Biologi Sebagai Inspirator Pemecahan Masalahan Kemasyarakatan

Sebuah perspektif integratif dan holistik

Sutiman B. Sumitro
Guru Besar Biologi Sel, Molekuler dan Nano Biologi
Universitas Brawijaya
sutiman@ub.ac.id

Higher Education Tasks

Bologna mission:
Bequeath skill and scientific knowledge to the younger generation (empowering)

A continuum process for Scientific Literacy
Developing students multidimensional competency (teach the students how scientist see the world)

Strong task in research
(student apprentice in the research activities)

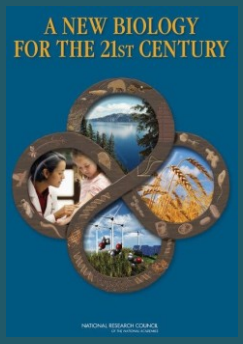
Riset akhir-akhir ini membawa Biologi pada titik *inflection* kepada pandangan baru

- **Integrasi subdisiplin dalam Biologi**
- **Cross-discipline integration: riset bidang ilmu hayati dengan perspektif fisika, komputasi, ilmu bumi dan bidang rekayasa**
- **Kemajuan teknologi yang membawa ahli bioologi pada teknik koleksi data dengan kualitas dan kuantitas yang jauh meningkat** *unprecedented in quantity and quality*
- **Investasi masa lalu yang membawa pada perubahan-perubahan yang tidak terduga**

New Biology with impact at an unprecedented scale

Committee on a New Biology for the 21st Century

United State Government's New Biology Initiative



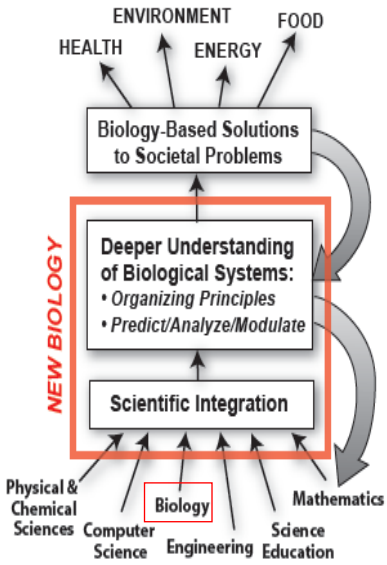
Goals:

- *Propel science to a new level*
- *Provide solutions to pressing societal problems*

Improve productivity across the life sciences

What is the New Biology?

The use of Biological Law to generate concept or understanding of any thing

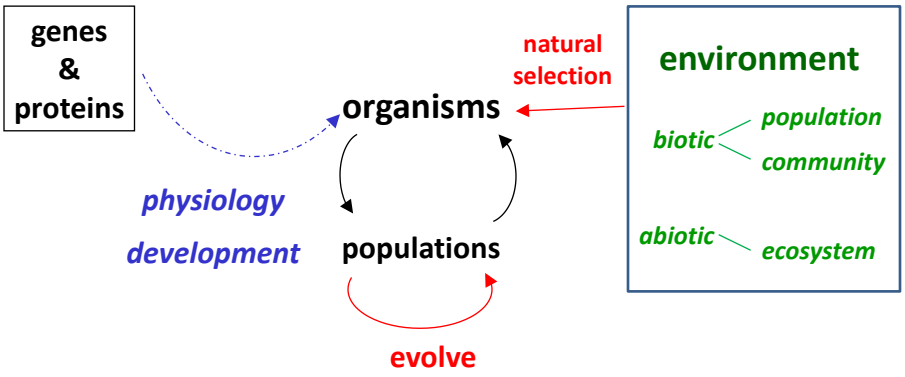


Perubahan Paradigma dalam Sains (Biology for 21st Century)

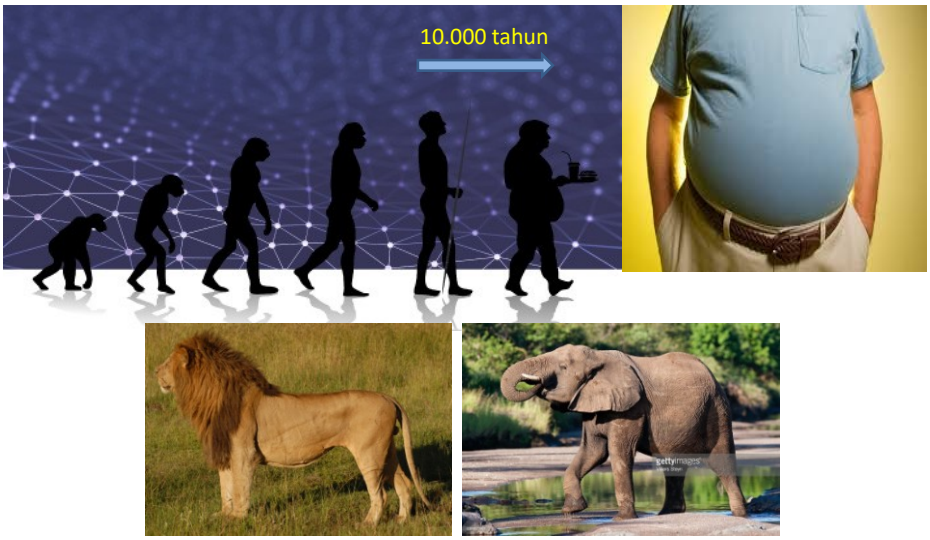
Paradigma Lama	Paradigma Baru
Sain Terpisah , reduksionistik , parsialisme, analitik	**Sain saling terhubung (interkoneksi)**
Sain empirik. Cenderung susah berubah apabila nalar telah bersesuaian dengan bukti empirik	**Sain progresif,** ada temuan-temuan baru dan perlu *update*
Spesialisasi, terbagi dalam disiplin-disiplin, semakin **sempit dan fokus**	**Semakin holistik**

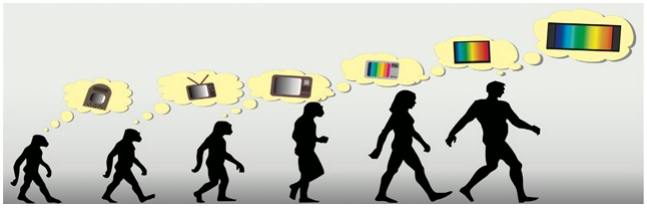
Evolution is a unifying theme in biology

(connects all levels of biological organization)



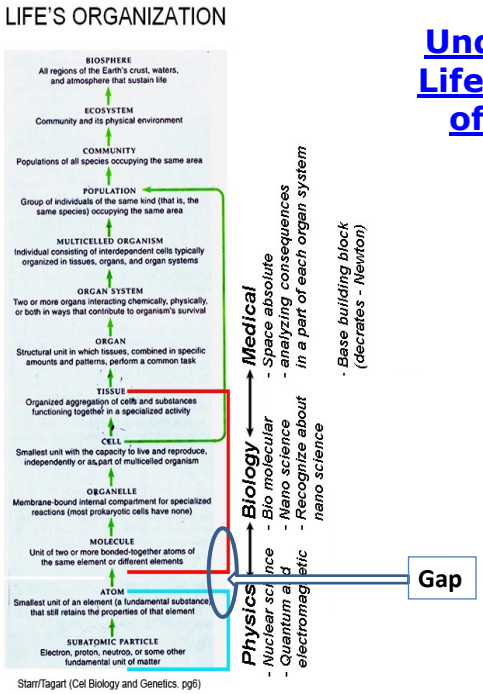
Hukum Biologi:
Hubungan struktur dengan fungsi





Inspiring to be wise

Evolution is no longer seen as a competitive struggle for existence, but rather as a cooperative dance in which creativity and the constant emergence of novelty are the driving forces. And with the new emphasis on complexity, nonlinearity, and patterns of organization, a new science of qualities is slowly emerging



Understanding Life at the level of one atom

All creatures can be describe as atomic, an angle to view living system

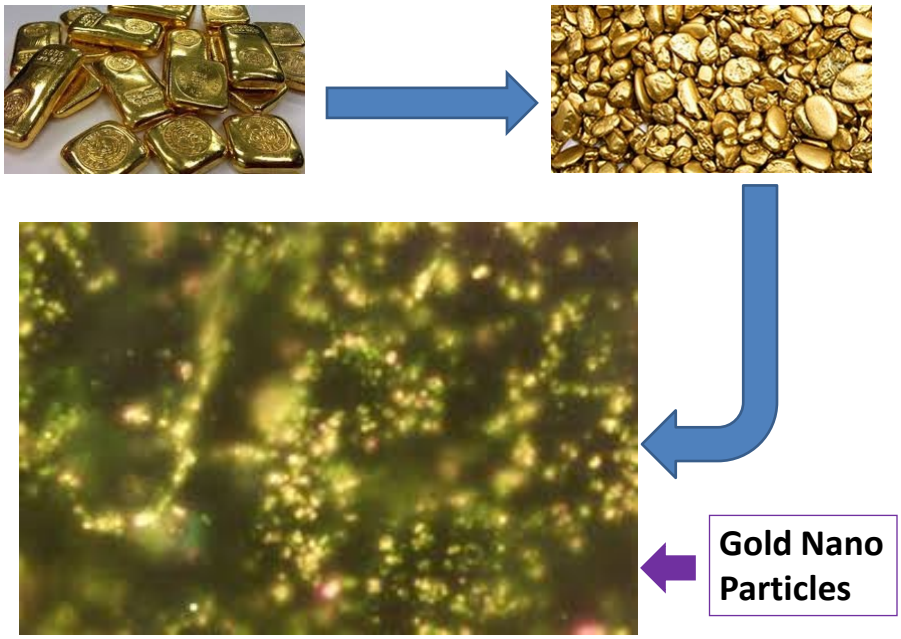
Where is the ideas of performing life is located?

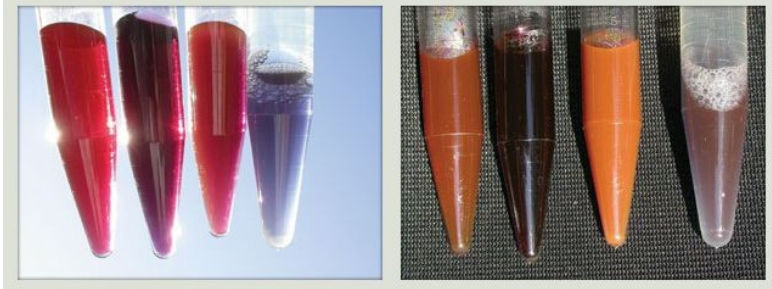
Nano Science

- Kajian materi berskala di bawah 100 nm
- Bermula dari kajian Ilmu Material

Graphite **Intan**

keduanya berbahan karbon


Gold Nano Particles

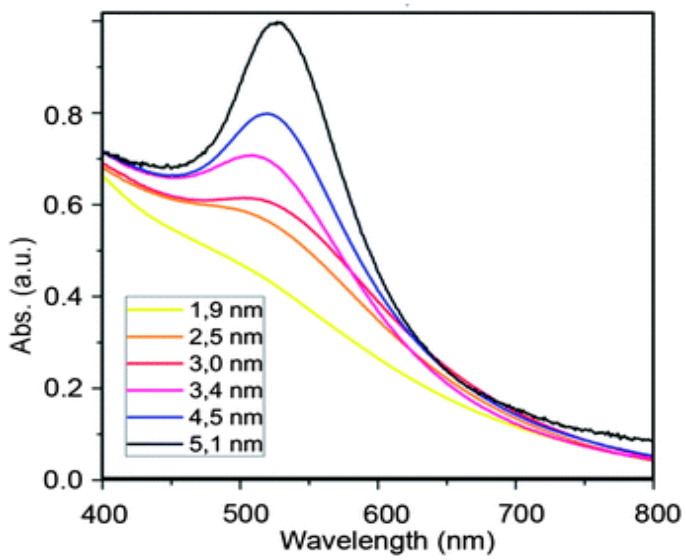

Transmitted light
Reflected light

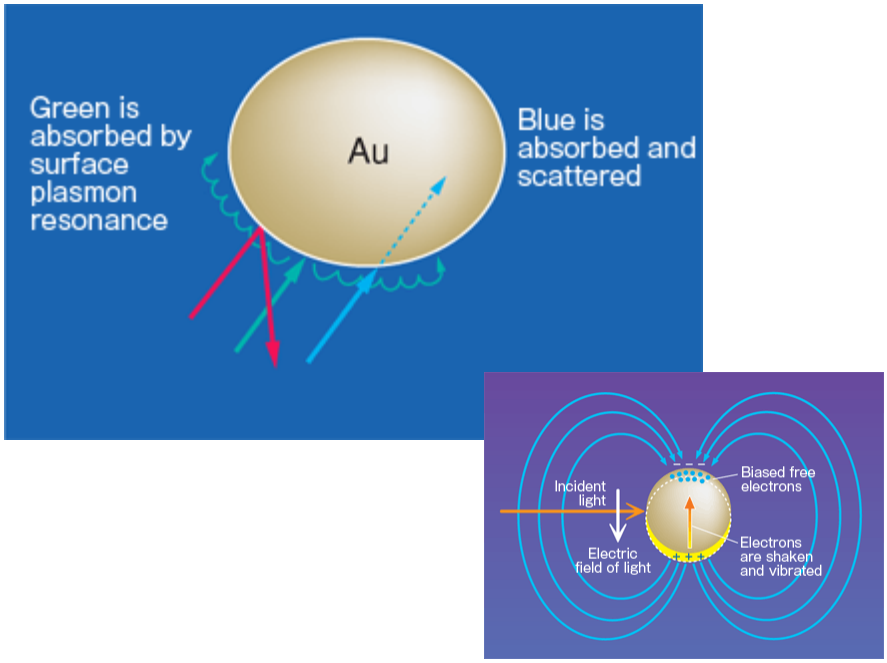

2nm
5nm
50nm
100nm
200nm

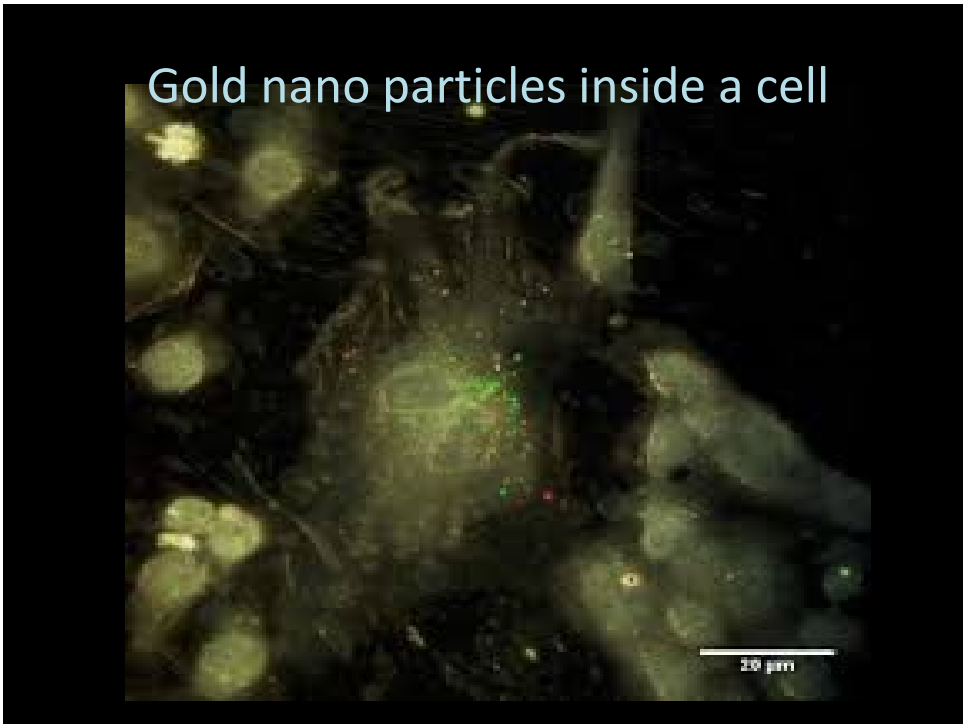
Negative Index Refraction

(Making Light Bend the 'Wrong' Way)

Difference light absorbance among particle sizes




Green is absorbed by surface plasmon resonance
Au
Blue is absorbed and scattered
Incident light
Electric field of light
Biased free electrons
Electrons are shaken and vibrated

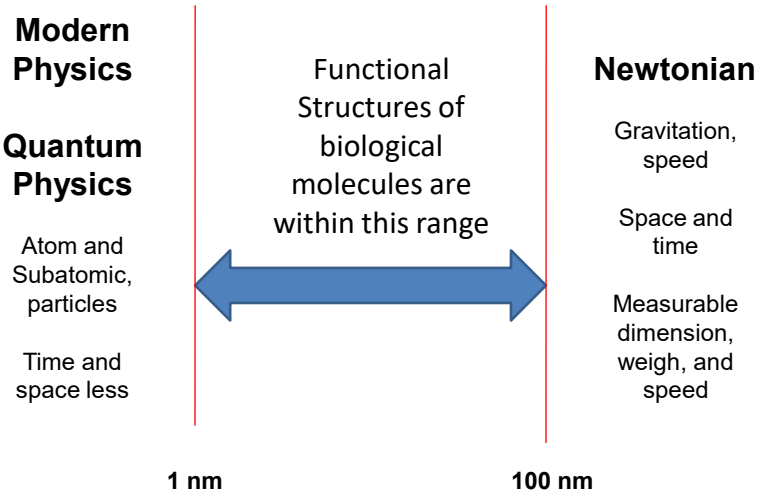

Gold nano particles inside a cell
10 µm

Nanobiology

- Many fundamental biological functions are carried out by molecular machineries that have the sizes of 1-100 nm

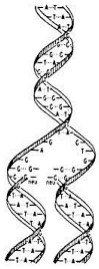
  eg., ribosomes, enzymes, nuclear pore etc.,
- Movements, shapes, localization
- Merges mechanistic biology and morphology

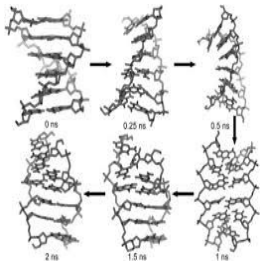
Cell Biology and Molecular Biology are Nano Science

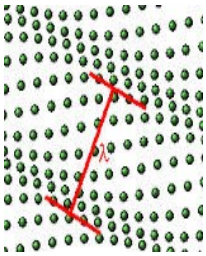


The phonon in twisting and stetching modes of DNA

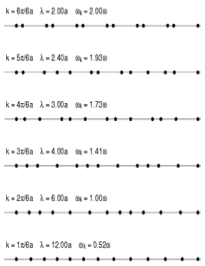
(Müller et al., 2002)







Phonon is collective exitation in a periodic, elastic arrangement of atoms or molecules in condensed matters, represents exited state in quantum mechanical quantization of modes of vibrations of elastic structures of interacting particles (Igor Tamm, 1932).



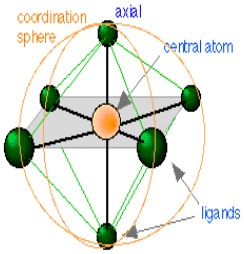
Electricity and Magnetism in Biological Molecules

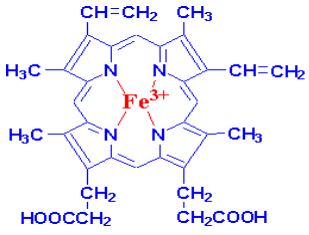
- Energy generation to build complex structure of organic chemical compounds is based on their physical and chemical characters

- Electrical properties of Biological molecules can conduct electricity and influence development of molecular electronic (Porath, et al., 2004)

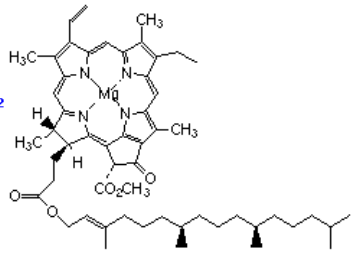
- DNA and other biological macromoleculs behave as an isolator, semiconductor, conductor or superconductor depending on the surounding molecules or the medium (Braun et al., 1998; Pablo et al., 2000; Zang et al., 2002; Storm et al., 2001; Porath et al., 2005; rakitin et al., 2001; Cohen et al., 2005)

- These Biological molecules perform electronic transport and have magnetic phenomena (Zong et al., Eds, 2003)





Heme

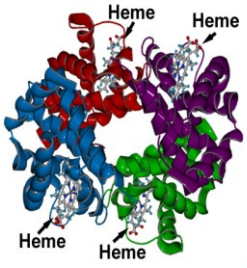


Chlorophyll *a*

Bioinorganic

A *coordination complex* is one in which a *central atom* or ion is joined to one or more *ligands* through what is called a *coordinate covalent bond* in which both of the bonding electrons are supplied by the ligand.

Cytochrome-c

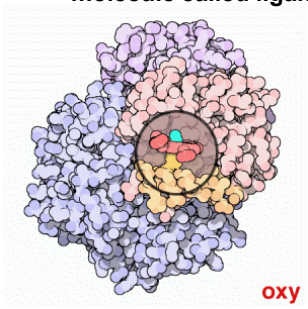


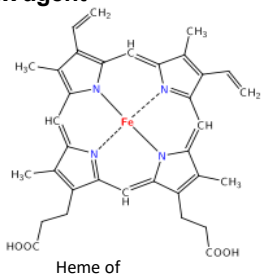
Hemoglobin

Catalase

In such a complex the central atom acts an electron-pair acceptor (*Lewis , 1992)*

A compound formed by union of a metal ion (usually a transition metal) with a non metallic ion or molecule called ligand or complex agent



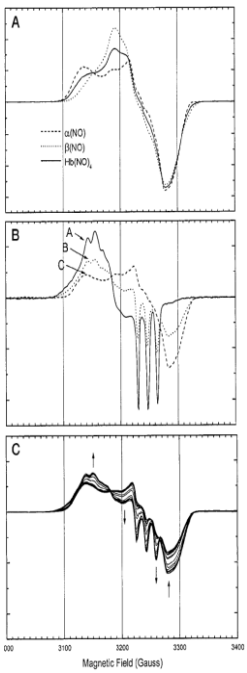


Heme of red blood hemoglob in

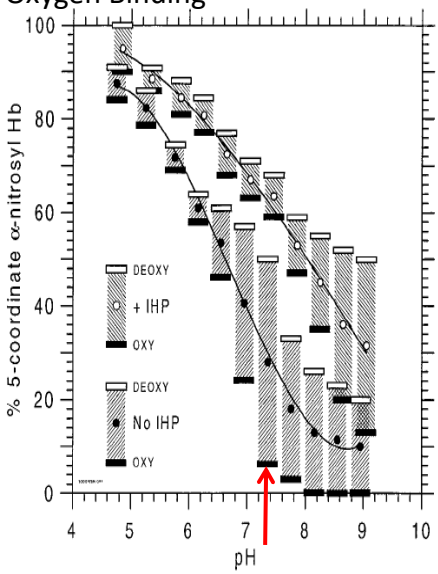
Iron's oxidation state in oxyhemoglobin

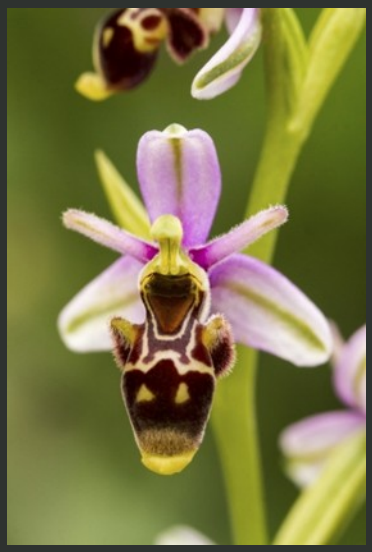
Assigning oxygenated hemoglobin's oxidation state is difficult because **oxyhemoglobin (Hb-O2), by experimental measurement, is diamagnetic** (no net unpaired electrons), yet the low-energy electron configurations in both oxygen and **iron are paramagnetic** (suggesting at least one unpaired electron in the complex).

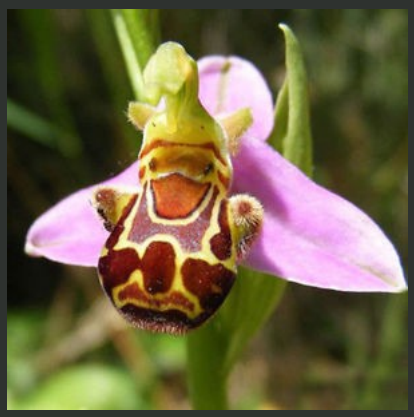
Albert et al., 2007



Electron Spin Resonance Spectroscopy (ESR) Studies of Oxygen Binding







Bioinorganic and colouring

The whole is greater and smarter than the sum of the parts

Complex compound or Coordination compound

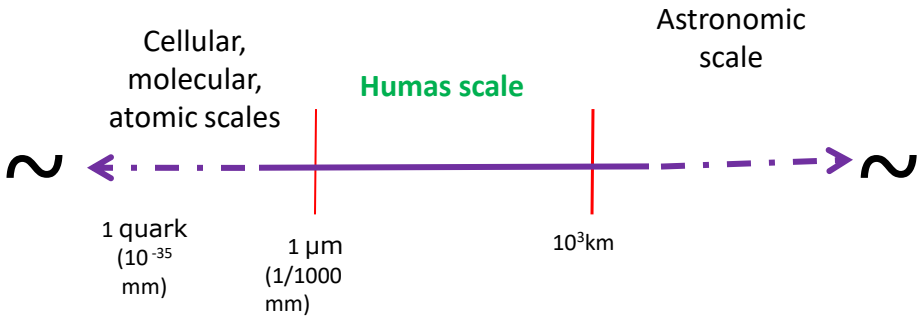
(*in atomic language*)

Complex ion:

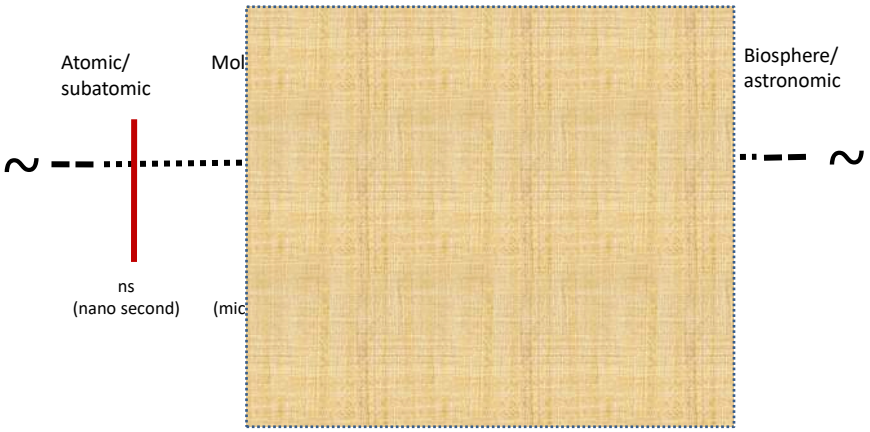
Anions which has a molecular structure consisting of a central atom bonded to other atoms by coordinate covalent bonding

The notion of a complex system is distinguished from that of complicated system, which is more than the sum of its parts. This complex systems indicate that the whole is greater and smarter than the sum of the parts

The Space



The Time



A moment of unique opportunity

Current research has brought biology to an inflection point

- **Integration of sub disciplines within biology**
- **Cross-discipline integration: life science research by physical, computational, earth scientists, engineers**
- **Technological advances enable biologists to collect data unprecedented in quantity and quality**
- **Past investments providing value beyond expected**

An opportunity for a New Biology with impact at an unprecedented scale

Kerangka Kualifikasi keahlian dalam KKNI

Level 7 : Monodisipliner

Level 8 : Inter- atau multidisipliner

Level 9 : Inter-, multi- dan transdisipliner

Penutup

Ada Baiknya memperhatikan pendapat **Alvin Toffler**, American Writer and Futurist

"The illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn."