# Creative Discovery System
A generative Approach to Scientific Discovery via Activity Tracking

- Outline:
  - 1- hints from a case taken in history of science (induction),
  - 2- general principles,
  - 3- contemporary case

- A case study suggesting a way to design a Generative Approach to Scientific Discovery via Activity Tracking

- For this case study: our perspective and question are:

  How models of the solar system have evolved to enable first a coarse description of the movement of planets, second a more general explanation and description of all movements (including the movements of objects on earth)

From Ptolemaic system (with epicycles) to Kepler laws (elliptic orbits of planets)

Ptolemy's geocentric system: with epicycles not to abandon the centrality of earth in the planets' system
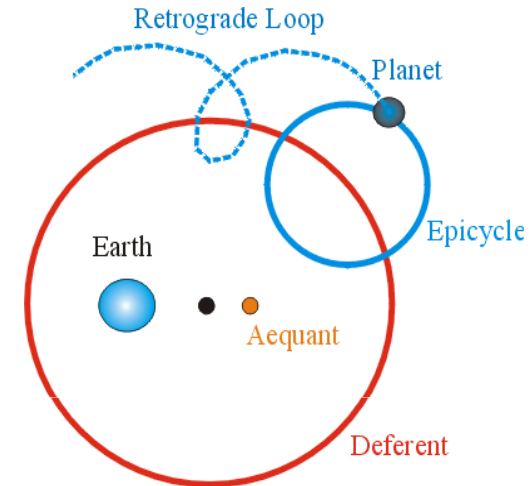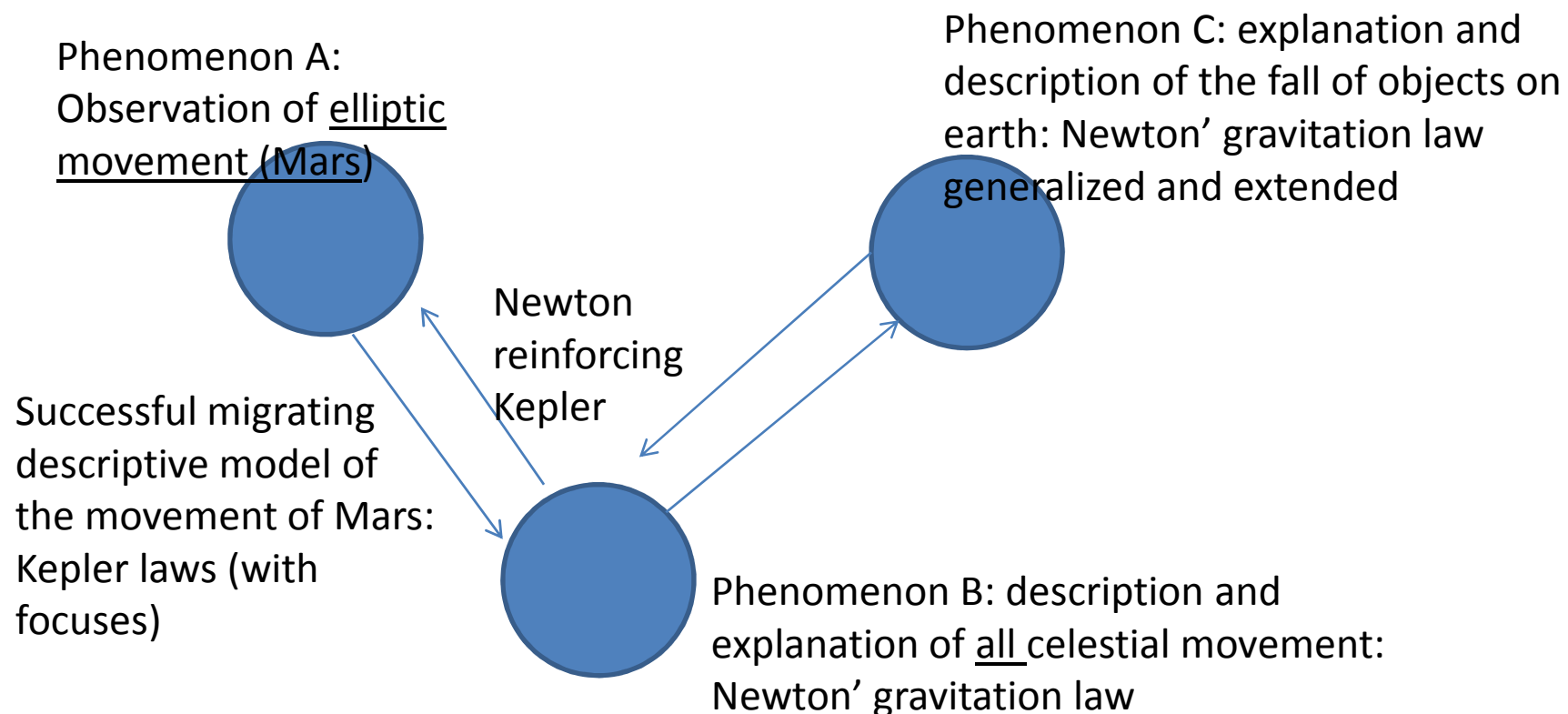
Kepler's model for elliptic orbits (with focuses): with the measure of Tycho Brahe, on the movement of Mars


Retrograde Loop · Planet · Epicycle · Earth · Aequant · Deferent
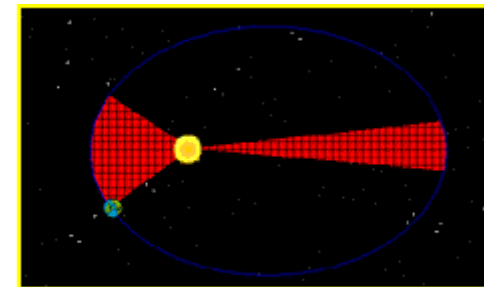
Click Above Image to View Animation

From Kepler's ellipsis to Newton's general gravitation law

- General gravitation law explains the elliptic form of the orbits AND the fall of objects on earth at the same time : a kind of generalization AND extension

- Hence: First scheme of the evolution of models:

Phenomenon A: Observation of elliptic movement (Mars)

Phenomenon C: explanation and description of the fall of objects on earth: Newton' gravitation law generalized and extended

Newton reinforcing Kepler

Successful migrating descriptive model of the movement of Mars: Kepler laws (with focuses)

Phenomenon B: description and explanation of all celestial movement: Newton' gravitation law

Creative Discovery Systems (CDS):
Generative Approach to Scientific Discovery via Activity Tracking

Migration
(Transfer) Activity

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• model
schema
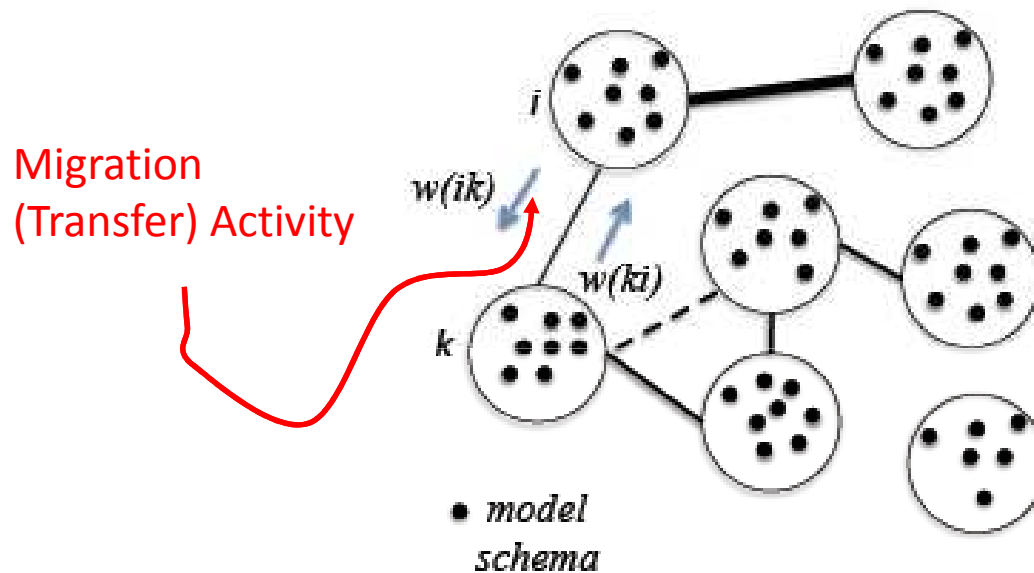
- Due to synergistic combination of evolution and ecological perspective, the generated solution that is defined in terms of an ensemble of ensembles is flexible due to consequence of multiple feedback loops that keep the solution in a state of dynamic balance.
- The solution is not biased toward a single targeted attribute; hence, the solution is not optimized toward one specific aspect. Rather, ensembles fluctuate around their optimal forms.

Exploit the Synergy of Models of
# Creative Cognition and Scientific Discovery
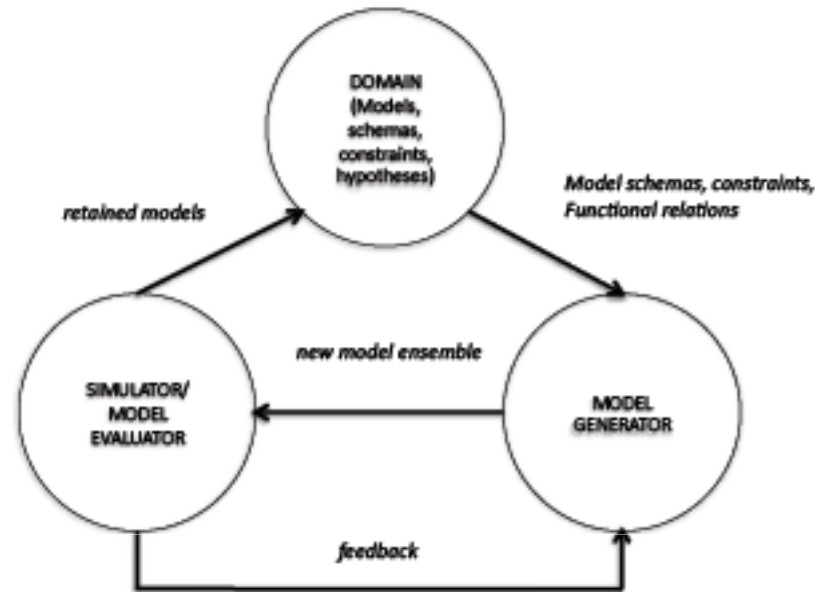
• Analogue composition is a hypothesis: these components as composed become a mechanism upon execution, and that mechanism will lead to measurable phenotypic attributes that mimic pre-specified, targeted, referent attributes.

• A more interesting analogue is one capable of a greater variety of phenotype mimicry, and for which the mappings from analogue to referent mechanisms can be concretized; conceptual mappings cannot. Improved analogue-to-referent mappings at the mechanism level are expected to lead to deeper insight. Analogues capable of greater mimicry of targeted attributes are retained.

The cell differentiation case

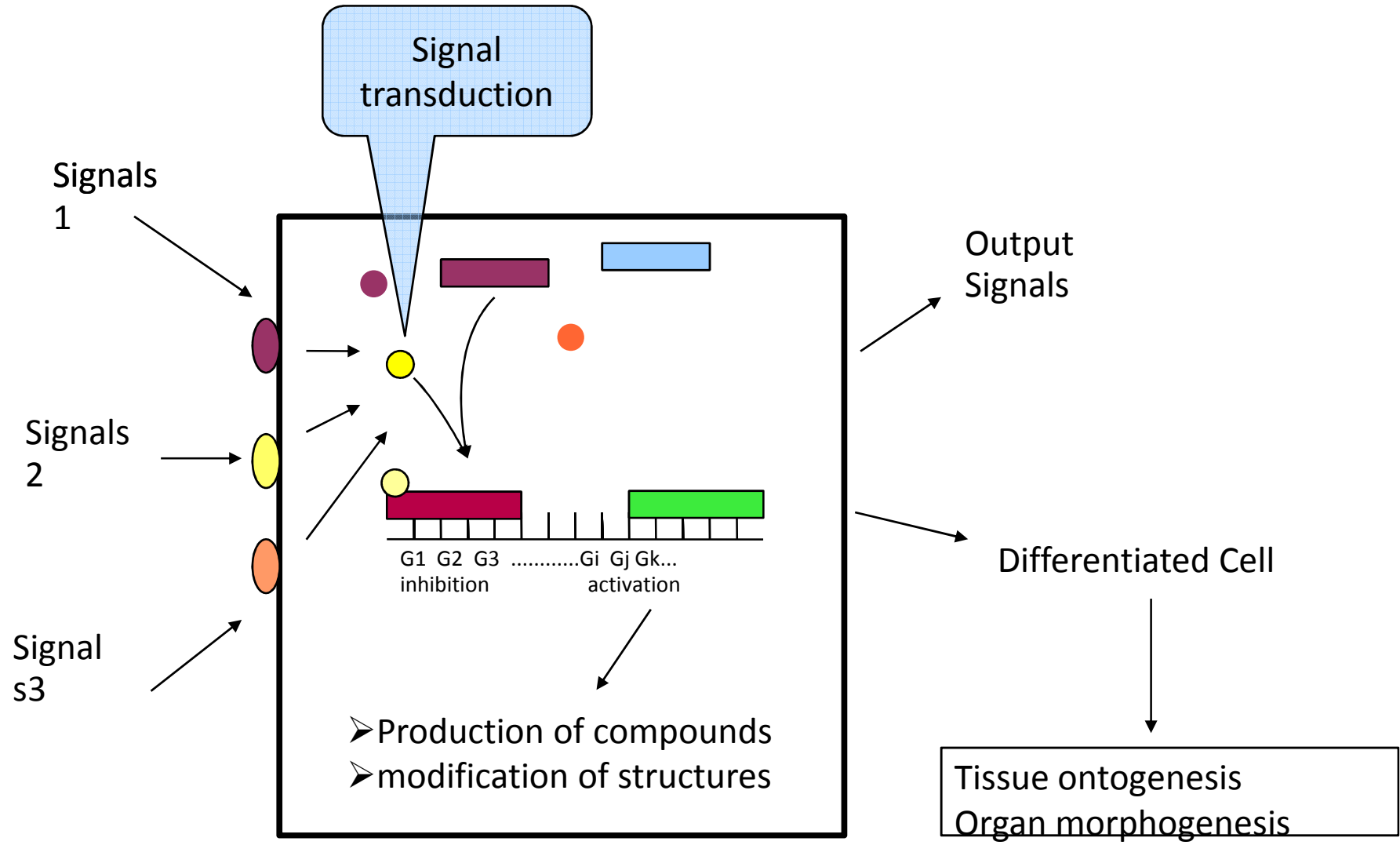Histology Lab Part 7: Slide 48
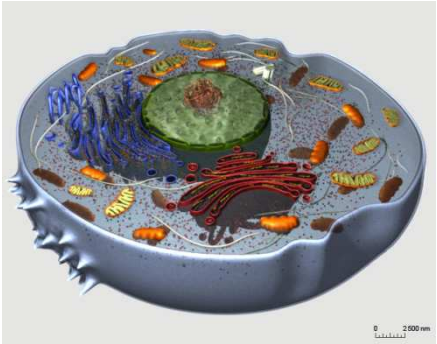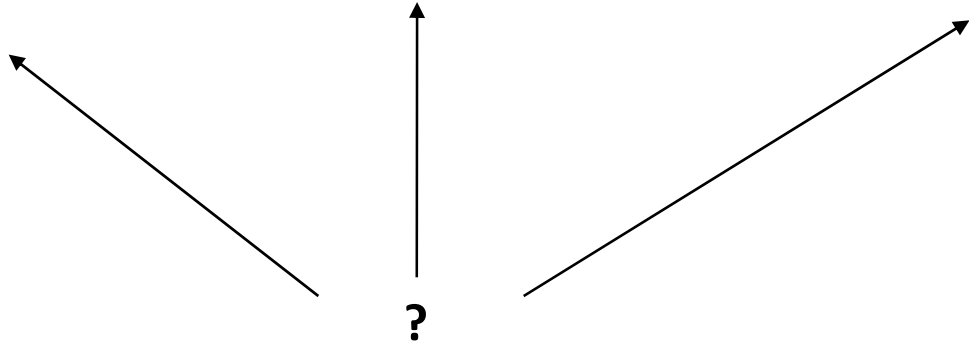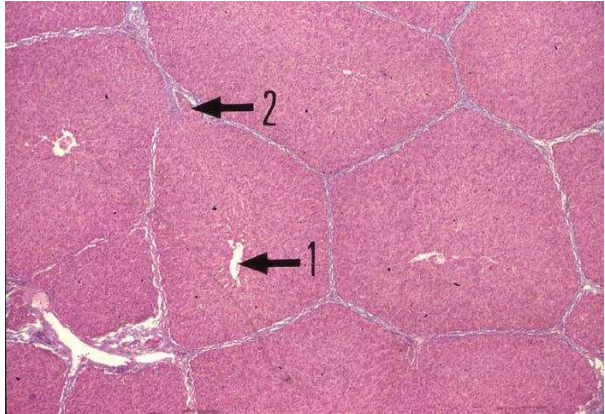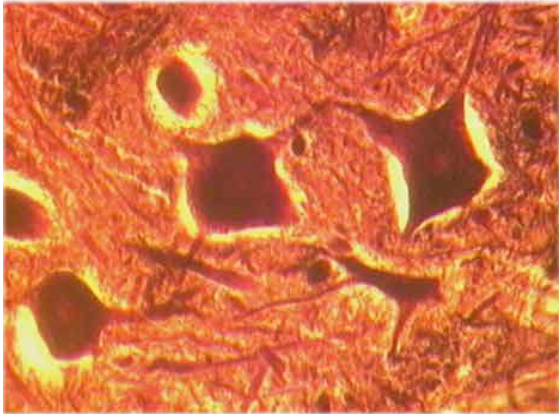
Totipotent Cell

Stem Cell Cultivation
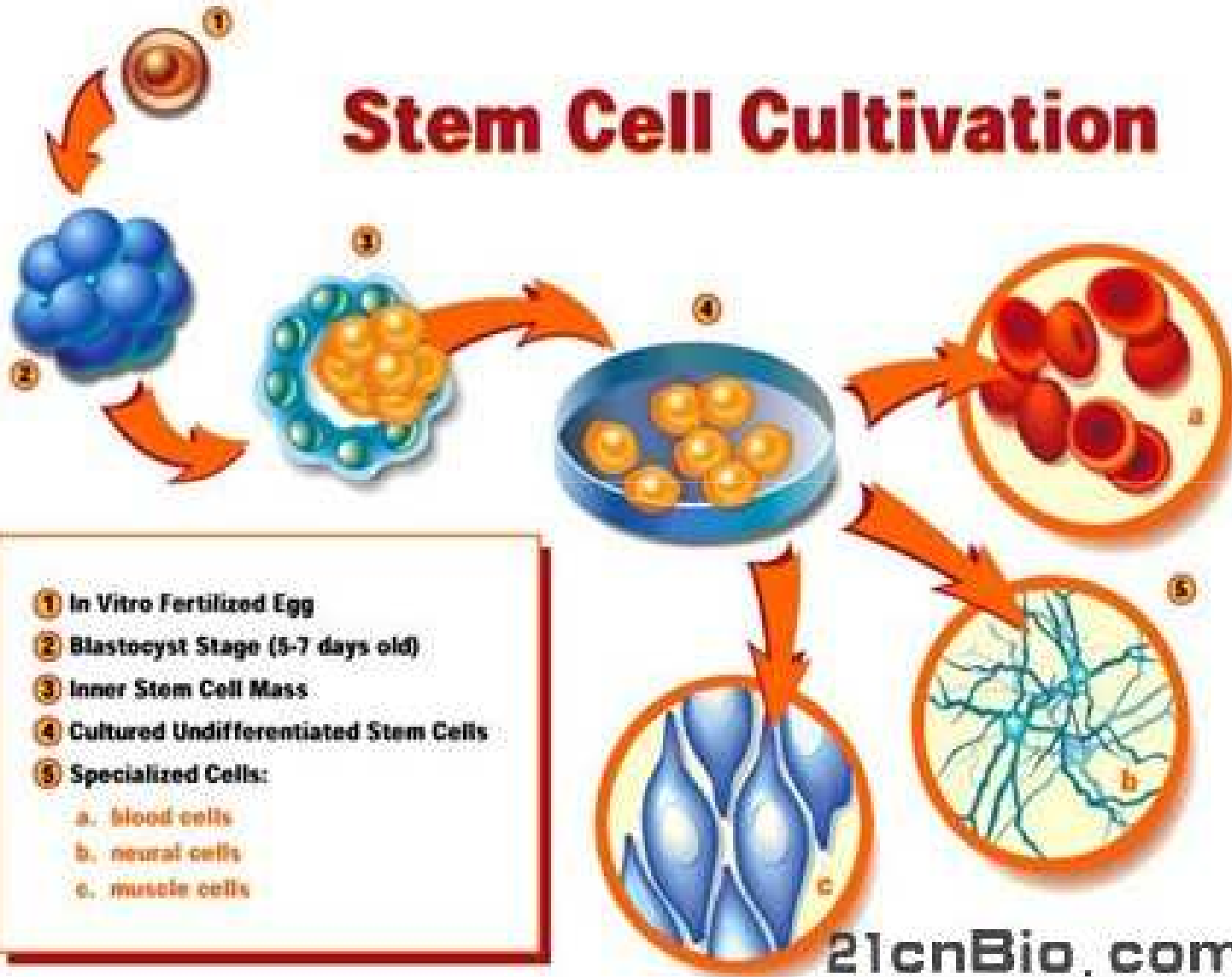
1. In Vitro Fertilized Egg
2. Blastocyst Stage (5-7 days old)
3. Inner Stem Cell Mass
4. Cultured Undifferentiated Stem Cells
5. Specialized Cells:
   a. blood cells
   b. neural cells
   c. muscle cells

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Same genes
Same cellular organelles → Very different cells : structures &
Same structures functionalities

Signal transduction

Signals 1

Signals 2

Signals 3

Output Signals

G1 G2 G3 ....Gi Gj Gk...
inhibition activation

➤ Production of compounds
➤ modification of structures

Differentiated Cell

Tissue ontogenesis
Organ morphogenesis

Same genes
Same cellular organelles → Very different cells : structures &
Same structures functionalities

Three different competing models
(involving differents metabolic ways and mecanisms)