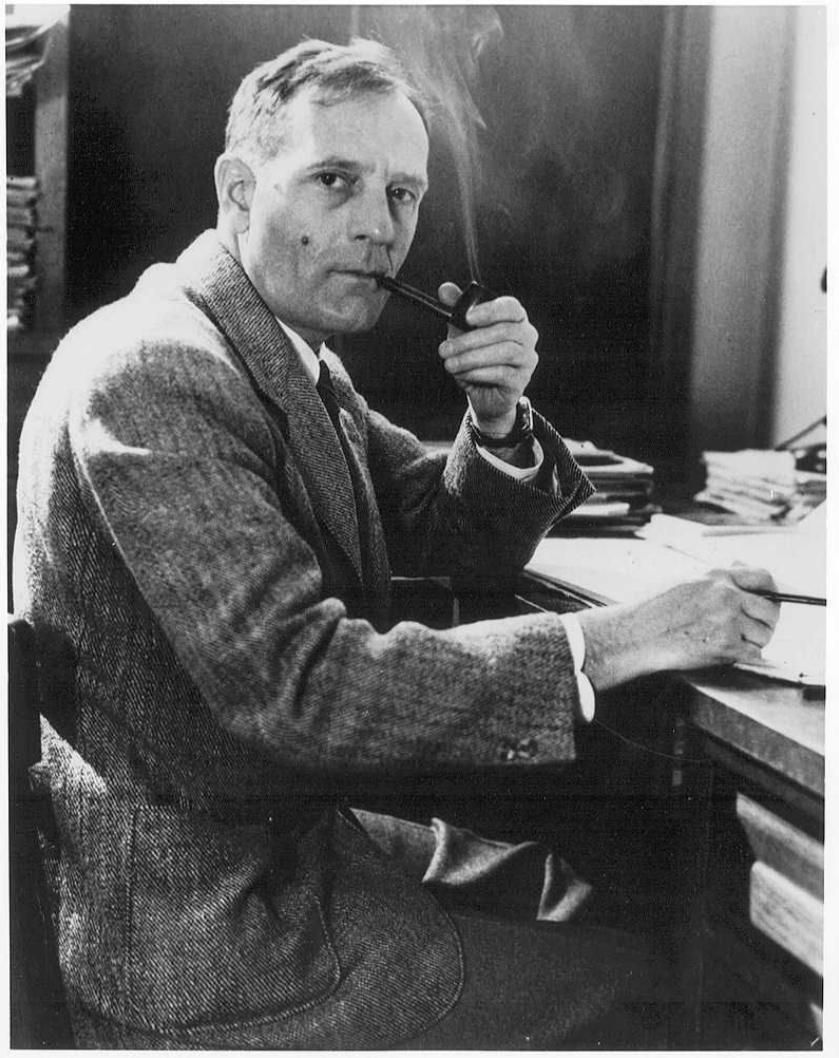
… felt the need to explain a static universe

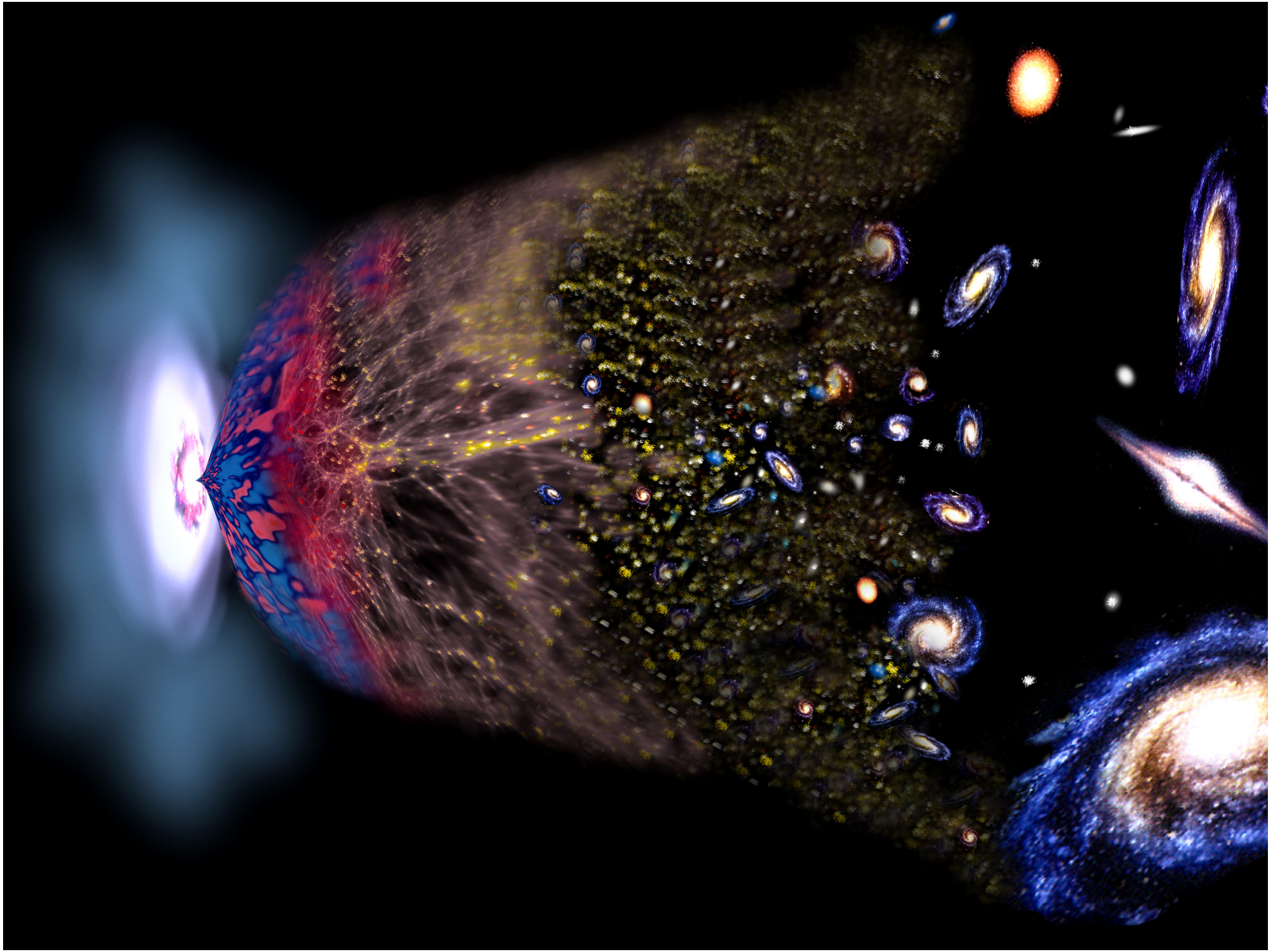



Georges Lemaitre

Edwin Hubble

…discovered an expanding universe

Fred Hoyle:  “Big Bang”



# Just three events

- Big Bang: a world of physics and chemistry
- Origin of life: a world of biology
- Origin of human language: a world of ideas, inventions, the human mind, individuality

# A world view:

- **Naturalism**: science explains all there is.
- The material world is all there is.

- **But:** science does not explain mathematics.
- Mathematical truth is not material / not in matter.

# Another world view:

- There is a material world of change.
- There is an unchanging immaterial world.
- We are within both of those worlds.

# Any world view should address

- What is it that exists?
- How do we know things?
- What is the purpose of life?

What is your goal? Why are you here?

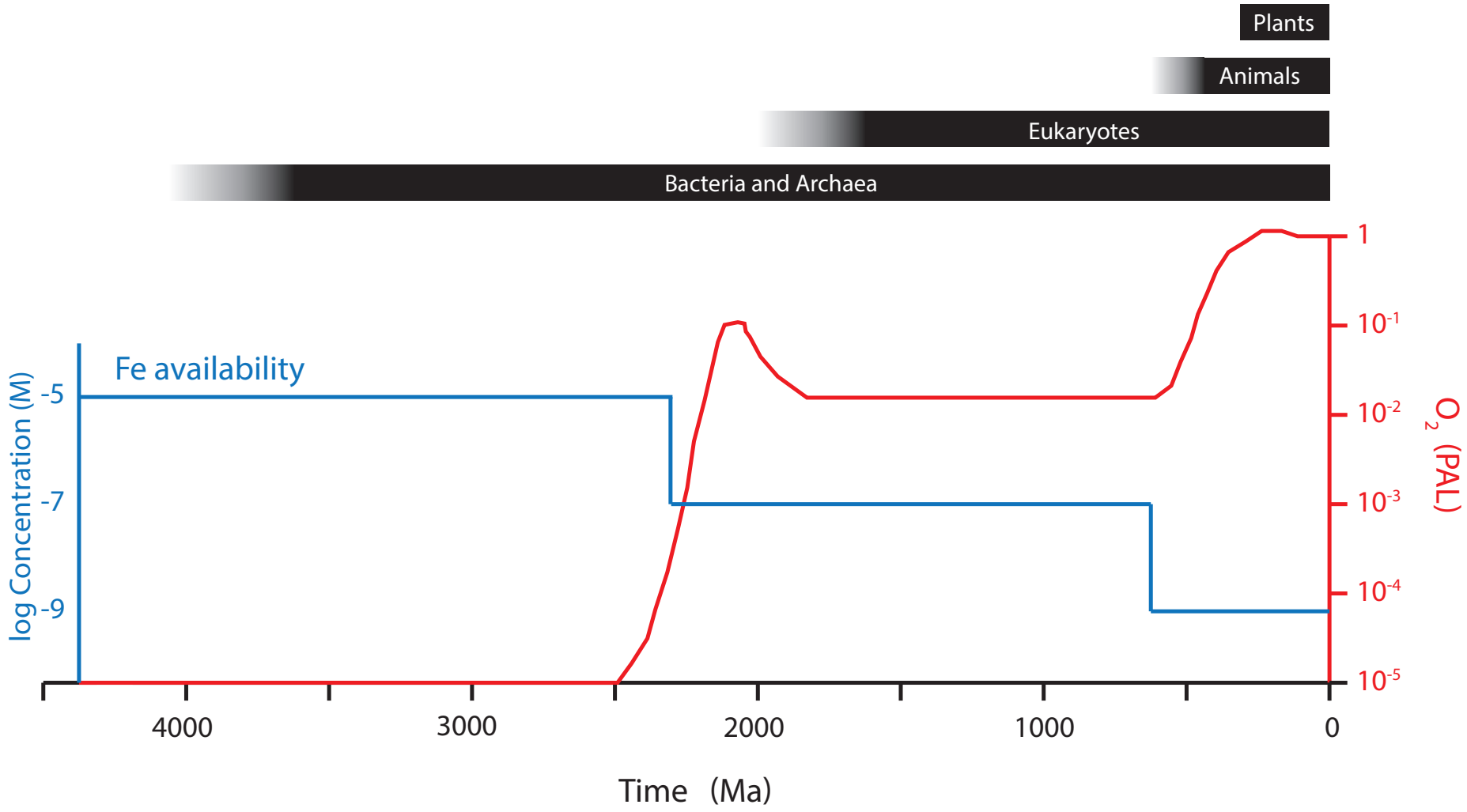
# The time scale

- Big bang: 13.7
- Sun, earth, moon 4.6

origin of life on earth ?

- Bacteria: 3.5
- Eucaria: 1.8
- Complex multi-cellularity: 0.6
- Humans: 0.001

(billion years ago)

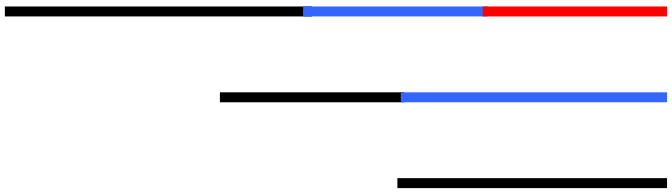

Plants
Animals
Eukaryotes
Bacteria and Archaea
Fe availability
log Concentration (M)
-5
-7
-9
1
10-1
10-2
10-3
10-4
10-5
O2 (PAL)
4000
3000
2000
1000
0
Time (Ma)

1809 Charles Darwin born

1809 Jean Baptiste Lamarck publishes *Philosophie zoologique*

# Jean-Baptiste Pierre Antoine de Monet, Chevalier de Lamarck

(1744-1829)



Spontenous generation of life from matter

Complexifying force

Transmission of acquired characteristics

“biology”,  “invertebrates” …

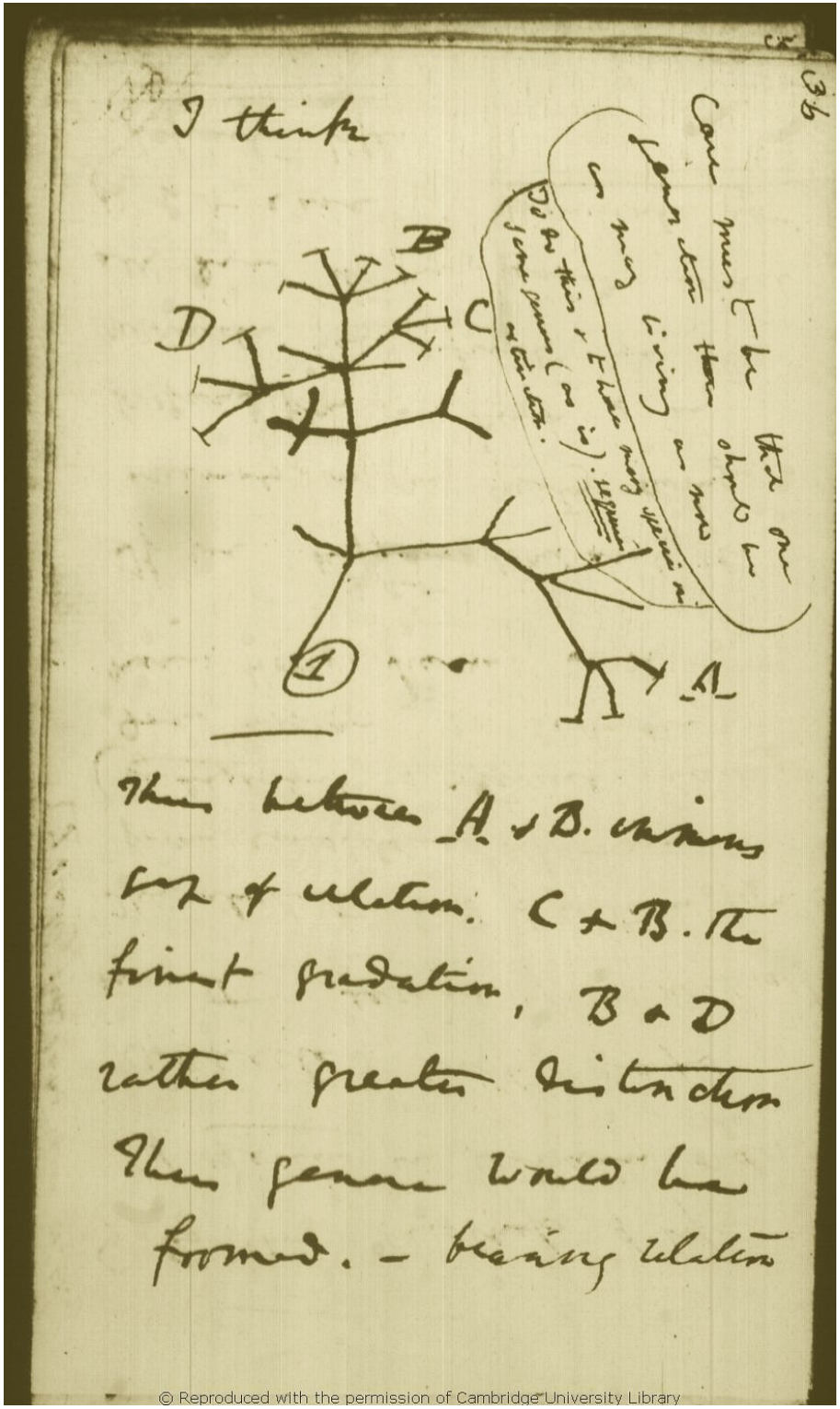
1809 Charles Darwin born

1809 Jean Baptiste Lamarck publishes *Philosophie zoologique*

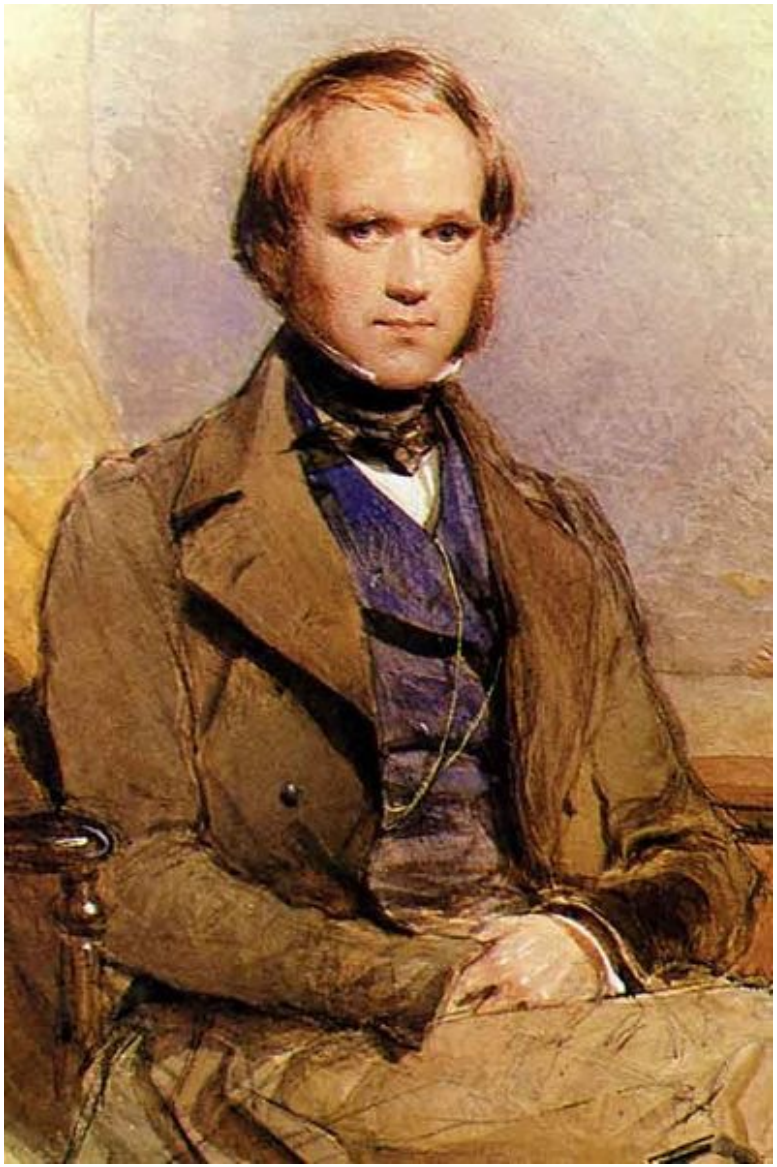
1825-31 Darwin student in Edinburgh and Cambridge

1831-36 Voyage of the Beagle

1842 the “pencil sketch”







1837 notebook

# Alfred Russel Wallace

1809 Charles Darwin born

1809 Jean Baptiste Lamarck publishes *Philosophie zoologique*

1825-31 Darwin student in Edinburgh and Cambridge

1831-36 Voyage of the Beagle

1842 the “pencil sketch”

1858 Darwin and Wallace publish on natural selection

1859 “On the origin of species”

# Co-discoverers of evolution

Charles Darwin

Alfred Russel Wallace

# Patrick Matthew

“What is all the fuss?”

**Patrick Matthew** in **1831**
in a book on Naval Timber:

THERE is a law universal in nature, tending to render every reproductive being the best possibly suited to its condition that its kind, or that organized matter, is susceptible of, which appears intended to model the physical and mental or instinctive powers, to their highest perfection, and to continue them so. This law sustains the lion in his strength, the hare in her swiftness, and the fox in his wiles.

As Nature, in all her modifications of life, has a power of increase far beyond what is needed to supply the place of what falls by Time's decay, those individuals who possess not the requisite strength, swiftness, hardihood, or cunning, fall prematurely without reproducing—either a prey to their natural devourers, or sinking under disease, generally induced by want of nourishment, their place being occupied by the more perfect of their own kind, who are pressing on the means of subsistence.

**Darwin** in **1860**:

I have been much interested by Mr. Patrick Matthew's communication in the Number of your Paper, dated April 7th . I freely acknowledge that Mr. Matthew has anticipated by many years the explanation which I have offered of the origin of species, under the name of natural selection.

I think that no one will feel surprised that neither I, nor apparently any other naturalist, had heard of Mr. Matthew's views, considering how briefly they are given, and that they appeared in the appendix to a work on Naval Timber and Arboriculture. I can do no more than offer my apologies to Mr. Matthew for my entire ignorance of his publication. If another edition of my work is called for, I will insert a notice to the foregoing effect.

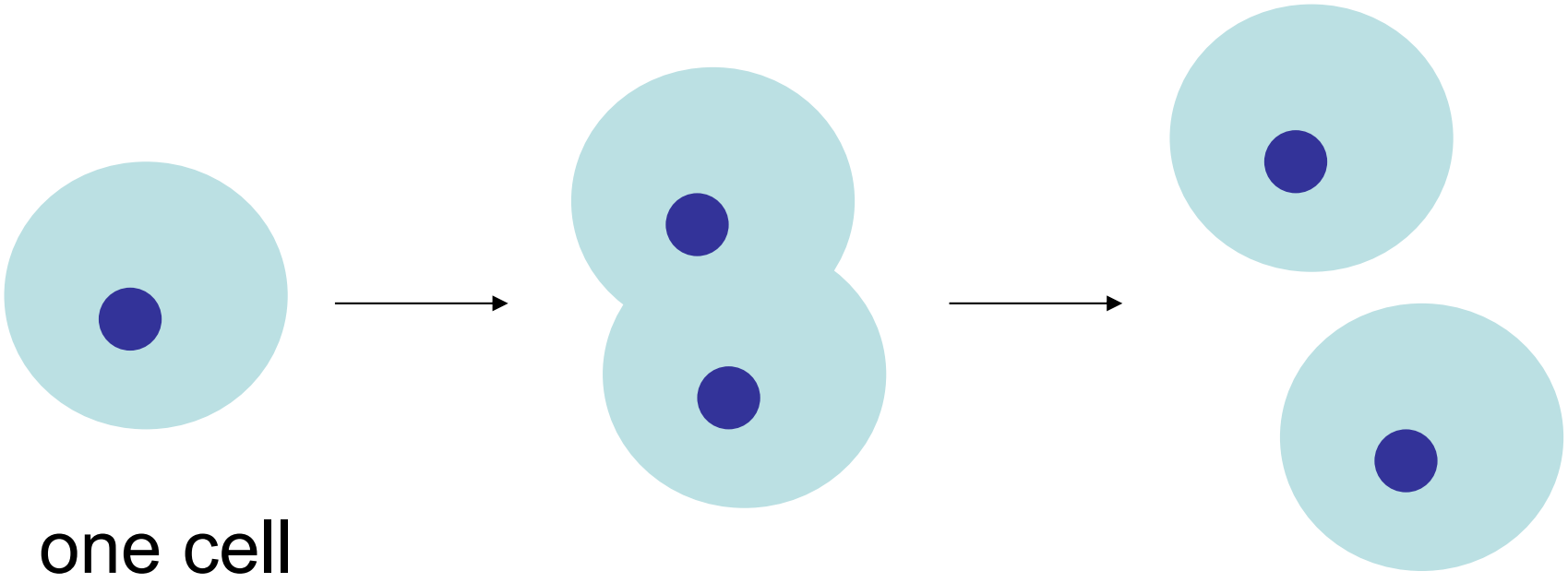
- James Hutton, in 1794, uses natural selection for improvement of varieties
- William Charles Wells, in 1813, proposes that natural selection can lead to new varieties
- Edward Blyth, in 1835, uses natural selection as a process to preserve the unchanging essence of a stable species

# What is evolution?

# What is evolution?

- Reproduction
- Mutation
- Selection

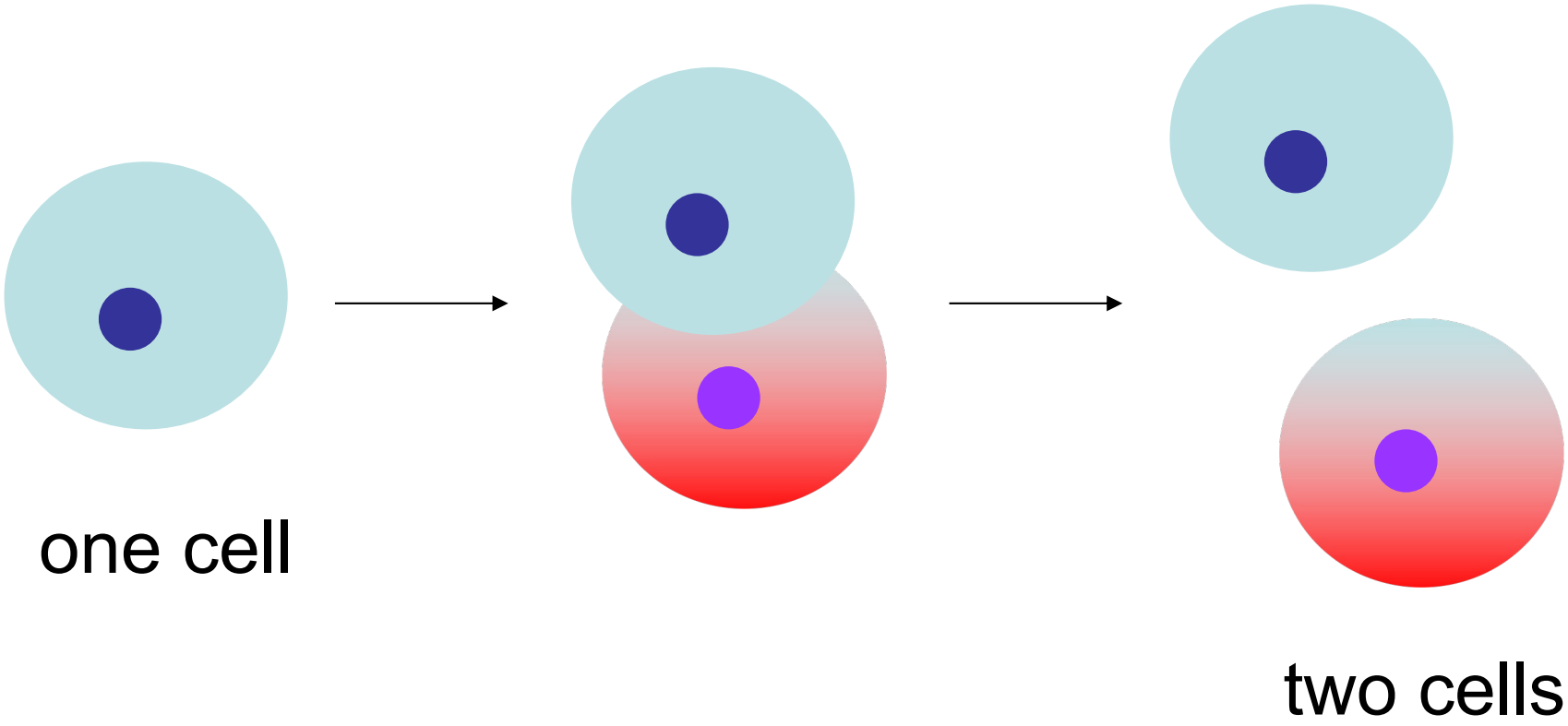
# Reproduction



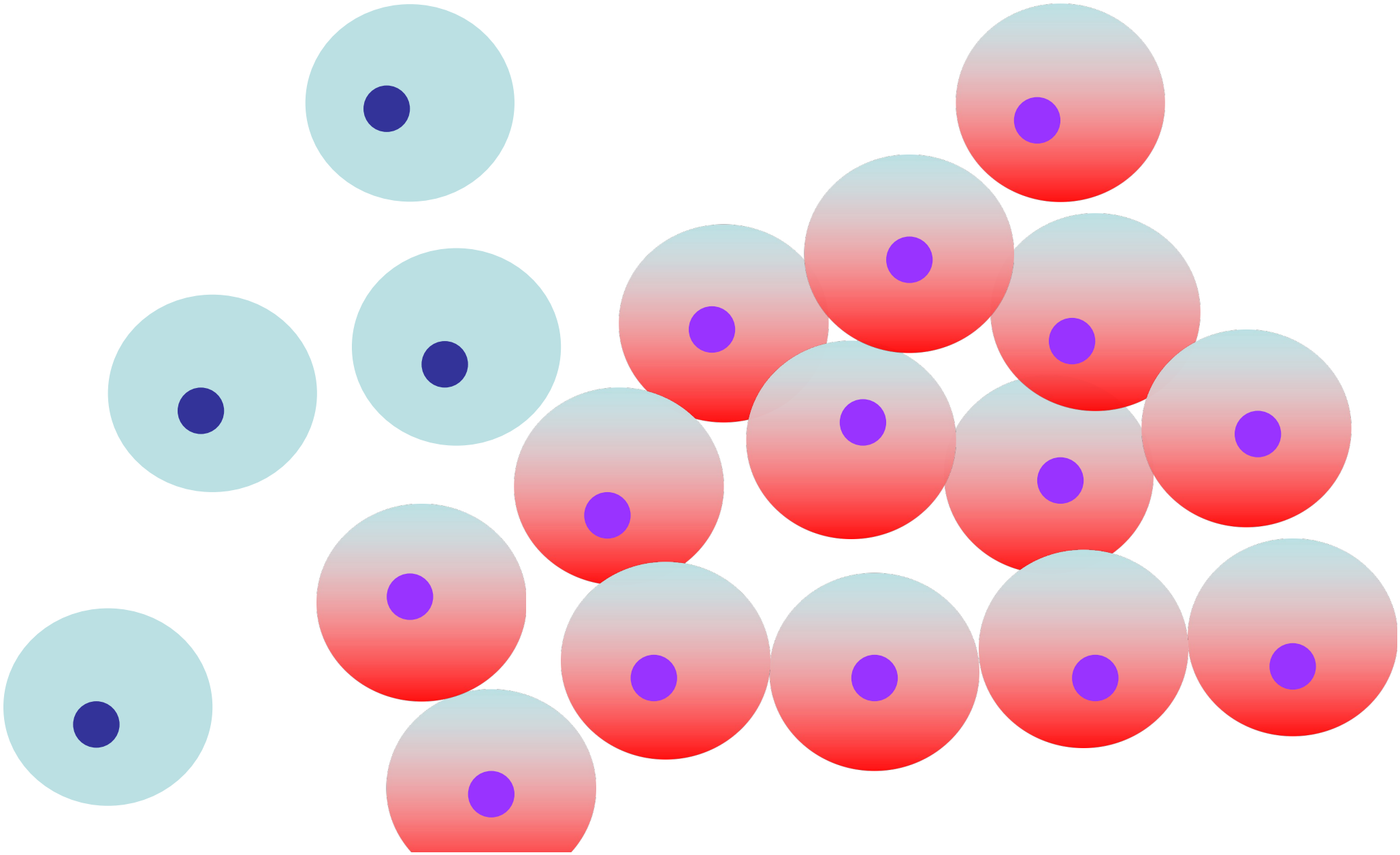
one cell

two cells

# Mutation



# Selection



# What is evolution?

- Reproduction
- Mutation
- Selection
- Cooperation (is the master architect of complexity)

# What is it that evolves?

# Populations evolve