

<http://www.GeoChemBio.com>:

***Drosophila melanogaster*, fruit fly**

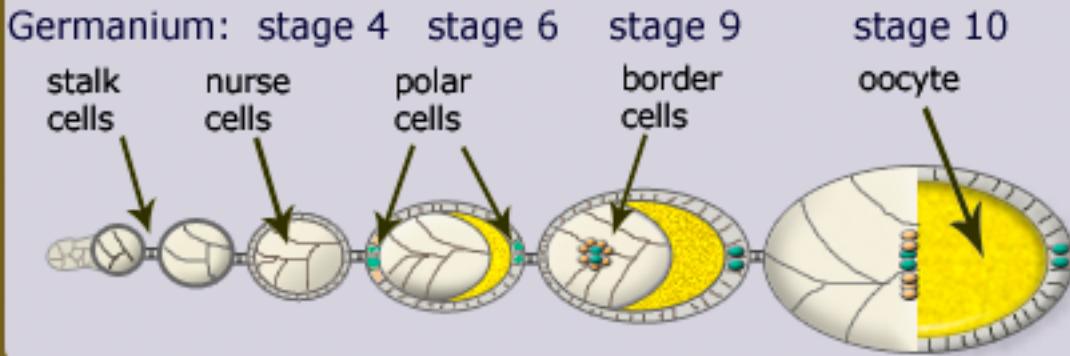
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Taxonomy

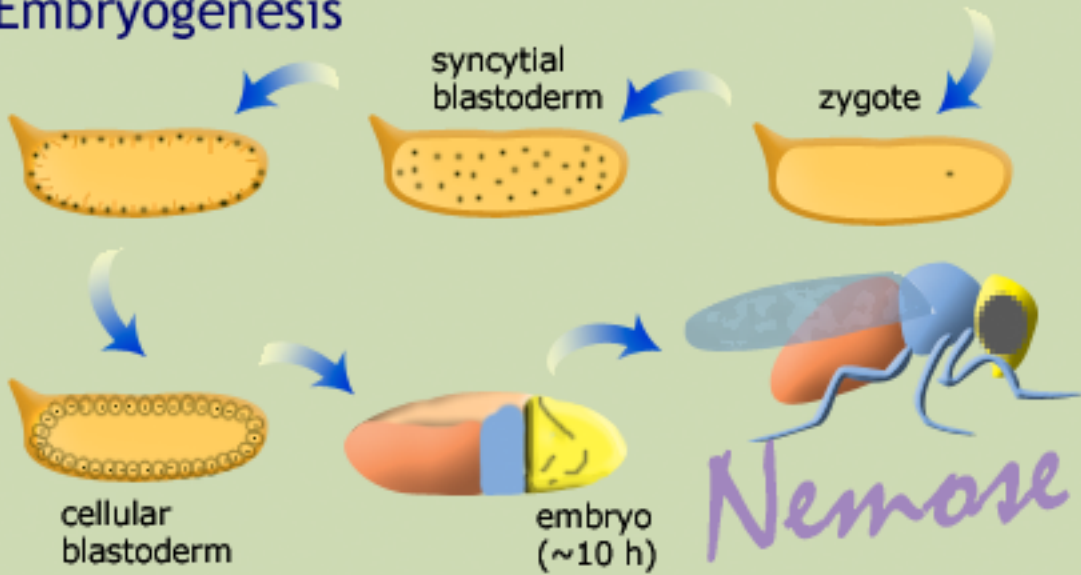
cellular organisms - Eukaryota - Fungi/Metazoa group - Metazoa - Eumetazoa - Bilateria
- Coelomata - Protostomia - Panarthropoda - Arthropoda - Mandibulata - Pancrustacea
- Hexapoda - Insecta - Dicondylia - Pterygota - Neoptera - Endopterygota - Diptera -
Brachycera - Muscomorpha - Eremoneura - Cyclorrhapha - Schizophora - Acalyptratae
- Ephydroidea - Drosophilidae - Drosophilinae - Drosophilini - Drosophilina -
Drosophiliti - Drosophila - Sophophora - melanogaster group - melanogaster subgroup
- Drosophila melanogaster

Drosophila melanogaster development

Oogenesis



Embryogenesis



Brief facts

- *Drosophila melanogaster* (Latin: "black-bellied dew-lover") is a fly, about 3 mm long, which can be frequently seen around spoiled fruit.
- *Drosophila melanogaster* is the most studied model organism in biological research for several reasons. To name just a few: the fruitfly is small and readily reproducing under lab conditions, it has only 4 pairs of chromosomes, a huge number of mutants is commercially available, etc.
- The *Drosophila* genome sequence was completed and published in 2000.

Developmental stages (life cycle)

The developmental period of *Drosophila melanogaster* varies with temperature. The shortest developmental time (egg to adult), 7 days, is achieved at 28°C. Under ideal conditions (at 25°C) the cycle takes about 8.5 days.

- oogenesis

oogenesis takes place inside female ovaries; each ovary contains more than a dozen ovaries which are an assembly line for new egg chambers: the maturation of the oocyte takes place inside a ovarium surrounded by follicle cells

- ovarium stages 1-3

follicle cells envelop the maturing, pre-fertilized egg; nurse cells provide nutrients the embryo will require, storing them in the yolk; approximately 10-14 of the somatic cells cease proliferation and differentiate into stalk cells that form a bridge between the consecutive ovaries, and polar cells at the anterior and posterior poles of each chamber

- ovarium stages 4-5

follicle and nurse cells proliferate

- ovarium stages 6-7

a single cystocyte (the precursor cell of the egg), which contains a microtubule organizing center (MTOC), develops into

the oocyte; nurse cells continue to grow and accumulate yolk material

- germanium stages 8-9

a small group of border cells, non-germ cell in origin, that have lagged behind at the anterior end of the developing cystoblast-becoming-oocyte, pass through three nurse cell junctions to arrive at the anterior end of the oocyte; the border cells are implicated in the terminal system, which creates and maintains anterior-posterior polarity in the egg

- germanium stages 10-11

the follicle cells have matured and begun secretion of a vitelline membrane around the oocyte; the mature nurse cells flow their cytoplasmic contents in bulk into the oocyte

- egg

- unfertilized egg

mature eggs ovulate one at a time and pass into the uterus; once mated, females are able to release stored sperm from their seminal receptacles

- fertilized egg

sperm enter the micropyle while the egg is still in the uterus; the first meiotic division has begun and is still in progress when fertilization and ovulation occur;

females lay some 400 eggs (embryos), about five at a time, into rotting fruit or other decaying material

- embryo

- pronuclear fusion

Bownes stage 1, 0-15 min after fertilization

- cleavage

in *Drosophila* and other insects, cleavage involves repeated mitosis but without cytokinesis; the daughter nuclei remain suspended within the single egg compartment; after several thousand nuclei have been formed, they migrate to the margins of the egg; only then do plasma membranes form around each nucleus forming true cells

- preblastoderm

Bownes stage 2; mitotic cycles 1-9; 15-70 min after fertilization

- polar bud formation

Bownes stage 3; nuclear division 9; 70-90 min after fertilization; polar buds are formed around the nuclei located at the posterior pole of the embryo; the end of this stage is defined by appearance of a clear cytoplasmic rim at the periphery of the embryo

- syncytial blastoderm

Bownes stage 4; mitotic cycles 10-13; 90-130 min after fertilization; cellularization occurs by means of the introgression of membrane furrows to separate single blastoderm nuclei; blastoderm cells around the perimeter of the entire egg at this stage still share cytoplasm, through wide cytoplasmic bridges

- **cellular blastoderm**

Bownes stage 5; 130-180 min after fertilization; completion of cellularization of the blastoderm

- **gastrula**

- **meso- and endoderm**

Bownes stage 6; 180-195 min after fertilization; formation of meso- and endoderm

- **germ band extention**

Bownes stages 7-11; 195-440 min after fertilization; organogenesis and segmentation begin

- **germ band retraction**

Bownes stages 8-13; 200-620 min after fertilization

- **dorsal closure**

Bownes stages 14-15; 620-800 min after fertilization; dorsal closure; head involution; dorsal epidermal segmentation

- organogenesis

Bownes stages 16-17; 680-900 min after fertilization; final steps of organogenesis

- hatching

first instar larva hatches

- larval

- 1st instar larva

takes 1 day

- molting

- 2nd instar larva

takes 1 day

- molting

- 3rd instar larva

takes 2-3 days

- pupa

the larvae encapsulate in the puparium and undergo a four-day-long metamorphosis (at 25°C), after which the adults eclose (emerge)

- newly eclosed

young fly

- adult

females become receptive to courting males at about 8-12 hours after

emergence; during copulation males transfer hundreds of very long sperm in seminal fluid to the female; females store the sperm until eggs are ready to be fertilized

- **Alcoholic Anonymous for flies**

Fruit flies (*Drosophila* species) feed on overripe or rotting fruit and are frequently exposed to quite high ethanol concentrations. Despite of this, they display a range of alcohol-induced behaviors that are very similar to humans. At the beginning of the ethanol exposure flies become hyperactive, then, they lose their locomotor control and balance, and finally, they keel over and lie on their back (sleeping?). This was all well known. Most recent studies found that after daily administration of ethanol, drunk males express a novel type of sexual disinhibition: they exhibited active intermale courtship (wild fruit flies are highly heterosexual). The chronic ethanol exposure also affected male flies' behavior toward females. On one hand, it dramatically enhanced sexual arousal expressed in increased courtship activity, on the other hand, it drastically diminished sexual performance: approximately 35% of sober males copulated with females successfully, whereas only a small percentage of drunk males accomplished it. Rings true? (Lee HG et al. PLoS ONE. 2008 Jan 2; PMID: 18167550).

- **Coping with rejection**

Male fruit flies (*Drosophila* species) are passionate suitors. Male fly performs beautiful courtship rites in order to engage an attractive female: (1) he aligns himself so that to have a good look at her abdomen; (2) he reaches out and taps the female's abdomen with his foreleg; (3) he extends one of his wings perpendicularly out from his body and vibrate it to produce a "song", an alternating series of hums and bumping sounds; (4) he moves even closer and extends his proboscis to lick the female's genitals; (5) finally, he mounts the female and copulates with her. The scenario occurs when normal adult male courts a virgin female. If the female has already mated, she will reject

the male outright by extruding her ovipositor in his face. After such rejection male experiences "depression" - when placed with virgin and receptive female he will attempt to court her only about 25% as much as a naive male would. This depression can last for several hours. Mutant with learning disabilities may not have this depression at all - after the scornful rejection by mated fly he will court another fly (either mated or virgin) immediately. Sounds familiar?

- **Reward/punishment on learning**

Fruit flies (*Drosophila* species) can be taught to associate an odor with either a punitive shock or a sugar reward. After the training flies show a preferential avoidance of, or an attraction to, the odor without the reinforcement. Learning speed is about the same for both types of training, however, memory based on reward training persists much longer than memory based on punishment - for days rather than for several hours. Researchers created a lot of mutants that behave differently, for example, there are flies that learn normally but forget quickly and flies that learn slowly but remember normally. Which combination is better?

References

PubMed articles

- [Free full-text articles: major topic "Drosophila"](#)

Websites

- [UNSW Embryology: *Drosophila* Development](#)
 - [The Interactive Fly: Stages of Development and Mitotic Domains](#)
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