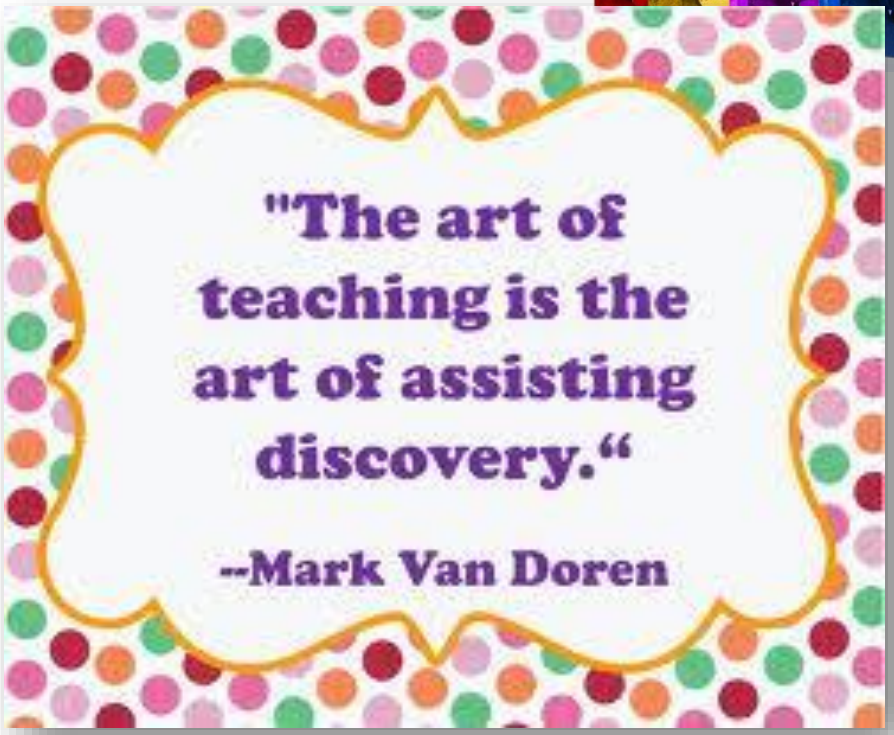

ENRICH
YOURSELF
wisdom


Why is
Continuing
Professional
Development
important for
teachers?


Does the Biology we Teach
Reflect the Biology we Do?
A View for the 21st Century
James P. Collins, Assistant Director for Biological Sciences
National Science Foundation
Transforming Undergraduate Biology Education: Mobilizing the
Community for Change
16 July 2009







Best researchers not always bets teachers !

天天忙着做powerpoint的人大多没有power!

老师们其实不图什么回报，
只求……

Science for
a better tomorrow