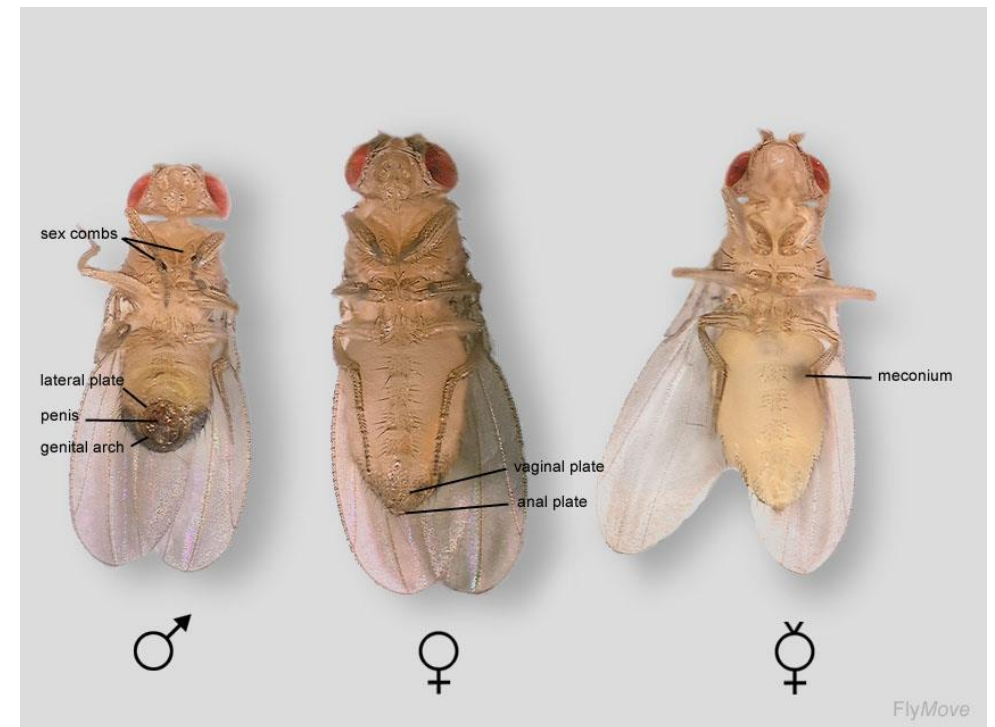
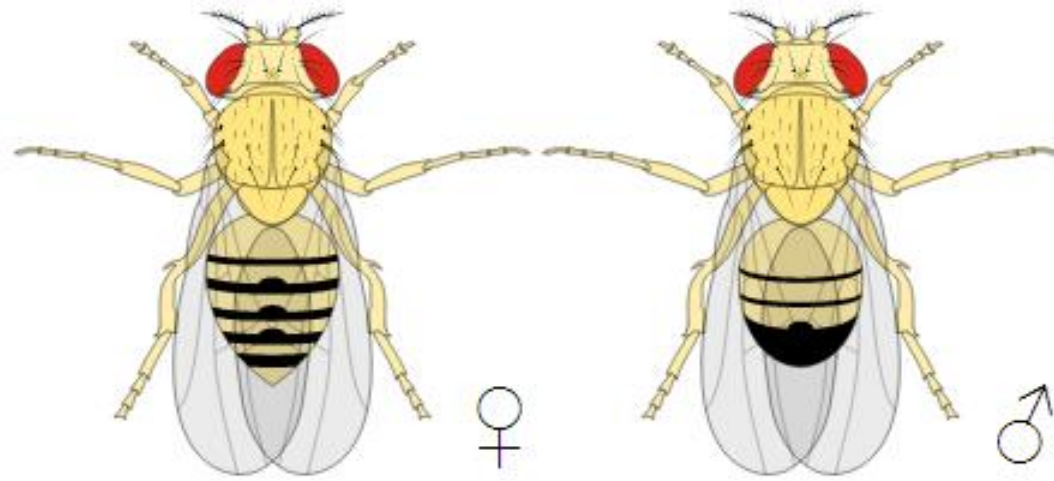


Methods in developmental biology

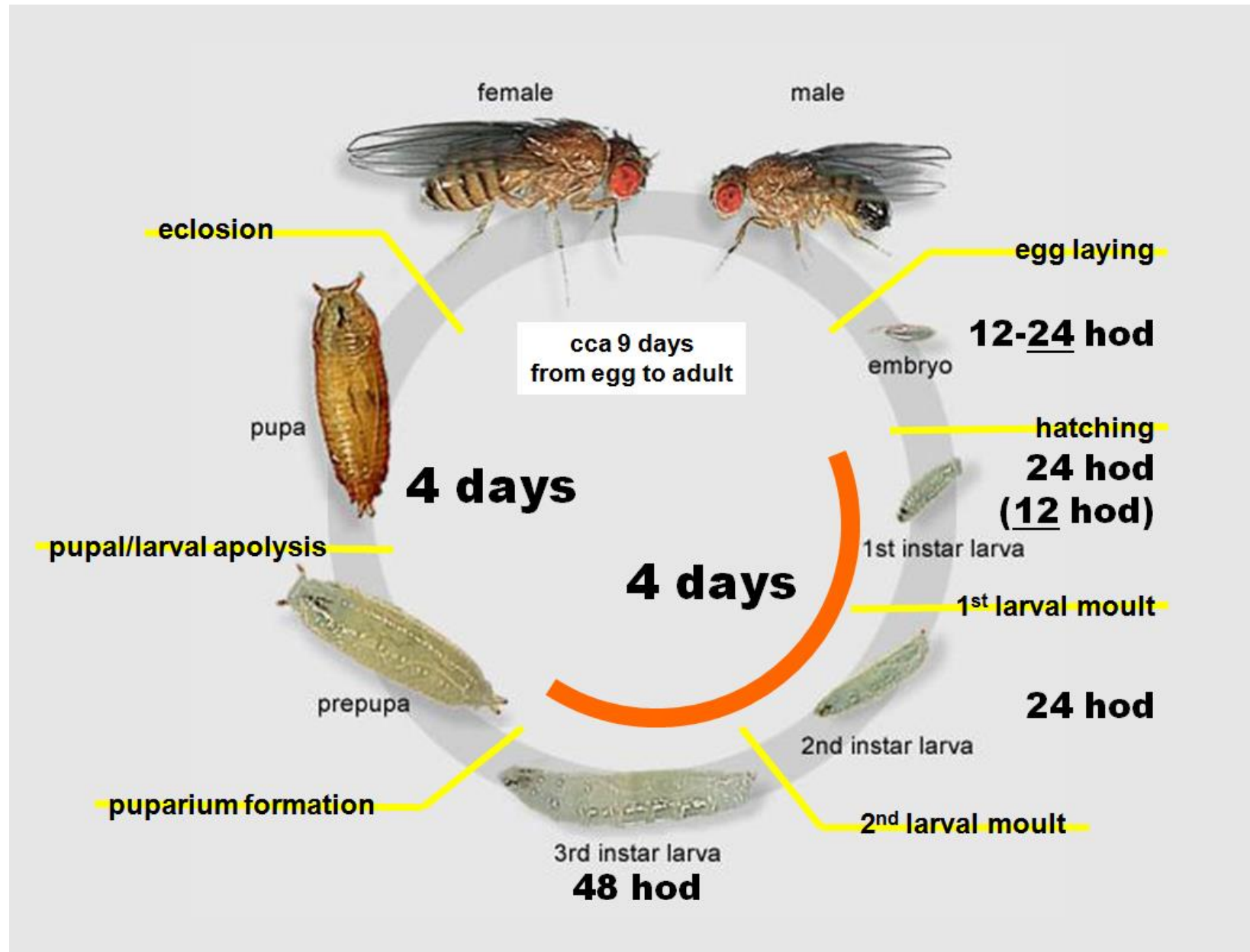
Drosophila melanogaster

Drosophila melanogaster - common fruit fly (Diptera)



Life cycle

- **short generation time:**
the shortest, seven days at 28 °C
(30 °C: 11 days; 18 °C: 19 days;
12 °C: 50 days)
- lifespan 30 days at 29 °C
- **high number of model animals:**
females produce about 500 eggs
in 10 days
- embryonic development
- embryonic development (comm.)
- Eric Wieschaus talks: Patterning
Development in the Embryo



Advantages of *Drosophila* model

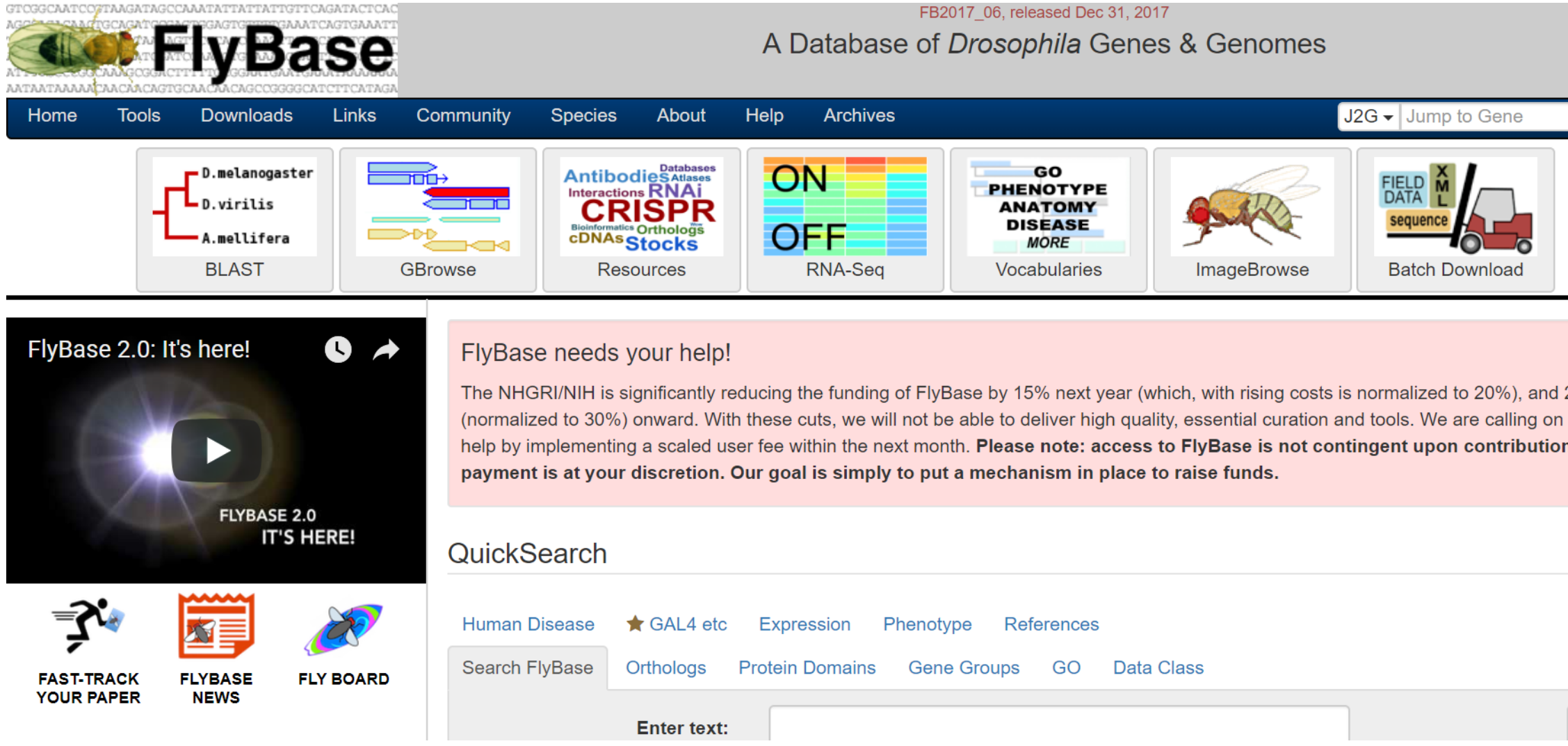
- one of the most studied organisms
 - ease of breeding, space-saving, low cost
 - well-known fate of individual cell populations
 - genetically tractable
 - at the molecular and cellular level, many developmental processes are similar to other species
-
- the basic model of eukaryotic genetics, embryogenesis, studies of maternal and homeotic genes, sex determination
 - 4 pairs of chromosomes: female XX (1X:1A), male XY (1X:2A)
 - haploid genome: 1.65×10^8 base pairs
 - fertilization occurs in the oviduct, the eggs are laid as diploid
 - superficial cleavage of eggs
 - recombination occurs only in females

What do we need for fly handling?

- vials / bottles with caps
- fly food (water, yeast, syrup or sugar, agar, mashed potato powder or soy flour, ascorbic acid, fungicide Nipagin); formerly, crushed banana peel with yeast
- brushes and pad for manipulation
- anesthesia (CO₂, cold, ether, FlyNap[®] Anesthetic Kit)
- stereomicroscope



FlyBase – gene database and availability of fly lines



The screenshot displays the FlyBase website homepage. At the top, a navigation bar includes 'Home', 'Tools', 'Downloads', 'Links', 'Community', 'Species', 'About', 'Help', and 'Archives'. A search box on the right contains 'J2G' and a 'Jump to Gene' button. Below the navigation bar is a row of six service tiles: 'BLAST' (with a phylogenetic tree), 'GBrowse' (with genomic track icons), 'Resources' (listing various databases and CRISPR), 'RNA-Seq' (with an ON/OFF heatmap), 'Vocabularies' (with GO, Phenotype, Anatomy, Disease), and 'ImageBrowse' (with a fly illustration). Below this is a large pink notice: 'FlyBase needs your help!'. To the left of the notice is a video player for 'FlyBase 2.0: It's here!'. Below the video are three icons for 'FAST-TRACK YOUR PAPER', 'FLYBASE NEWS', and 'FLY BOARD'. At the bottom is a 'QuickSearch' section with a search input field and a list of filters: 'Human Disease', '★ GAL4 etc', 'Expression', 'Phenotype', 'References', 'Orthologs', 'Protein Domains', 'Gene Groups', 'GO', and 'Data Class'.

FlyBase needs your help!

The NHGRI/NIH is significantly reducing the funding of FlyBase by 15% next year (which, with rising costs is normalized to 20%), and 2 (normalized to 30%) onward. With these cuts, we will not be able to deliver high quality, essential curation and tools. We are calling on help by implementing a scaled user fee within the next month. **Please note: access to FlyBase is not contingent upon contribution payment is at your discretion. Our goal is simply to put a mechanism in place to raise funds.**

QuickSearch

Human Disease ★ GAL4 etc Expression Phenotype References

Search FlyBase Orthologs Protein Domains Gene Groups GO Data Class

Enter text:

<http://flybase.org/>

FlyExpress – gene expression maps



FlyExpress 7

Home

About

FAQ

Feedback

myFX

HitList (0)

Search the Image Database

Search our extensive digital library database for *in situ* embryonic images.

Search by gene symbol: ⓘ

Search using a PubMed ID: ⓘ

Search using an image ID: ⓘ

FBim

Search using keywords: ⓘ

Search using ontology: ⓘ

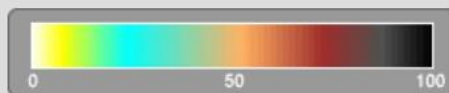
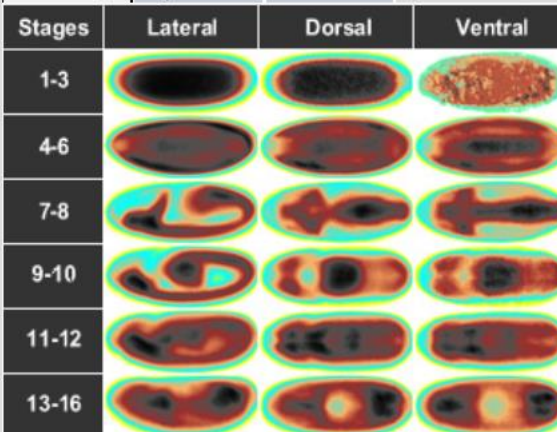
BDGP Fly-FISH

adult foregut precursor
adult hindgut precursor
adult midgut precursor
adult muscle precursor primordium
adult salivary primordium
amnioserosa

Search for Co-Expressed Genes

Genomewide Expression Maps (GEMs) provide spatially aggregated levels of genome-wide expression for each pixel at a given stage and orientation. Click any GEM to begin your fine-tuned search for co-expressed genes. ⓘ

BDGP Fly-FISH PubMed



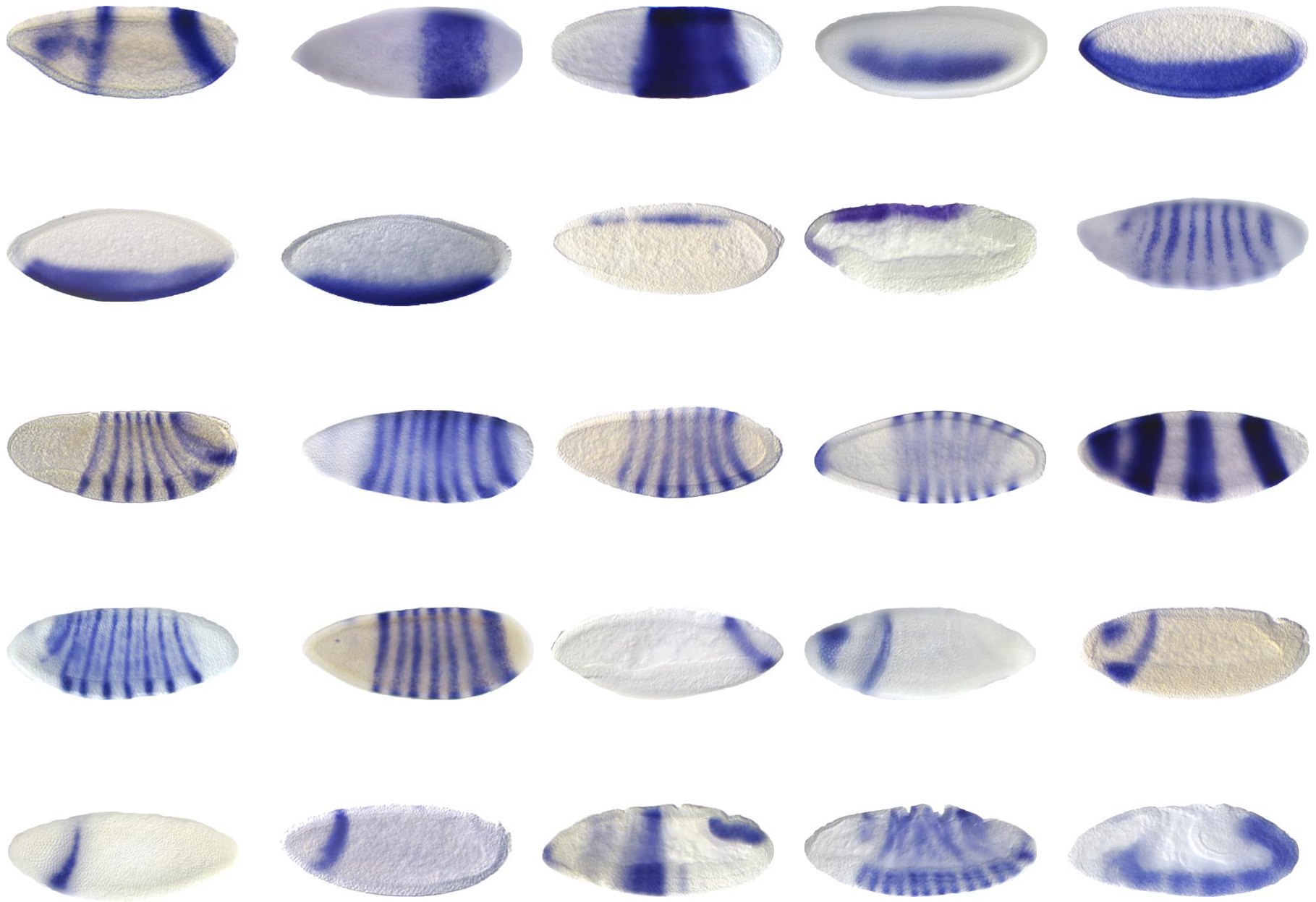
% of Genes

Analyze Gene Lists

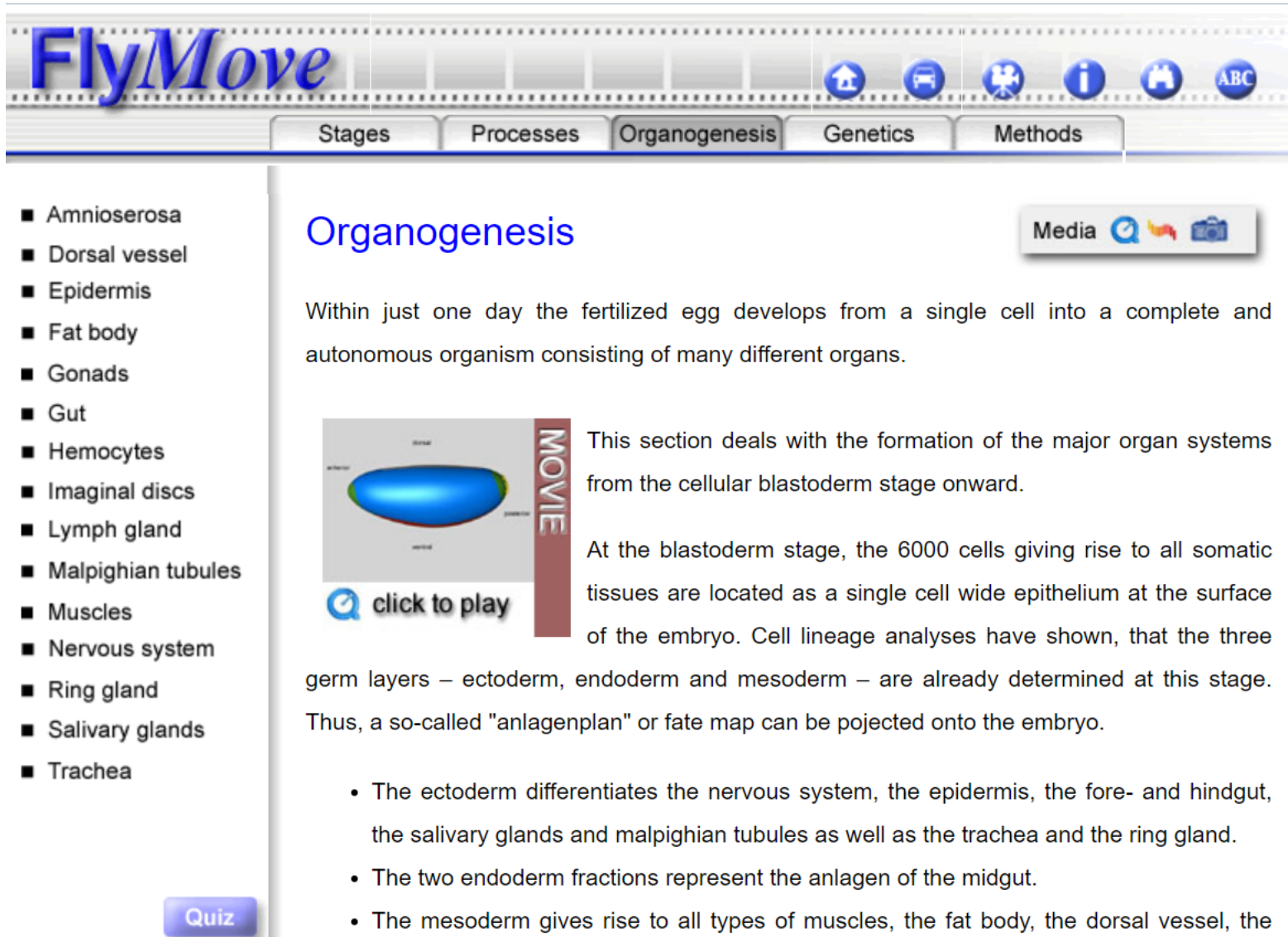
Enter a list of *Drosophila melanogaster* gene symbols or FlyBase FBgn accessions. Separate entries with commas, spaces, or line breaks.

 ⓘ

Upload a list (TXT or CSV) of gene symbols or FBgn accessions. ⓘ



FlyMove – developmental processes



The screenshot shows the FlyMove website interface. At the top, the logo "FlyMove" is displayed in a stylized blue font. Below the logo is a navigation bar with tabs for "Stages", "Processes", "Organogenesis", "Genetics", and "Methods". The "Organogenesis" tab is currently selected. To the right of the navigation bar are several icons: a home icon, a car icon, a video camera icon, an information icon, a person icon, and an "ABC" icon. Below the navigation bar is a sidebar on the left containing a list of anatomical structures, each preceded by a small square bullet point. The main content area on the right is titled "Organogenesis" in blue text. Below the title is a "Media" button with icons for a magnifying glass, a hand, and a camera. The text below the title describes the development of the embryo from a single cell to a complete organism. A "click to play" button is visible next to a small image of a fly embryo. The text explains that the three germ layers (ectoderm, endoderm, and mesoderm) are determined at the blastoderm stage, and a fate map can be projected onto the embryo. A list of bullet points follows, detailing the differentiation of these germ layers into various tissues and organs.

Organogenesis

Media

Within just one day the fertilized egg develops from a single cell into a complete and autonomous organism consisting of many different organs.

click to play

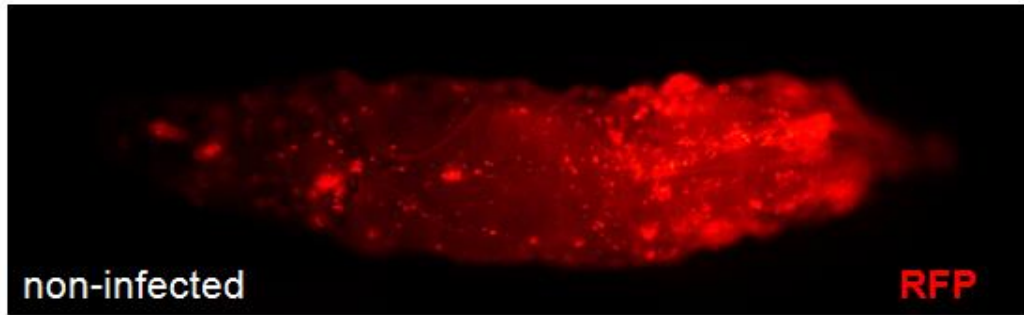
This section deals with the formation of the major organ systems from the cellular blastoderm stage onward.

At the blastoderm stage, the 6000 cells giving rise to all somatic tissues are located as a single cell wide epithelium at the surface of the embryo. Cell lineage analyses have shown, that the three germ layers – ectoderm, endoderm and mesoderm – are already determined at this stage. Thus, a so-called "anlagenplan" or fate map can be projected onto the embryo.

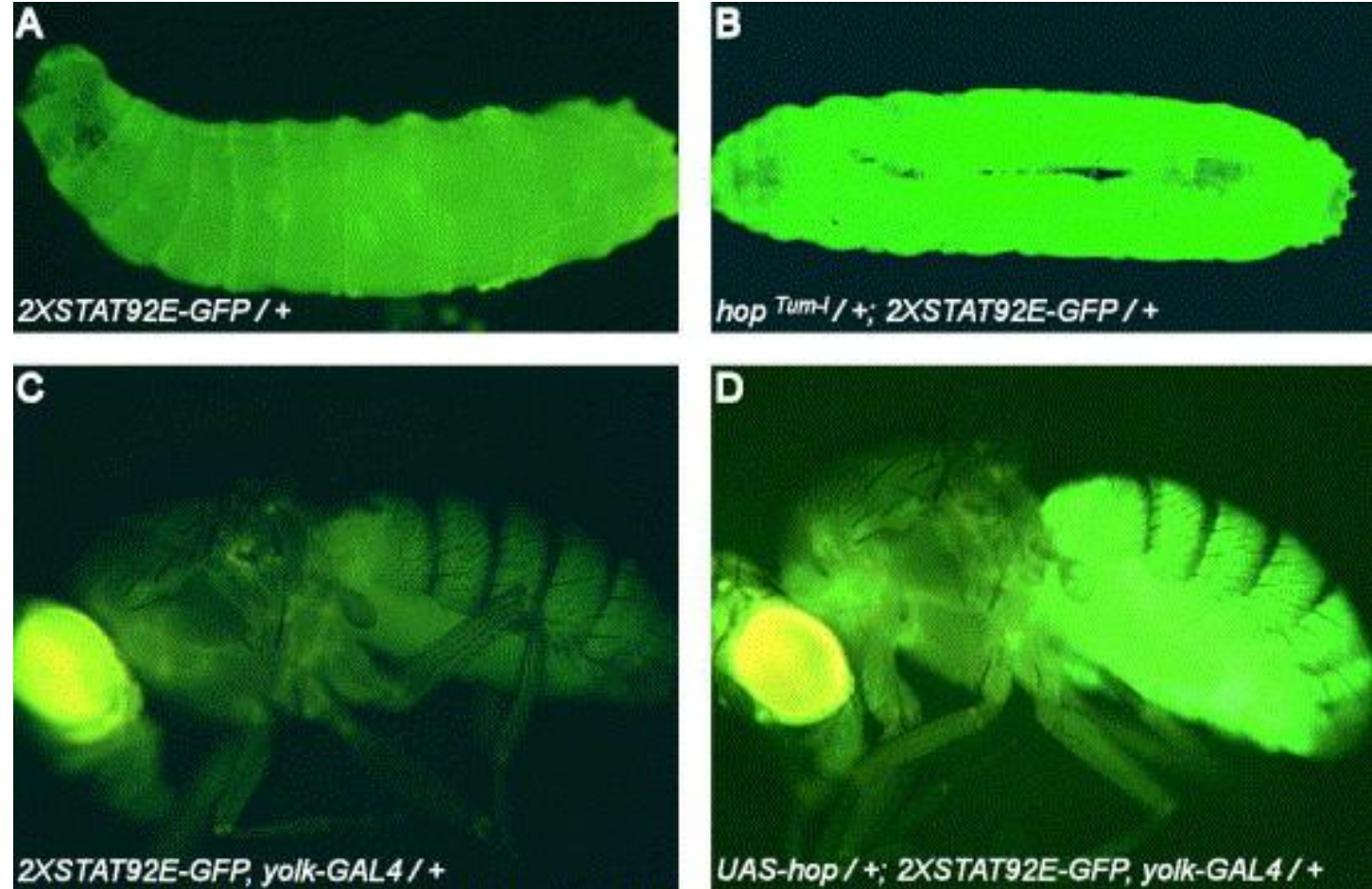
- The ectoderm differentiates the nervous system, the epidermis, the fore- and hindgut, the salivary glands and malpighian tubules as well as the trachea and the ring gland.
- The two endoderm fractions represent the anlagen of the midgut.
- The mesoderm gives rise to all types of muscles, the fat body, the dorsal vessel, the

Reporter lines

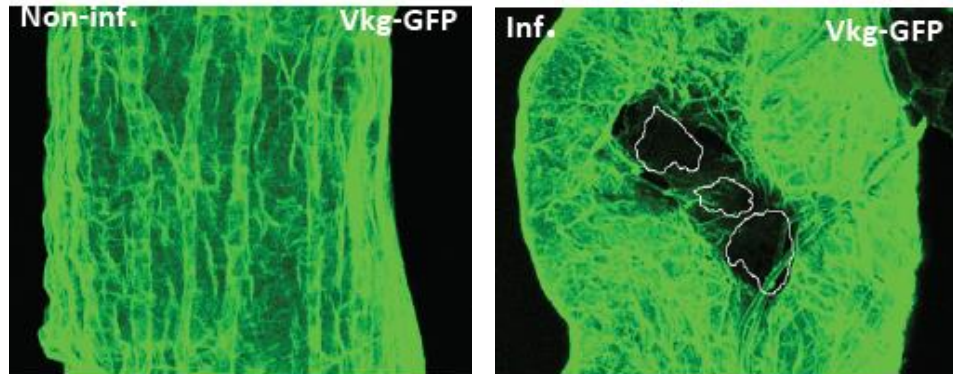
Haemocyte reporter line (hml-Gal4 UAS-RFP)



STAT pathway reporter line (STAT92E-GFP)



Collagen visualisation (Vkg-GFP)



Bach et al. (2007) GFP reporters detect the activation of the *Drosophila* JAK/STAT pathway *in vivo*. <https://doi.org/10.1016/j.modgep.2006.08.003>

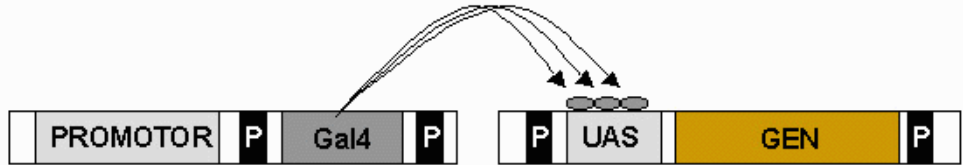
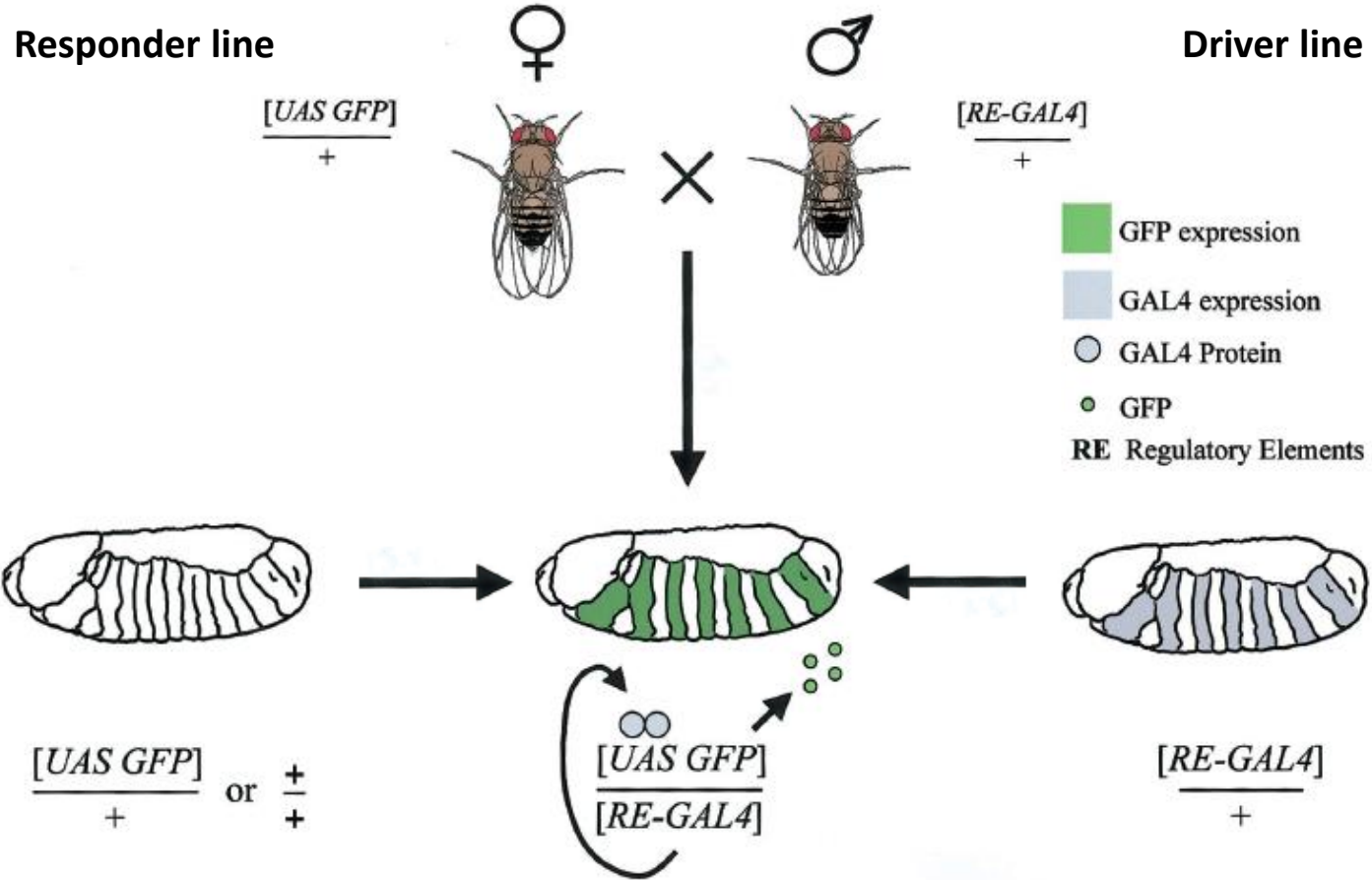
UAS/Gal4 system for targeted gene expression

„driver line“

- specific promotor mediates spatial and temporal synthesis of Gal4
- Gal4 binds to DNA and activates transcription

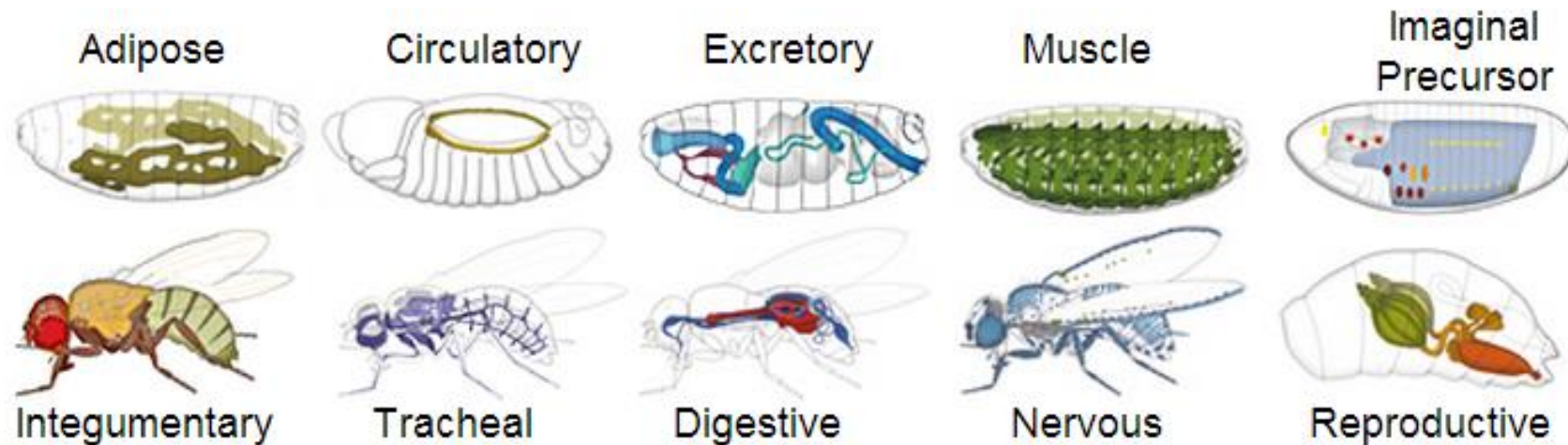
„responder line“

- **Upstream Activating Sequences** bind Gal4 protein
- RNAi construct / GFP / copy of the target gene – its transcription is regulated by UAS which require Gal4 binding



UAS/Gal4 system for targeted gene expression – driver lines

- Actin-Gal4 (ubiquitous expression)
- hemolectin-Gal4 (embryonic/larval haemocytes; no lamellocyte expression observed)
- Hemese-Gal4 (haemocytes, embryonic/larval lymph gland)
- Lz-Gal4 (crystal cells)
- PPL-Gal4 (embryonic and larval fat body)
- NP1-Gal4 (gut)



UAS/Gal4 system for targeted gene expression

- **knock-down** (UAS-RNAi, UAS-rpr), **over-expression** (UAS-gene sequence) or **visualisation** of target gene expression
- allows spacial and temporal control of gene expression (Gal4 drivers available both tissue and time-specific; eg. Bloomington)
- allows the maintenance of lethal mutations and mutations causing sterility (genotype is split into two fly lines and the harmful effect will not appear until both lines are crossed at 29 °C)

Critical steps of the use:

- the sequence of regulated gene must be known
- off-target effects
- rearing the flies at 29 °C
- non-complete knock-down (leaky expression)

The Nobel Prize in Physiology or Medicine 1995

The Nobel Assembly at the Karolinska Institute in Stockholm, Sweden, has awarded the Nobel Prize in Physiology or Medicine for 1995 to **Edward B. Lewis, Christiane Nüsslein-Volhard and Eric Wieschaus** for their discoveries concerning “**the genetic control of early embryonic development**”.

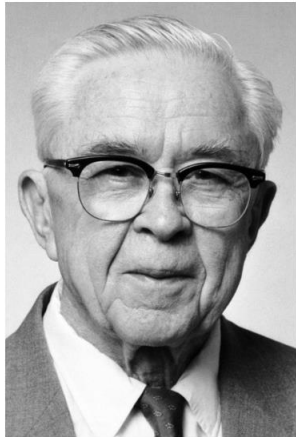


Photo from the Nobel Foundation archive.

Edward B. Lewis

Prize share: 1/3



Photo from the Nobel Foundation archive.

Christiane Nüsslein-Volhard

Prize share: 1/3

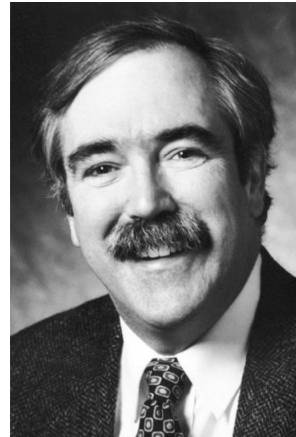
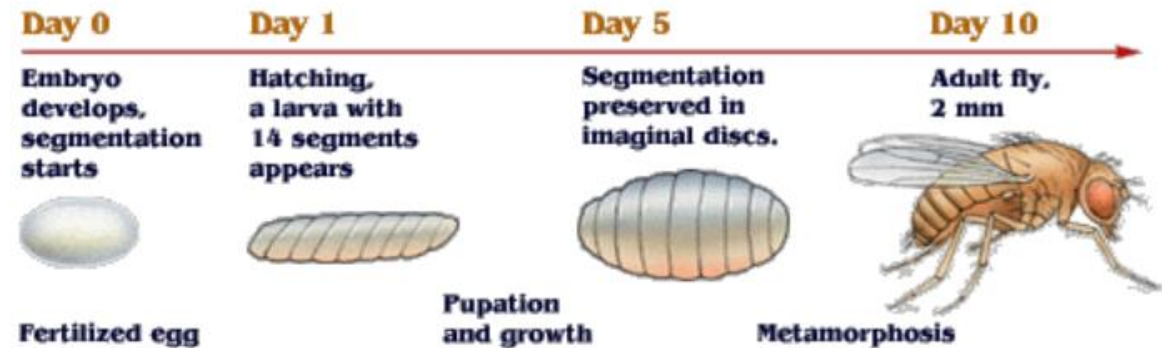


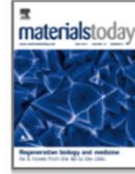
Photo from the Nobel Foundation archive.

Eric F. Wieschaus

Prize share: 1/3



- the mechanisms of Wnt action have emerged from several systems: genetics in *Drosophila melanogaster* and *Caenorhabditis elegans*
- [the Wnt homepage](#)



Review

Drosophila – a versatile model in biology & medicine

Barbara H. Jennings ✉

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[https://doi.org/10.1016/S1369-7021\(11\)70113-4](https://doi.org/10.1016/S1369-7021(11)70113-4)

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Minireview

Posterior gut development in *Drosophila*: a model system for identifying genes controlling epithelial morphogenesis

Judith A Lengyel ✉ & Xue Jun Liu

Cell Research **8**, 273–284(1998) | [Cite this article](#)

J. Dev. Biol. **2017**, 5(3), 9; <https://doi.org/10.3390/jdb5030009>

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Editorial

Introduction: *Drosophila*—A Model System for Developmental Biology

by [Nicholas S. Tolwinski](#) ^{1,2} ✉

¹ Division of Science, Yale-NUS College, Singapore 138527, Singapore

² Department of Biological Science, National University of Singapore, Singapore 138615, Singapore

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The *Drosophila* lymph gland as a developmental model of hematopoiesis

Seung-Hye Jung*, Cory J. Evans*, Christine Uemura and Utpal Banerjee†

Department of Molecular, Cell and Developmental Biology, Department of Biological Chemistry and Molecular Biology Institute, University of California, Los Angeles, CA 90095, USA

*These authors contributed equally to this work

†Author for correspondence (e-mail: banerjee@mbi.ucla.edu)

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Practical part

- 1) fly handling
collection of virgins
visualisation of fat body using UAS/Gal4 system
- 2) preparing of *D. melanogaster* larvae for nanoinjection
microscopy of reporter *D. melanogaster* lines
- 3) nanoinjection of *D. melanogaster* larvae and adults