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DROSOPHILA: AN IN VIVO ALTERNATIVE ANIMAL MODEL IN THE BIOMEDICAL RESEARCH

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ABSTRACT

A wide variety of animal models have been used in the biomedical research studies and animal testing that includes Rat, Mice, Guinea pig, Rabbits and Monkeys. The greatest achievements such as development of new drugs and vaccines have been successful using animal models. Nevertheless, there are significant limitations and increased animal welfare issues towards use of vertebrate animal models which to minimize its use in the scientific experiments an alternative approach to replace and reduce the animal models is the need of an hour. Distinctly an alternative animal model used is *Drosophila* an invertebrate model organism a type of fruit fly. Certainly, it has become popular model organism in the field of developmental genetics and genomic evolution. Homogenous characteristics of *Drosophila* fly proved appropriate model as per latest scientific research. The utmost advantages of using Drosophila as a model organism is its short life cycle that is attainability of large number of flies to be produced within a short period of time through selective breeding. The major benefit of using *Drosophila* fly is that there are no raising ethical issues which are more common constrains for vertebrate and mammal models. Understanding the fruit fly genetics and manipulating certain genes allows researchers to study the molecular mechanisms involved in cancer, Neurological, Cardiac, and Metabolic diseases.

Keywords: Alternative animal model, Biomedical Research, *Drosophila*, Invertebrate and Animal welfare

INTRODUCTION:

The fruit fly (***Drosophila melanogaster***) is the most extensively utilized invertebrate animal model and one of the well-developed of all the available model organisms. Use of *Drosophila* as a model in the biomedical research studies began in the early 20th century. After many years later, human genome project also submitted the comparisons of both genomes, revealed high degree homologies between the *Drosophila* and human genomes that gives positive signal as a model organism (Adams *et al*., 2000). A model organism, genus *Drosophila* has well defined phylogeny and has extensive literature on their genetics, development, and ecology. The first person to use the fly and accepted as a model organism by W.E. woodworthand it has been suggested to use as an alternative to animal model by W.E.

Castle. In 1994, the Nobel Prize for physiology and Medicine was given to three scientists Ed Lewis, Eric Weichaus and Christiane Nusslein for their work on *D.melanogaster* that led to the discovery of defining gene structure and identification of vital genes involved in embryogenesis. A complete genome sequence of the *Drosophila* was published in the year 2000. Genome has 168,736,537 base pairs in length and contains 13, 937 protein coding genes. In 2001, Reiter and his colleagues found that 77% of 929 genes were like be homologues with human diseases. Relatively, the genome of *Drosophila* fly is ideal model for the study of genetics and their development. The fly genome is only about 5% of the size of the human genome, in terms of base pairs. Nonetheless, the fly has about 15,500 genes distributed among its 4 chromosomes while human genome contains 22,000 genes among their 23 chromosomes. The fly has only 4 chromosomes making them easy manipulation and handles under laboratory circumstances. Of the four one pair are of sex chromosomes and remaining three are autosomes. The fly has large salivary gland chromosomes known as polytene chromosomes. Human and drosophila retained the same genes from a common ancestor, which constitutes over 60% of their genome. Therefore, about 75% of human disease genes have counterparts with fly genome. (Pandy and Nichols 2011) Overall, the importance *Drosophila* can be a good model organism extraordinarily in the field of genetics and their development.

GENERAL CHARACTERISTICS:

Drosophila fruit flies has red eyes, their body consists of brown and yellow color. Their body length is about 0.3cm. Conventionally, the male fruit flies have a slightly darker body than females. Another characteristic feature of male flies has a dense black spot on the abdomen; a male fly has slightly smaller than the females. Adult fly in the wild are tan color with black stripes on the back of the abdomen with bright red eyes (Fig.1). However, there are many visible genetic mutations of many different eye colors makes it valuable for studying genetics.

Fig1. Morphology of *Drosophila*

SALIENT FEATURES MAKE AN IDEAL MODEL ORGANISM:

- Fruit flies requires simple staple food for their growth and development often requires little space
- Life cycle of fruit flies of about 12 days at normal room temperature.
- They offer a greater number of offspring's which allow sufficient data to be interpreted.
- Drosophila contain small number of chromosomes (only 4 pairs), smaller genome size than the human chromosomes.
- Many *Drosophila* genes are homologous to human genes.

LIFE CYCLE OF *DROSOPHILA*:

Drosophila larvae are small, white, and glossy in nature like worms.

Approximately within 5-6 days they increase in weight about 1000-fold times. Fly has a short reproductive cycle about 8-14 days but it varies depending upon the environmental temperature. Female flies can able to live one month at room temperature. Life span can be increased to even two months throughaltering the environment factors. A female adult may lay about 30-50 eggs per day throughout her life span**.** On an average, each female fly lays between 750-1500 eggs in her life time**.** An embryonic development follows fertilization and the formation of zygote occurs within the egg membrane, egg hatches out the larva, larva grows to become pupa.The pupa finally develops into an adult. The duration of life cycle stages varies with the room temperature. At 20°C the average life cycle of the egg-larval stage is 8 days. At 25°C it has become reduced to 5 days.In a general sense, at 25°C the life cycle of Drosophila may be completed in about 10 days but at 20°C it requires 15 days to complete the life cycle (Fig.2) The life span of *Drosophila* fly varies on its surrounding environment. They can live up to 100 days when the conditions for their survival are good. On an average the life span of *Drosophila* is about 26 days for females and 33 days for males.

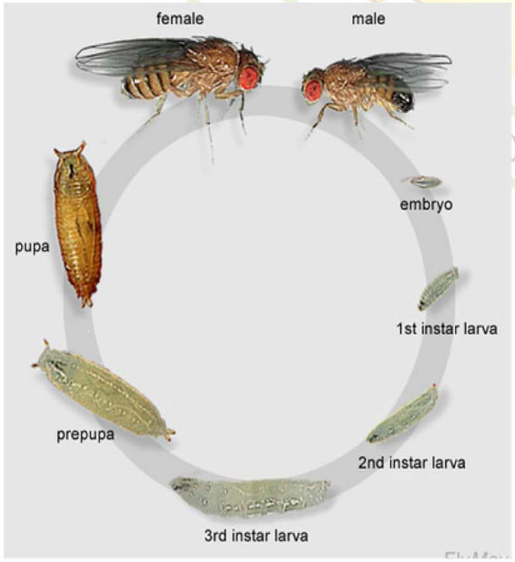

Fig2. Life Cycle of *Drosophila* Fruit Fly

RESEARCH DOCUMENTATION:

- The fly has been successfully used as a model organism of cancer prognosis study and has been proven to describing several mechanisms involved in cancer development.
- An invertebrate animal model has been successfully used as a model organism in many neurodegenerative diseases including Huntington's disease, Alzheimer's, and Parkinson's diseases.
- The most significant contribution of this fly to biomedical research has led to the discovery related to our sleep awake cycles. By isolating the specific gene and demonstrating that mutations of this gene led to the disruption of circadian rhythm this explains how the biological clock system worked on a molecular level. This great discovery awarded Nobel Prize in 2017.
- Fruit fly may be also employed in the study of cardiovascular diseases. The fly heart made of only one chamber but it still may be used to study some steps to use as a model organism in heart development and its defects.
- *Drosophila* is an emerging as a valuable model organism for use in the clinical drug discovery process. It can be used as a model to test the effects of novel drugs on the biochemical pathways conserved within humans that control many cellular activities for tissue regeneration such as cell division, differentiation, and movement.
- New drugs can be tested in *Drosophila* comparatively much faster than vertebrate animal models from time to time.

CONCLUSION:

One of the reasons were *Drosophila* making an ideal alternative model organism is that it is convenient and cost effective to perform large scale genetic screens of mutants relatively simple. *Drosophila* has been very frequently employed to investigate and understand the root cause of many human diseases with advantages.On the other hand, drosophila as a model organism is relatively inexpensive and easy to handle. Moreover, they are commonly used as a teaching aid in high school biology classes for demonstrating the basic structure, principles of genetics and inheritance. Besides, the welfare of laboratory animals is also considered as per CPCSEA (Committee for the Purpose of Control Supervision of Experiments on Animals) norms.

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