Caenorhabditis elegans as a Model Organism

Caenorhabditis elegans

(caeno, recent; rhabditis, rod; elegans, nice)

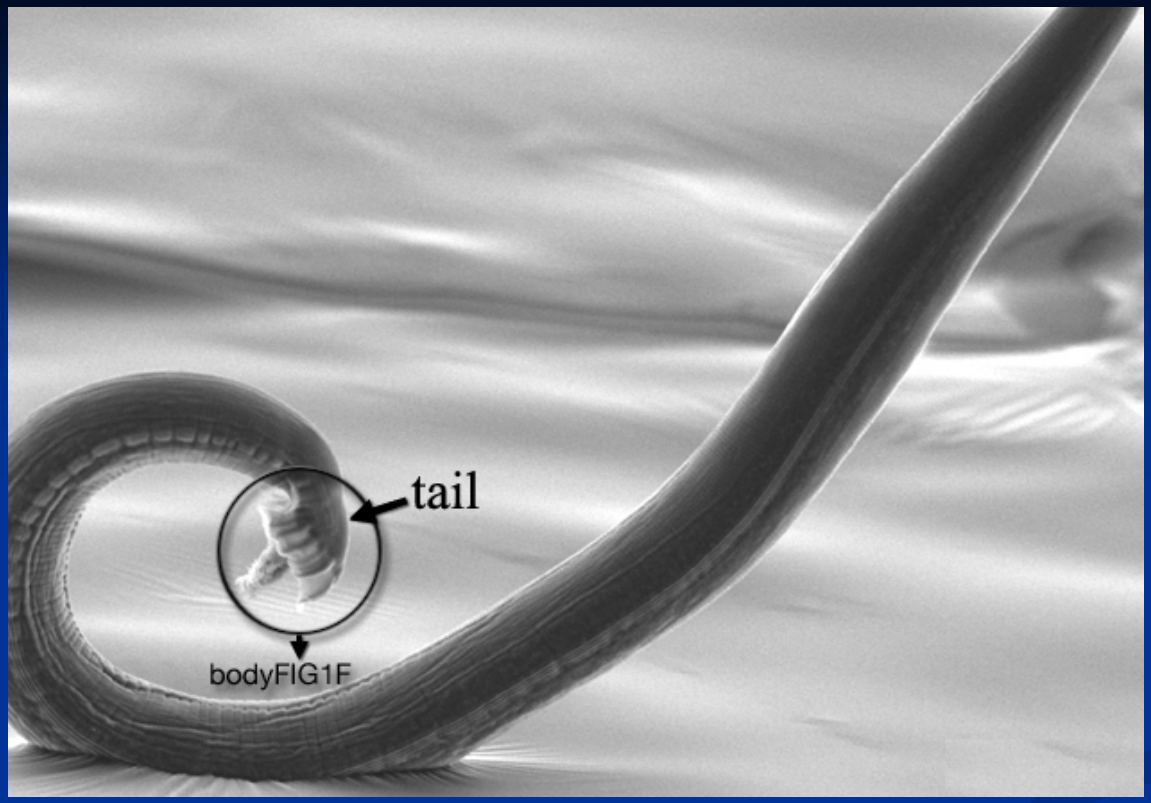
Dr. Samson Davis Padayatty
Asso. Professor, Department of Zoology
S. H. College, Thevara

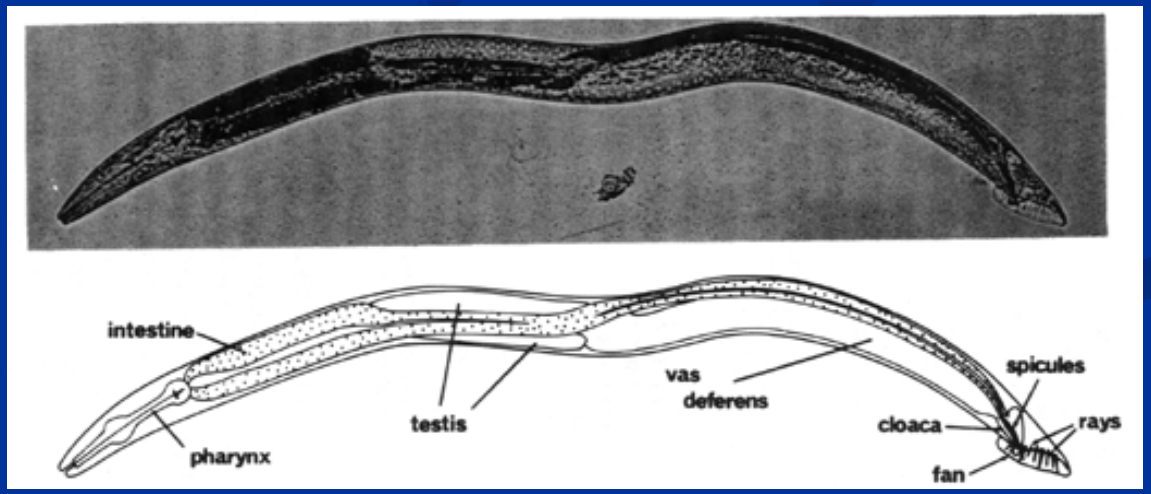
Caenorhabditis elegans

- a free-living parasitic nematode
- 1mm long and transparent – internal organs can be observed
- lives in soil
- across most of the temperate regions
- feeding on microbes such as bacteria
- hermaphrodite sex - self fertilization
- rare males (0.05%) – cross fertilization
- life span 2-3 weeks
- one generation in 4 days

Caenorhabditis elegans

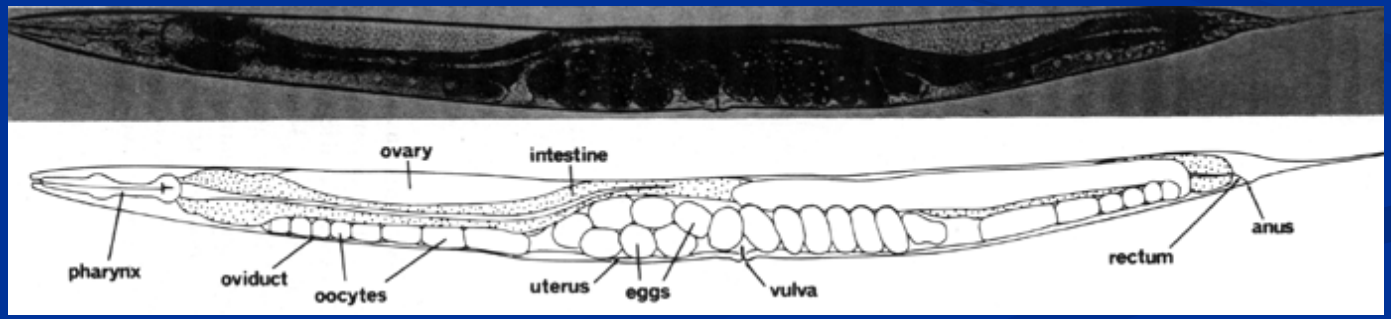
MALE



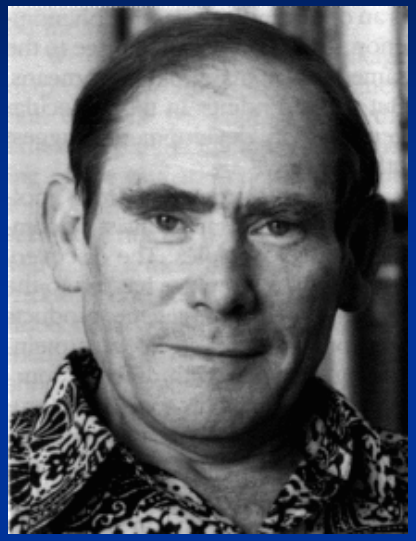


Caenorhabditis elegans

HERMAPHRODITE



Caenorhabditis elegans



Sydney Brenner

- 1965 - Sydney Brenner
  developed the use of this worms as model organism
- 1974 - Brenner introduced mutants
- 1976 - Sulson and Horwitz determined
  postembryonic cell lineages
- 1983 - Deppe et al., Sulson et al.
  complete embryonic cell lineages
- 2002 - Nobel Prize for Brenner, Sulson, Horwitz
- 1991-98 - RNAi and miRNA discovered in worms
  Nobel Prize: Fire, Mello 2006
- 1998 - First animal, complete genome sequenced

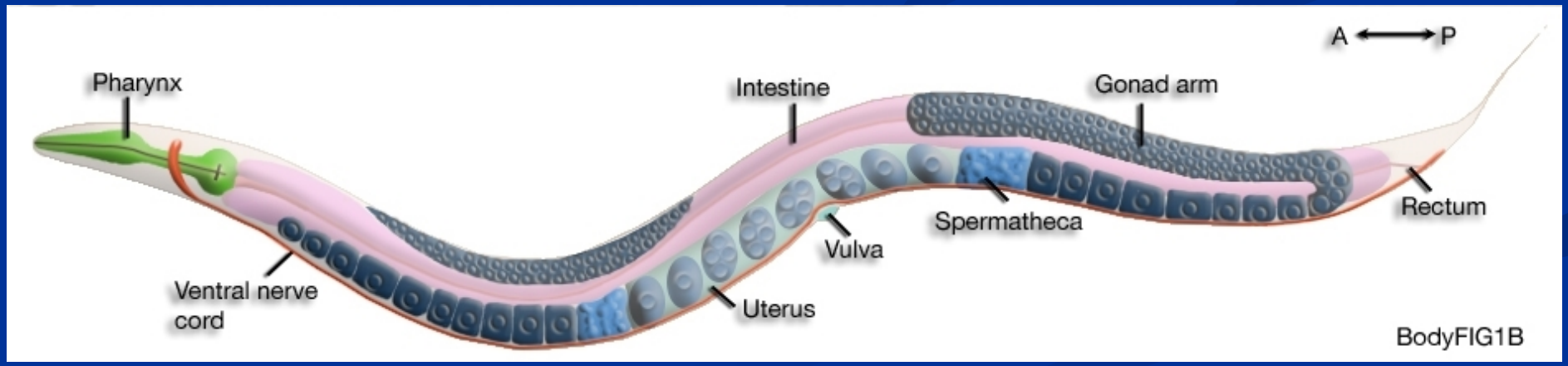
Now uses as model organism for studies in
genetics, developmental genetics, physiology, neurology, etc

more plus points…….

Caenorhabditis elegans

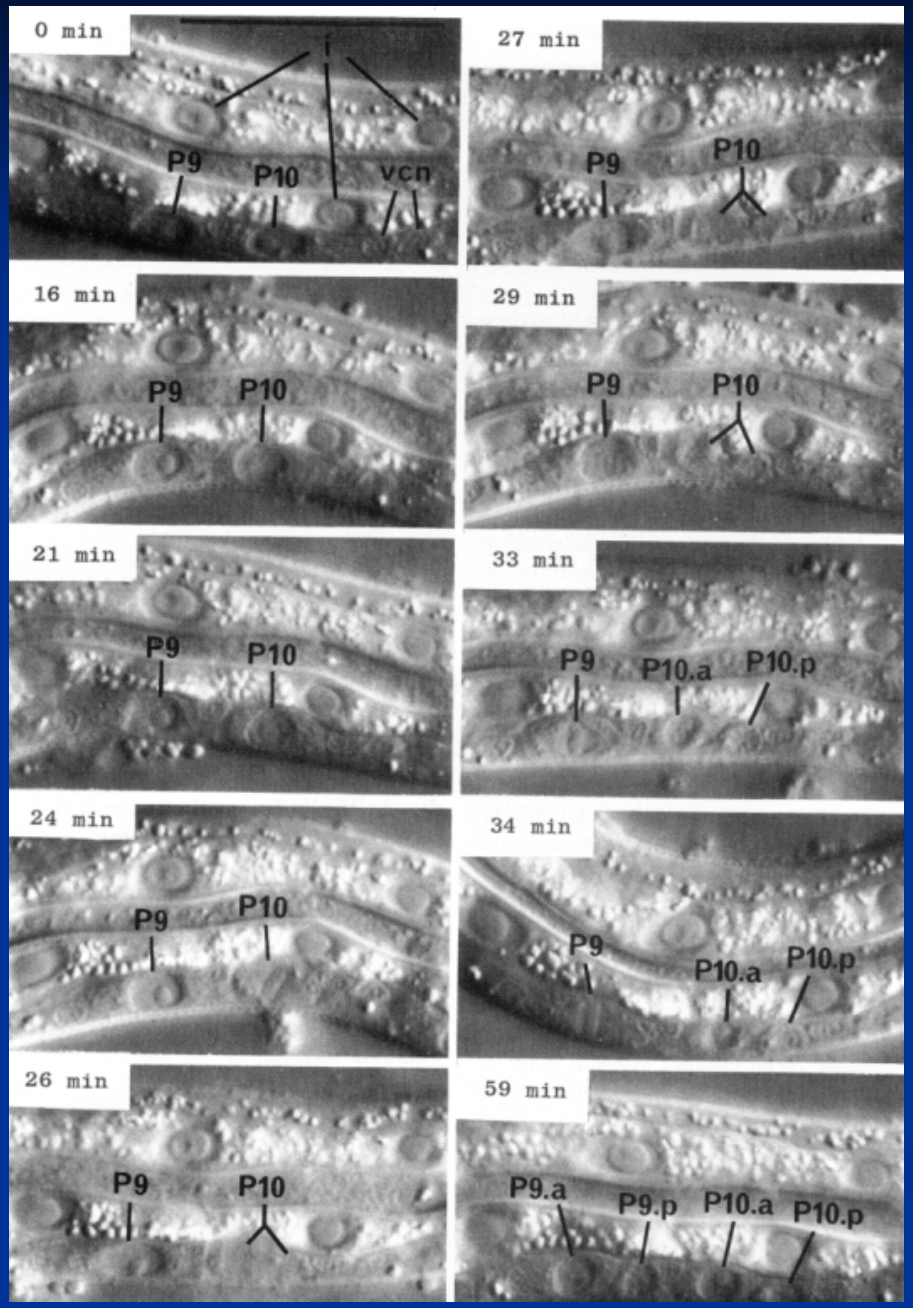
Being a nematode fixed number of cells
959 somatic cells in hermaphrodites and 1031 in males

Transparent body



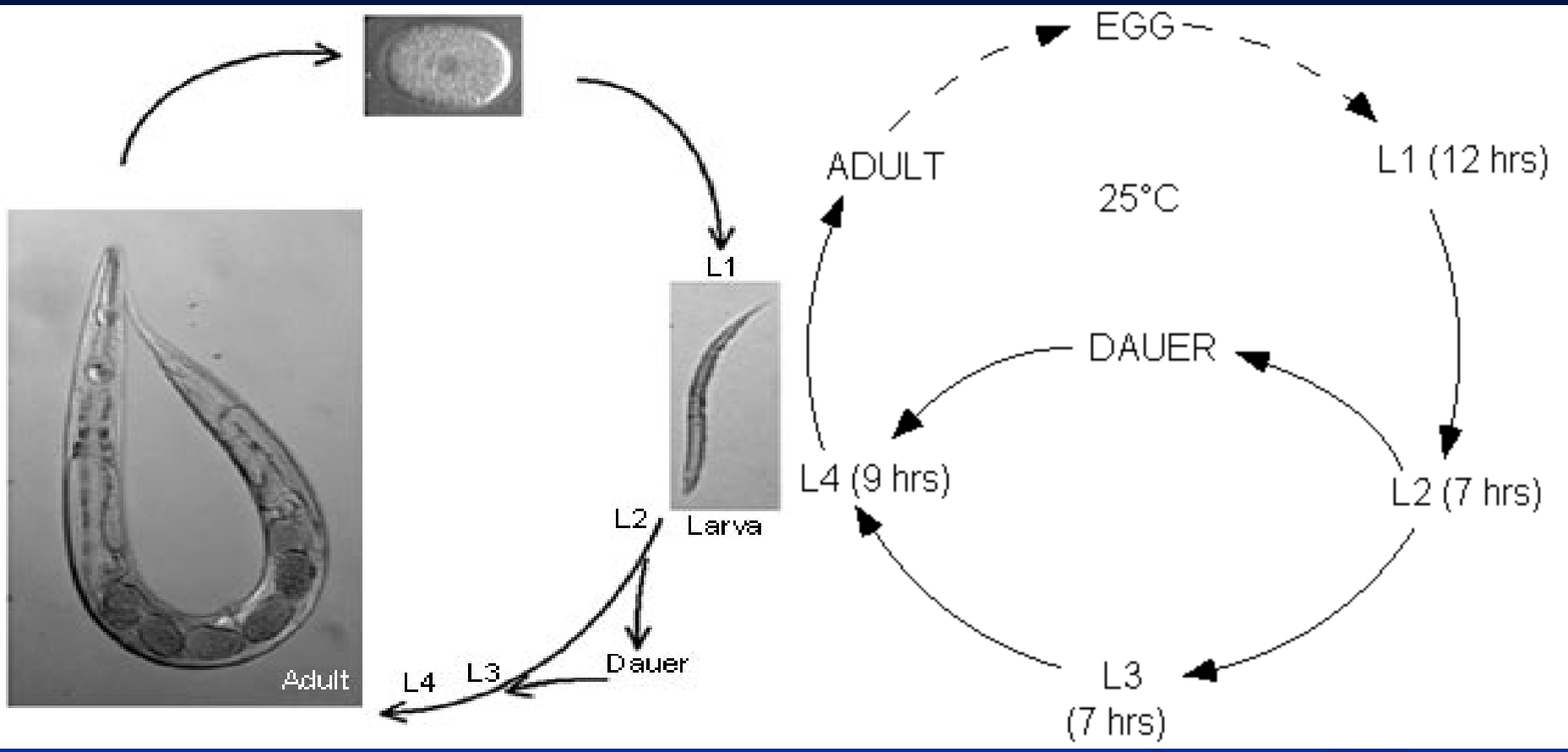
Anatomy of *C. elegans*

Direct observations of cell division through Nomarski microscope



Sequential photographs of
0 min, interphase;
16 and 21 min, P10 prophase;
24 min, P10 metaphase;
26 min 10 anaphase;
27 mm, P10 telophase;
29 min, P9 prophase;
33 and 34 min, P9 metaphase.

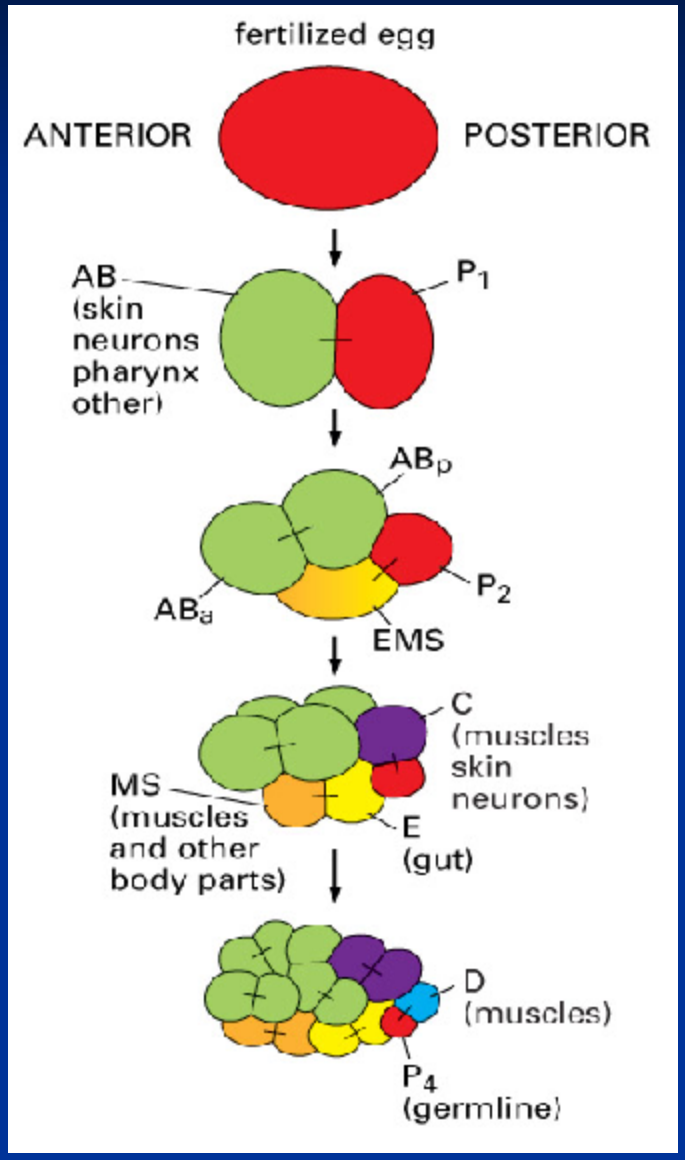
Life cycle of *C. elegans*



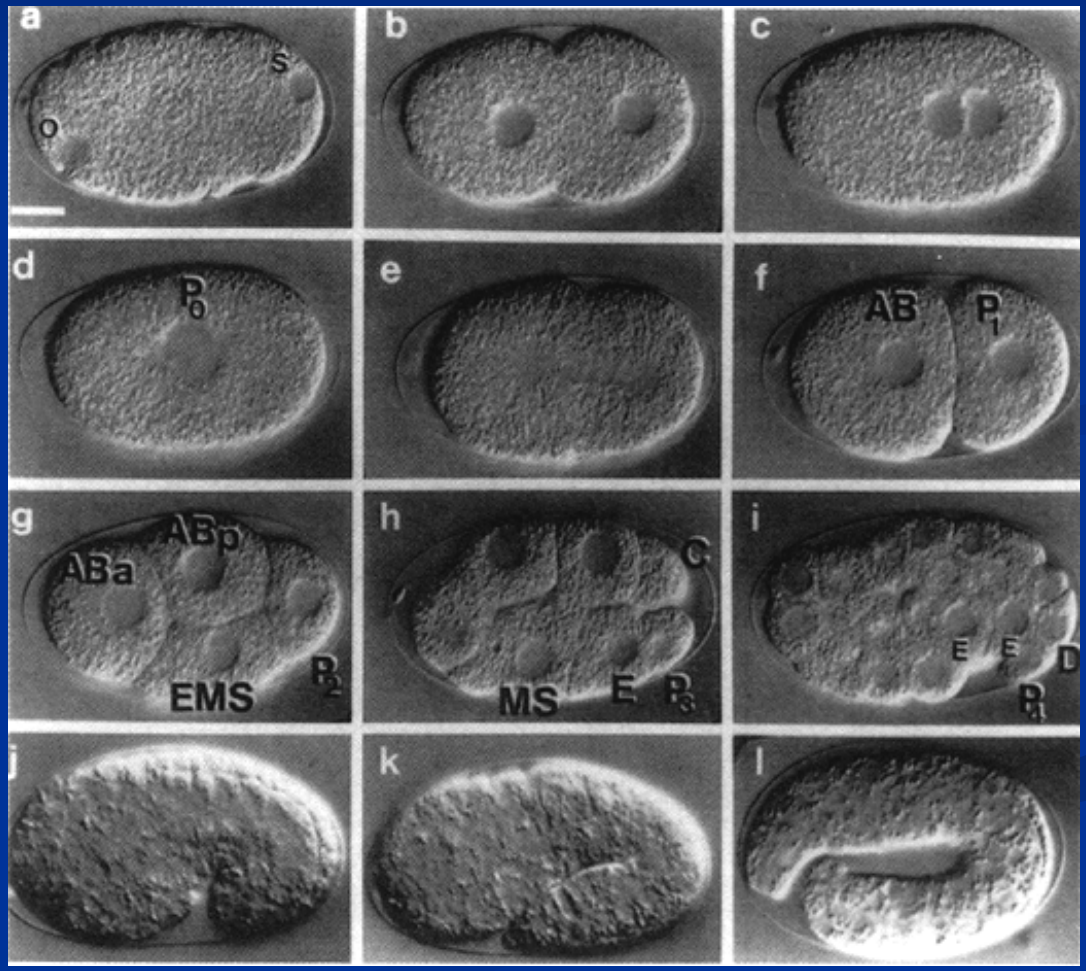
temperature-dependent, egg to egg-laying parent in in 5.5 days at 15°C, 3.5 days at 20°C, and 2.5 days at 25°C, when a worm encounters shortage of food, it enters

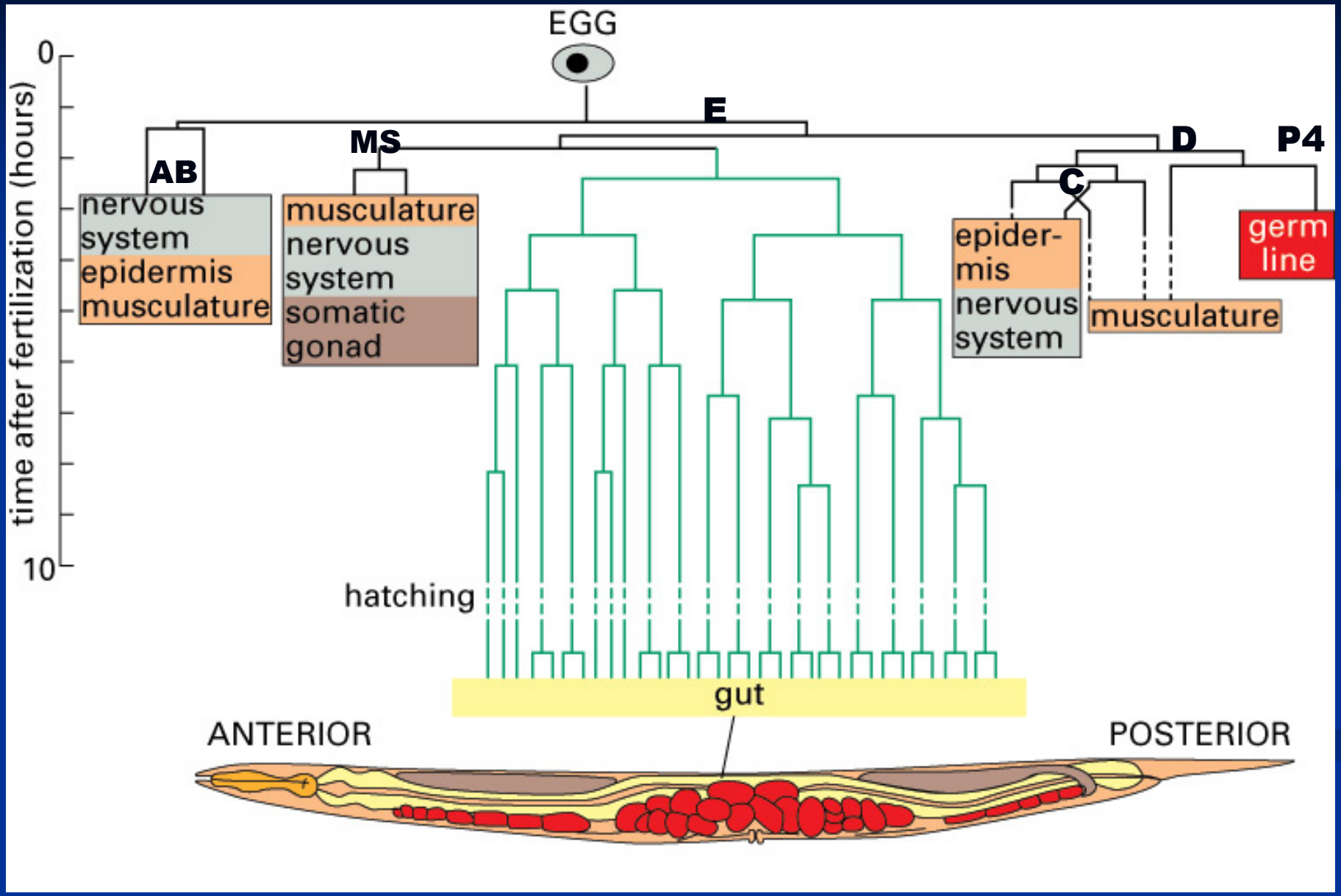
the developmental pathway to form the dauer larva that can survive for months without food.

Developmental pattern in *C. elegans*

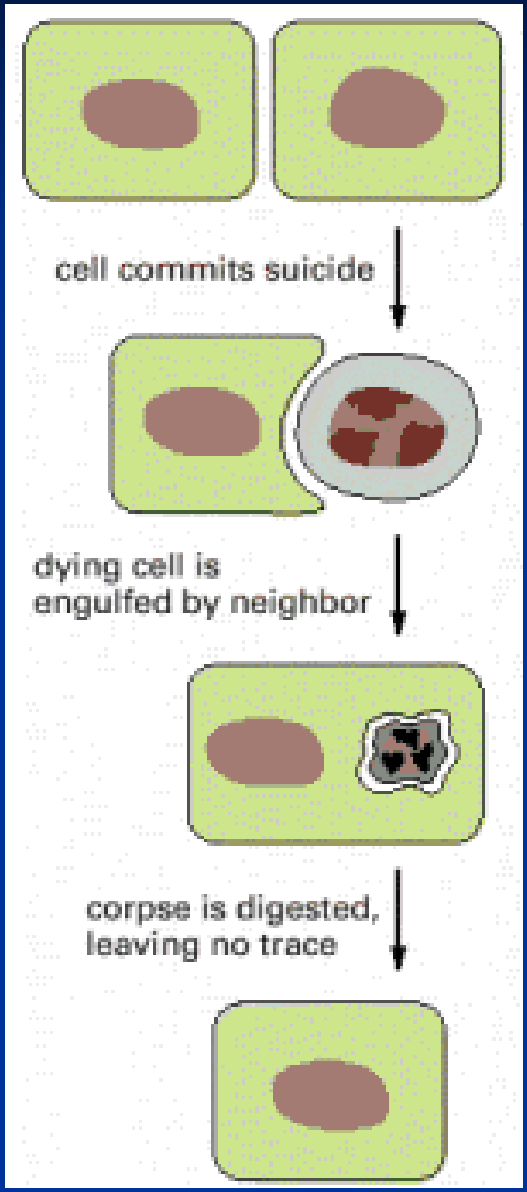


AB, MS, E, C, D and P4 are
Founder cells




EGG
0
time after fertilization (hours)
10
E
AB
MS
C
D
P4
nervous system
epidermis
musculature
musculature
nervous system
somatic gonad
epider-mis
nervous system
musculature
germ line
hatching
gut
ANTERIOR
POSTERIOR

The phenomenon Programmed Cell Death was discovered in *C. elegans*



- Specific cells with diverse developmental origins undergo programmed cell death at specific times during development.
- Programmed cell death is characterized by a series of specific morphological changes.
- There must be genes that control both the decision to express that fate and the execution.

1982 - "Programmed cell death" (Horwitz et al.)
Nobel Prize Brenner, Sulson, Horwitz 2002

miRNAs (micro RNA) were discovered in ***C. elegans***

C. elegans has over 100 miRNAs, humans have over 200

RNAi (RNA interference) was discovered in *C. elegans*.

RNAi is a process of post-transcriptional gene silencing

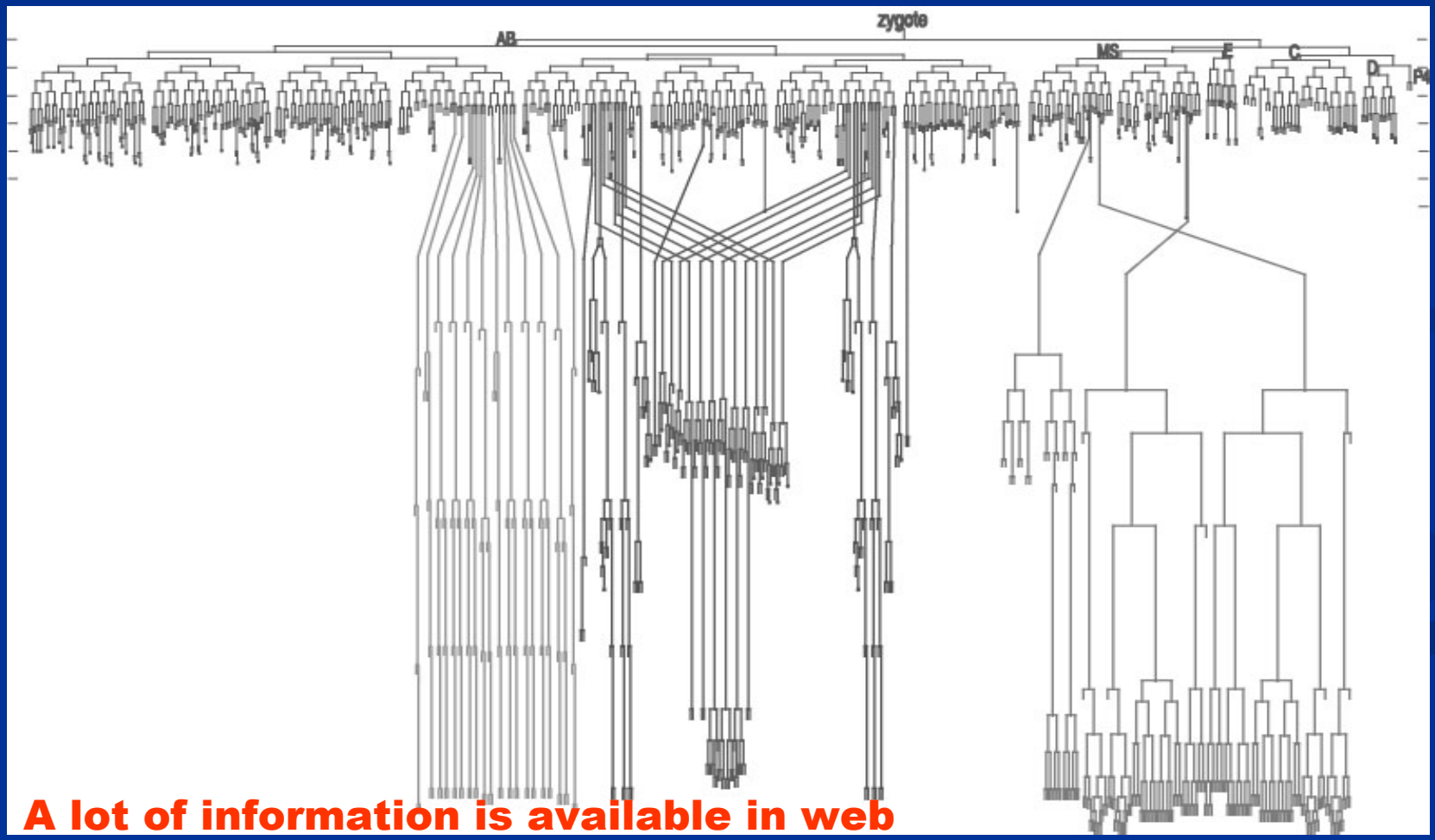
1991-98 RNAi and miRNA discovered in worms.

•Nobel Prize: Fire, Mello 2006

C. Elegans - first animal genome sequenced

more plus points……

- 5 autosomes I-V and XX(6 total) in hermaphrodites and XO in males
- Genome completely sequenced (100X6 bps) as 19,000 genes - 1998



A lot of information is available in web

In brief.....

Caenorhabditis elegans

A great model system for genetic analysis

- **Rapid life cycle, small size, easy to grow in lab, self fertilization, crossing with males**
- **Small genome(no redundancy) and simple anatomy (only about 1000 cells, transparent)**
- **Constant cell number in the same position make the animal suitable for studying development**
- **Limited number of chromosomes and completely sequenced genome**

Limitations of *C. elegans*.

- Biochemistry difficult
- No cell lines available
- dissection of specific tissues is unrealistic