Drosophila melanogaster

Introduction

D*melanogaster* a fruitfly which is very famous among biologists. its great importance attracted many scientists aroundthe world to find out more about it. Drosophila is a genus of small flies, belonging to the family Drosophilidae, whose members are often called “fruit flies”. One species of Drosophila in particular *D.melanogaster* has been heavily used in research in genetics and is a common model organism in developmental biology. The entire genus, however, contains about 1,500 species and is very diverse in appearance, behavior, and breeding habitat. Scientists who study Drosophila attribute the species’ diversity to its ability to be competitive in almost every habitat, including deserts.

D.melanogaster came into the scene in 1909 decades before bacteria and fungi, when Thomaos Hunt Morgan found sex linked inheritance gene on the chromosome of *D.melanogaster* with the help of genetic crosses only. Further his student Alfred Strutevant made first genetic linkage map whose ccorrectness cannot be challenge even with high throughput techniques available now.

The general principles of gene transmission, linkage, sex determination, genetic interactions; molecular, biochemical and developmental genetics, chromosomal aberrations, penetrance and expressivity, and evolutionary change may all be admirably demonstrated by using the fruit fly.

Morphology

Fruit flies are generally yellowish in color with several black bands across the abdomen. Females and males can be readily distinguished by examining their abdomens with a magnifier. In male fruit flies, the tip of the abdomen is rounded and has a broad black band: in females, it is slightly more elongated and has a narrow black band. Also, the abdomen of the female has seven segments, while the male’s has only five. These differences become more obvious when the female’s abdomen becomes distended with eggs. Another distinguishing feature of the male (which requires still higher magnification to observe) is the “sex comb,” several bristles found on each front leg.

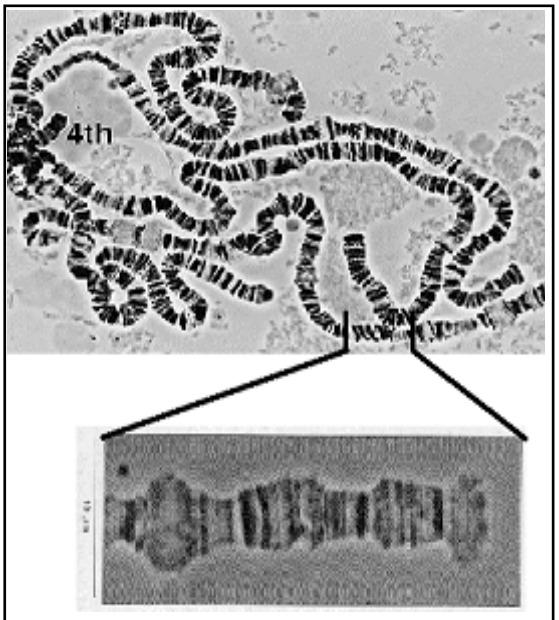
Ionising radiation and mutations

Hermann Joseph Muller was another of Morgan’s students at Columbia University. It was later in his career, while working at the University of Texas, that he discovered that radiation could produce genetic mutations. He won the Nobel Prize in 1946 in Physiology or Medicine for the conclusion that ionising radiation causes mutations such as chromosomal rearrangements. Muller reported in his article entitled Artificial Transmutation of the Gene published in 1927, that treating the sperm of Drosophila with X-rays produced mutations in genes that were stably inherited and could be followed through three or four further generations. Additionally, he found that there was a dose-response relationship between the dose of X-rays and number of mutations.

The extensive knowledge of the genetics of D. melanogaster and the long term experimental experience with this organism together with extensive genetic homology to mammals has made it of unique usefulness in mutation research and genetic toxicology. Many Drosophila genes are homologous to human genes and are studied to gain a better Athe last 50 years has resulted in a wealth of reference literature.

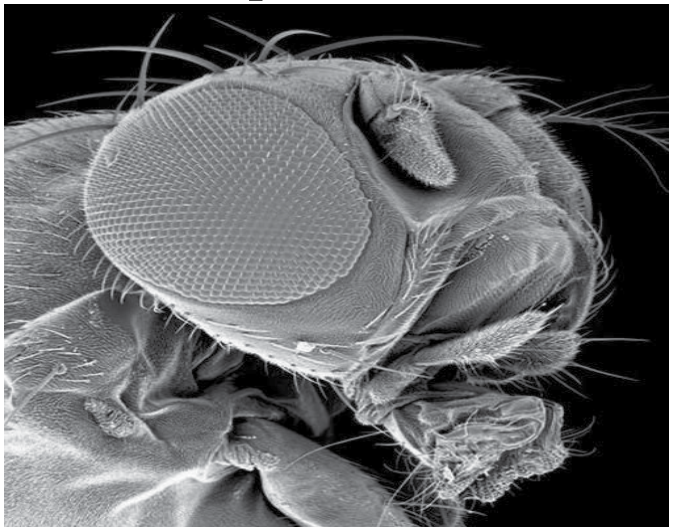
It is an ideal organism for several reasons:

- Fruit flies are hardy with simple food requirements and occupy little space.
- The reproductive cycle is complete in about 12 days at room temperature, allowing quick analysis of test crosses.
- Fruit flies produce large numbers of offspring to allow sufficient data to be collected. Examination and datacollection is easy because the flies can be quickly and easily immobilized for examination
- Many types of hereditary variations can be recognized with low-power magnification.
- Drosophila has a small number of chromosomes (four pairs), a genome size smaller than the human complement of 23 pairs of chromosomes (less than a tenth that of humans and mice).
- The giant ("polytene") chromosomes in the salivary (and other) glands of the mature larvae shows far more structural detail than do normal chromosomes, and they are present during interphase when chromosomes are normally invisible.
- A large number of genetically defined mutants are available which define most aspects of the fly's biology.
- Mutations can be targeted to specific genes and knowledge about hundreds of its genes.



Polytene chromosome of *Drosophila*

Life cycle of Drosophila

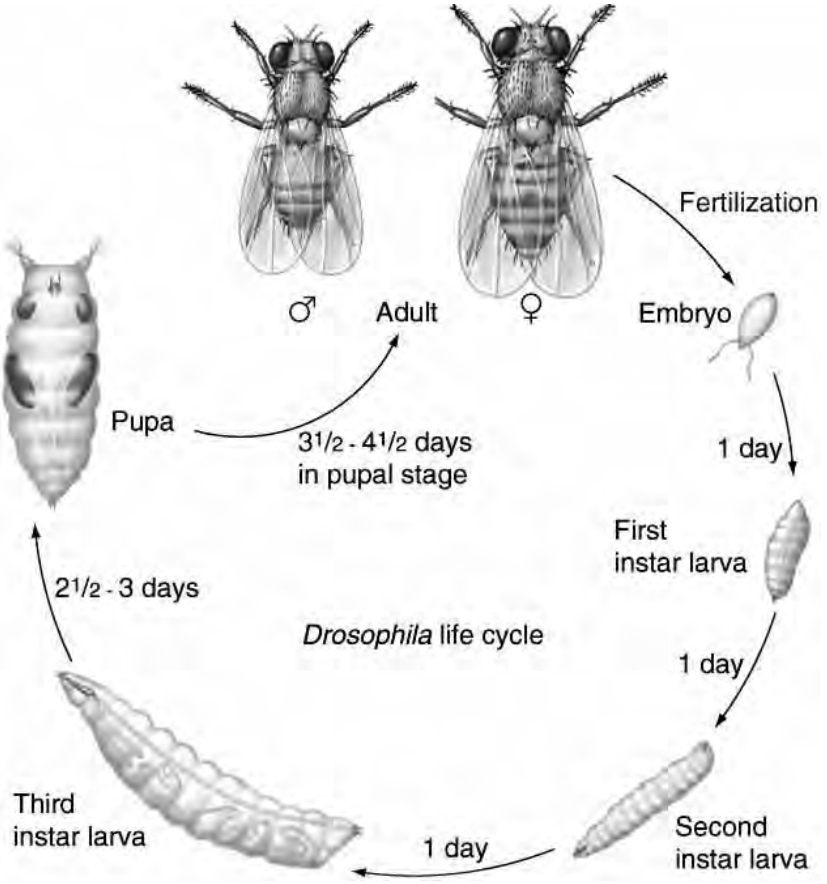


Embryonic development, which follows fertilization and the formation of the zygote, occurs within the egg membrane. The egg produces larva, which eats and grows and at length becomes pupa. The pupa, in turn develops into an imago or adult. At 20°C, the average length of the egg-larval period is 8 days; at 25°C it is reduced to 5 days. Continued exposure to temperatures above 30° C may result in sterilization or death.

Ferilization

Penetration of spermatozoa into egg occurs through a small opening or micropyle, in the conical protrusion at the anterior end, as the egg passes through the uterus. Many sperms may enter an egg, through normally only one functions in fertilization. The spermatozoa have been stored by the female since the time of mating. Immediately after the entrance of the sperm, the uction (meiotic) divisions are completed and the egg nucleus (female pronucleus) is formed.

The sperm nucleus and the egg nucleus then come into position side by side to produce the zygote nucleus, which divides to form the first two cleavage nuclei, the initial stage of development of the embryo. Eggs may be laid by the mother shortly after they are penetrated by the sperm, or they may be retained in the uterus during the early stages of embryonic development.



The Pupa

A series of developmental steps by means of which the insect passes from the larval into the adult organism is called “metamorphosis”. The most drastic changes in this transformation process take place during the pupal stage. Shortly before pupation the larva leaves the food and usually crawls onto the sides of the culture bottles, seeking a suitable place for pupation, and finally comes to rest. Soon the larva shortens and appears to be somewhat broader, thus gradually acquiring its pupal shape.

Adult stage

When metamorphosis is complete, the adult flies emerge from the pupa case. They are fragile and light in color and their wings are not fully expanded. These flies darken in a few hours and take on the normal appearance of the adult fly.

Upon emergence, flies are relatively light in color but they darken during the first few hours. It is possible by this criterion to distinguish recently emerged flies from older ones present in the same culture. They live a month or more and then die. A female does not mate for about 1Ahas mateAd, she stores a considerable quantity of sperm in receptacles and fertilizes her eggs as she lays them. Hence, to ensure a controlled mating, it is necessary to use females that have not mated before. These flies are referred to as virgin females.

The Larval Stages

The larva , after hatching from the egg , undergoes two molts, so that the larval period consist of three stages (instars). The larvae are such intensely active and voracious feeders that the culture medium in which they are crawling becomes heavily channeled and furrowed. The larvae are quite transparent. The primary mechanism by which the larva grows is molting. At each molt the entire cuticle of the insect, including many specialized cuticular structures, as well as the mouth armature and the spiracles, is shed and has to be rebuilt again. During each molt, therefore many reconstruction processes occur, leading to the formation ofstructures characteristic of the ensuing instar

The use of Drosophila melanogaster in medical and scientific research

From their ancestral home in equatorial Africa1 to laboratory benches throughout the world, Drosophila melanogaster are one of the most valuable model organisms in the scientific world ; but what is it that makes them an ideal model organism for research?

This includes the conservation of fundamental cell biology such as membrane trafficking, regulation of gene expression and cell death, which are present in all vertebrate systems.

Another key feature making Drosophila an attractive model is the range of genetic tools (including the GAL4 [a transcriptional activator in yeast]/UAS [upstream activating system], mosaic analysis with a repressible cell marker [MARCM] system and ribonucleic acid interface [RNAi]) available to manipulate them and the ease of introducing human genes into the fly.

Neurodegenerative Diseases

Since being employed as a transgenic model for spinocerebellar ataxia 3 (SCA3) in 1998, Drosophila have been used in the study of a wide range of human neurodegenerative diseases including Huntington's, Alzheimer's and Parkinson's disease (PD). This is possible because the fly possesses a complex nervous system that allows it to elicit complex neuronal tasks, such as learning and memory, similar to that in humans.

Notch pathway

Research using Drosophila melanogaster uncovered some key aspects of neurodevelopment, including the discovery of Notch and its mutations. In higher vertebrates, it is now known that the Notch signalling pathway determines cell fate during development. It is involved in cell identity, as well as differentiation, proliferation and eventual apoptosis of cells, also creating a boundary between cell populations allowing development.

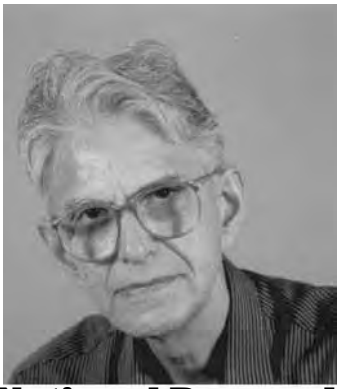
Dr. S C Lakhotia
Banaras Hindu niversity, Varanasi
Faculty of Science
Department of Zoology

My laboratory's focus is on studying the developmental roles and regulation of the non-coding hsr-omega, heat shock and a few other novel genes in Drosophila, using genetic, cell biological, molecular and recombinant DNA approaches. Roles of these genes in modulating apoptosis and neurodegeneration in Drosophila models of human diseases and cellular effects of certain Ayurvedic formulations using fly model are also being studied.

Circadian Rhythms

Work by Seymour Benzer (1921–2007) in the 1960–70s first formed the basis of our understanding of circadian rhythms. He designed the light counter-current assay, still used in research today, as a simple behavioural test in Drosophila. In this assay he quantitatively measured the behavioural responses of flies to a light stimulus. He then compared these responses with those of mutant flies, including those with faulty phototaxis mechanisms and those with X-chromosome mutations. He identified and then published a paper on the period (per) gene: the key to circadian rhythms.

However it was many years later that homologous genes were found in mice and humans.



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Lt. Prof. Siddiqi took to genetic neurobiology of the fruit fly Drosophila melanogaster. He found a set of temperature-sensitive paralytic mutants which exhibit defects in electrical activity of nerves and muscles. This discovery has led to a deeper understanding of ionic mechanisms involved in nerve conduction and synaptic transmission. Prof. Siddiqi and his associates have done pioneering work on neurogenetics of chemical senses, taste and smell. They have identified a variety of genes that control chemosensory behaviour of Drosophila. Some of these genes control sensory transduction, others regulate the formation of the neural network in the fly's brain.

Dr. Surjit Sarkar
Department of Genetics, University of Delhi South Campus, Benito Juarez Road, New Delhi

My research interest is primarily focused on harnessing the power of Drosophila genetics to address some basic questions associated with developmental genetics and for exploring the cellular and developmental basis of some fatal human neurodegenerative disorders and aging process.