

How an economy emerges from its technologies and grows

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Two great problems in economics

1. *Allocation* within the economy

2. *Formation* within the economy

“The most important of all the phenomena we seek to explain” -- Schumpeter (1908)

Standard growth theory

Solow's 1957 finding

- 85% of growth from tech change

Endogenous growth models

- Technologies considered, but largely amorphous

The economy = the set of arrangements and activities by which society fulfills its needs

These arrangements or “technologies” are means to human purposes. They include:

Devices, methods, industrial processes, trading systems, markets, distribution systems, banks. Also regulatory systems, institutions, legal systems, organizations, businesses

Some observations

The economy is not a container for its technologies, it is an **expression** of them

It is also a **gatekeeper** for its technologies

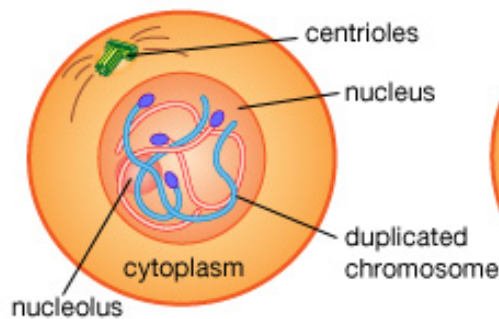
Technologies are not amorphous. They and their arrival and placement in the economy are **highly structured**

This suggests

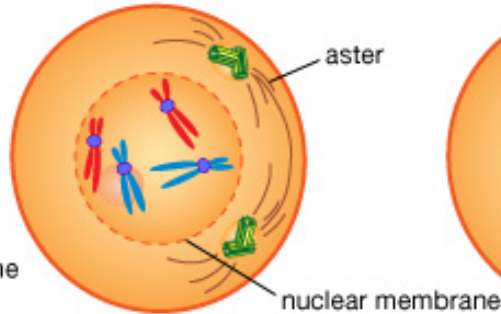
1. We should base any theory of growth or change on **technology**
2. We should properly **respect complication** (cf. devo mechanisms)
3. Any overall schema should encompass **what's been done**
4. We should think algorithmically. Growth and change as techs are added, modified, replaced are **procedural**, or **algorithmic**.

Cf. Mitosis is procedural, not mathematized

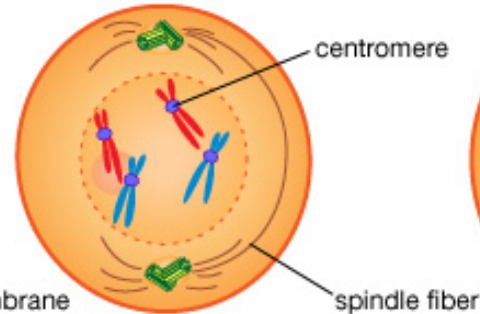
Mitosis, or somatic cell division



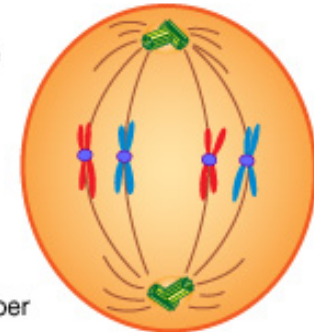
Prior to mitosis, each chromosome makes an exact duplicate of itself. The chromosomes then thicken and coil.



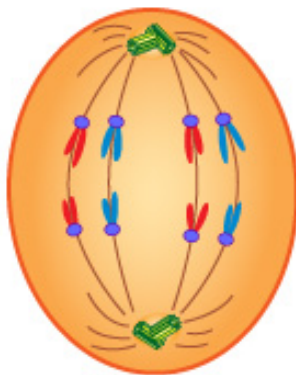
In early prophase, the centrioles, which have divided, form asters and move apart. The nuclear membrane begins to disintegrate.



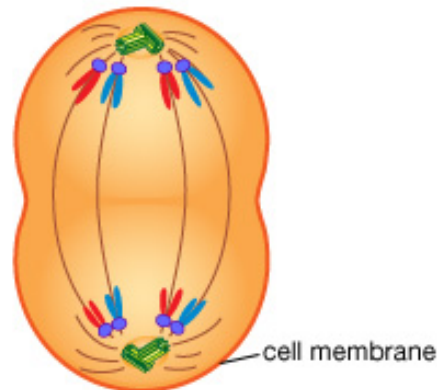
In late prophase, the centrioles and asters are at opposite poles. The nucleolus and nuclear membrane have almost disappeared.



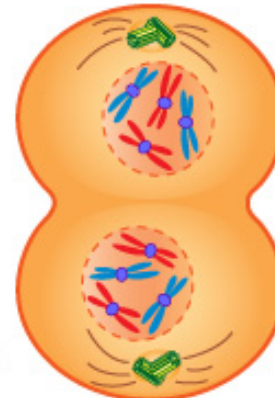
The doubled chromosomes—their centromeres attached to the spindle fibers—line up at mid-cell in the metaphase.



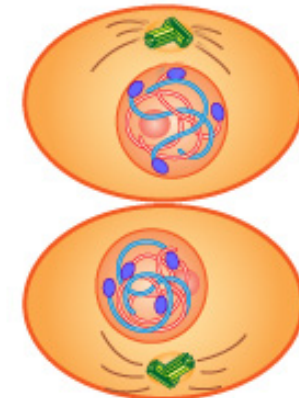
In early anaphase, the centromeres split. Half the chromosomes move to one pole, half to the other pole.



In late anaphase, the chromosomes have almost reached their respective poles. The cell membrane begins to pinch at the center.

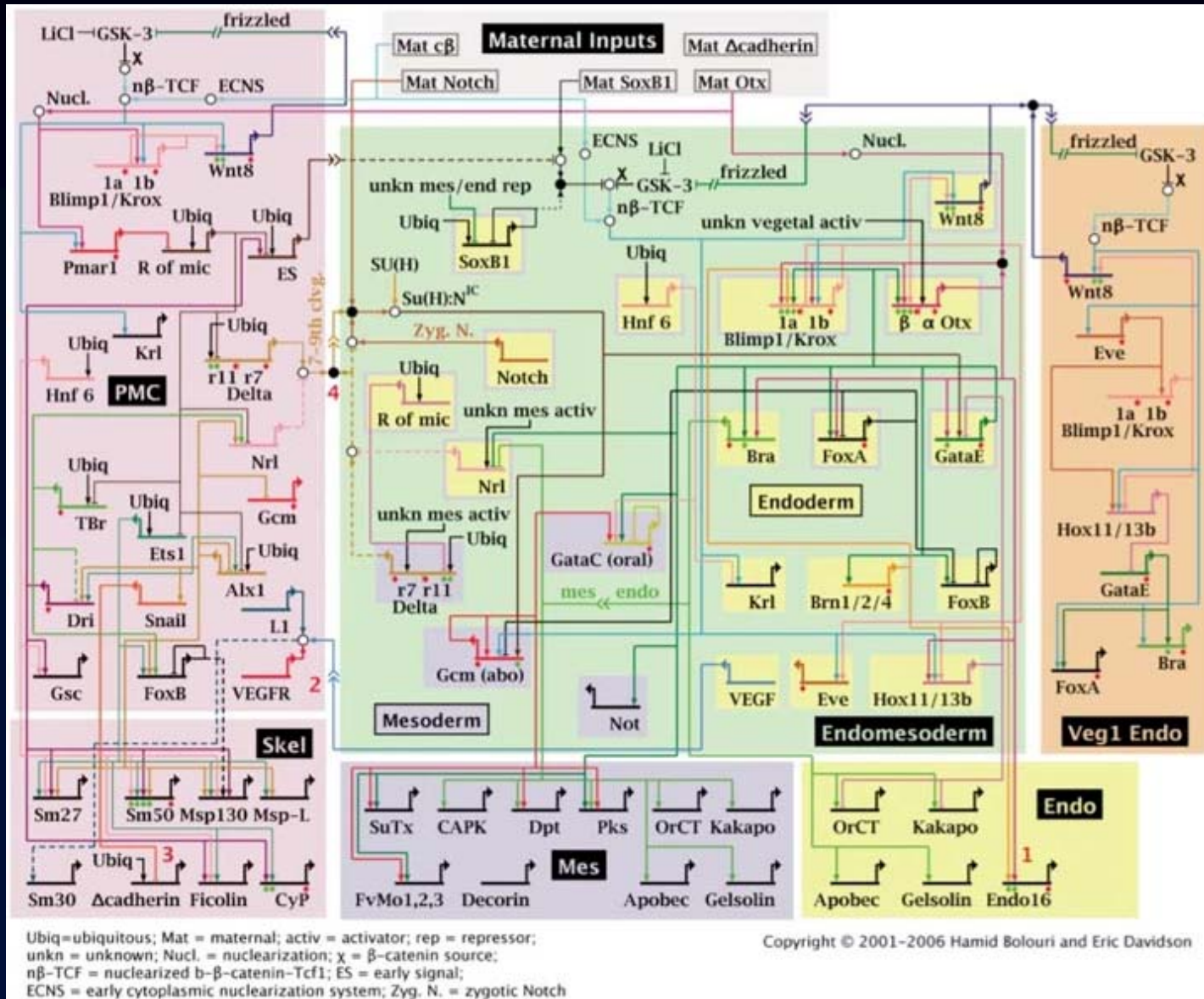


The cell membrane completes constriction in telophase. Nuclear membranes form around the separated chromosomes.



Mitosis completed, there are two cells with the same structures and number of chromosomes as the parent cell.

Cf. Process by which an organism develops



Nota Bene

Unlike development of an embryo (previous slide), economic formation is *highly* path-dependent and stochastic

Basic story

1. The **economy** forms from its arrangements, its “technologies”
2. **Technologies form from existing technologies**, replace inferior technologies
3. New techs **set up needs** for supporting technologies, organizations, and pose **challenges** answered by further techs
4. The economy remakes itself **constantly** as all this happens

Re-express this as an algorithm

1. Novel **element forms** from existing elements
2. **Replaces** existing technologies it improves on
3. **Generates new needs** or opportunity niches for further elements
4. The **economy readjusts** quantities and prices
5. **Adds to the substrate** of elements to construct from

Algorithm in more detail

1. Novel **element forms** from existing elements
 - by combination of existing elements
 - these arrive in families, or along trajectories
 - (some existing elements inhibit or promote)
 - (the existing substrate defines a frontier)
2. **Replaces** existing technologies it improves on
 - Directly. And by replacing components

Algorithm in more detail

3. **Generates new needs** or opportunity niches for further elements
 - For supporting technologies
 - For novel forms of organization
 - For means to meet challenges that arise
4. The economy readjusts quantities and prices
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How the economy evolves: Algorithm

1. Novel **element forms** from existing elements
 - by combination of existing elements
 - arrive in families or along trajectories
 - (some existing elements inhibit or promote)
 - (the existing substrate defines a frontier)
2. **Replaces** existing technologies it improves on
 - Directly. And by replacing components
3. **Generates new needs** or opportunity niches for further elements
 - For supporting technologies
 - For novel forms of organization
 - For means to meet challenges that arise
4. The economy readjusts
5. **Adds to the substrate** of elements to construct from

Comments

The process is **algorithmic** and massively **concurrent**

Any of the above **events can trigger further events**

Change is **endogenous, path-dependent, and non-deterministic, recursive, happens at all levels, never ceases**

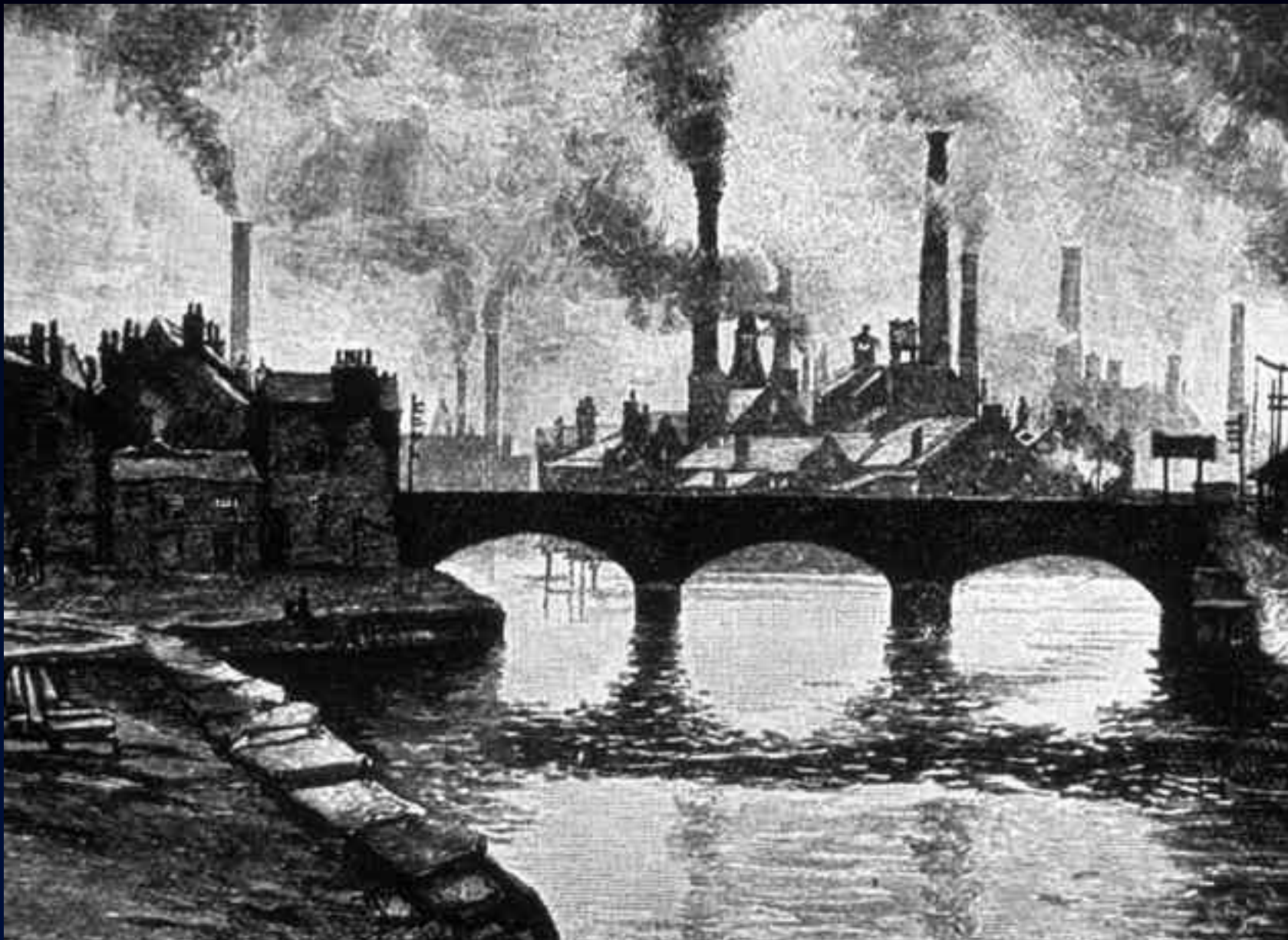
Major patterns set **the overall era**

Does this template fit reality?

England 1815



England 1845



The industrial revolution

(e.g. D. Landes, *Prometheus Unbound*)

Arrival of textile machinery replaced hand manufacturing,
called for factory organization, a larger scale

Many workers. This called for worker housing

Result: mill system, industrial cities

Result: appalling conditions

E.g. In the Victorian economy

Arrival of textile machinery replaced hand manufacturing, called for factory organization, larger scale

Many workers. This called for worker housing

Result: mill system, industrial cities

Result: appalling conditions

These in turn called for industrial safety standards, modern labor unions, proper sanitation, etc.

Comments

System constantly creates **new elements and structures out of existing ones** which call forth new elements and structures ...

- A form of complexity

Models can and should be partial

Connects with **economic history** and **political economy**

In summary

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