



Rediscovering Genetics

A Laboratory Manual

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A LABORATORY MANUAL

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Authors

Dr. Sunita Joshi is presently an Associate Professor at Department of Biochemistry, Daulat Ram College, University of Delhi with more than 25 years of teaching experience. She has trained around 100 students from Botany, Biochemistry and Life Sciences in *Drosophila* Genetics in last three years. She has been a resource person in ILLD; DBT and CBSE sponsored workshops for teachers. She is a co-author of Textbook of Biotechnology, Class XI (CBSE). She is also an educationist member in KVS for the past 5 years and reviewer of courses in Biochemistry offered by IGNOU. Dr. Sunita Joshi is the recipient of M.N Gupta memorial award in 2003.

Dr. Neeru Dhamija is presently an Assistant Professor at Department of Biochemistry, Daulat Ram College, University of Delhi. She has M.Sc. in Biochemistry and a doctorate in Biotechnology with specialization in HIV Biology. She studied the role of HIV-1 Tat protein in regulation of host cellular genes, under the guidance of Dr. Debashis Mitra at National Centre for Cell Science. She has trained around 70 students from Botany, Biochemistry and Life Sciences in *Drosophila* Genetics in last two years. She has worked as Assistant Professor at Cluster Innovation Centre, DU in 2013. She is also an eContent writer in UGC-ePG Paathshaala (Chemistry).

REDISCOVERING GENETICS

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Dedicated to

Our Parents and everyone who supported and believed in us

Preface

Genetics is taught in all life science related disciplines at the undergraduate level, but the most commonly used teaching methods do not motivate students. More specifically the information passed on is largely theoretical and over the years the approaches that have been perfected are the use of a handful of coloured beads and through problem solving.

We strongly felt that there was a need to change the way Genetics was taught to undergraduates. This lab manual is an outcome of our efforts made in the last three years (2012-15) of designing experiments using *Drosophila* as a model system, to teach the principles of transmission genetics. The purpose of *Drosophila* Resource Centre was to demonstrate the ease of learning Genetics through experimentation. Wherever required the existing approaches also complemented the new effort.

It was encouraging to observe the way students became more and more interested in the subject. All that was taken for granted by them from their schooldays was seen in a completely different perspective when they performed crosses, scored flies and analysed their data to 'rediscover' the principle of heredity. They also designed crosses to test their hypothesis. Above all, the students realized the power of simple tools to do science and to generate useful information. They also developed a keen sense of observation.

A lab manual for beginners in Genetics is not available. Even globally a semester course in Genetics emphasizes at best on few experiments such as a Mendelian and a non-Mendelian crosses using *Drosophila*; squashes of salivary glands of Dipteran larva to show large polytene chromosomes; separation of eye pigments and study of few human genetic traits.

The experiments are designed to teach the basic principles of Genetics in a one-semester course. More than 90% of the exercises were conducted using a handful of *Drosophila* mutants.

- The students worked in groups of 3 or 4 depending on the class strength.
- Each group was assigned at least two independent exercises.

- They were expected to spend at least one hour each day usually before the first class. They were encouraged to regularly observe their tubes and record/take photographs of interesting observations.
- Once the final data was available, each group was expected to analyse and explain the underlying genetic basis. Wherever required, the data was analysed statistically.
- Finally, one/two members of the group presented their results and analysis before the class for discussion prior to recording the experiment.
- Experiments that do not require genetic crosses and scoring of large number of progenies were performed individually.
- Few experiments such as testing PTC tasting ability and blood groups were done on human subjects.
- At the end of each exercise we have included two sheets for the student to put their observations.

Most of the exercises are organized in a similar fashion covering 6-8 pages. Each exercise provides background information with supporting examples from literature; protocol; observations and calculations (if any) and finally results and discussion. The data and photographs are from the work of final year students in the past three years.

As the user will carefully analyse the data it will be apparent that some of the results are near perfect while in case of some exercises there is scope for further improvement. This is expected as progenies of a given kind arise as a consequence of chance events and also at times certain mutants have poor survival. We cannot ignore experimental errors. The purpose of such results not only calls for possible explanations, but also tells us that foolproof results as depicted by use of coloured beads or tailor-made problem is not always the case.

The results also guide a newcomer of the need to score large number of progenies to obtain statistically significant results. This kind of work is feasible when students work in small groups and generate more raw data for analysis.

The basic idea to design a manual in this way is deep rooted to our early days of learning quantitation in biochemistry labs. The book that continues to be useful even today is 'Biochemical Calculations' by I. Segal essentially because the author left nothing to imagination but systematically solved all kinds of preliminary calculations required in a biochemistry lab.

We hope that this manual will serve as a starting point for those who wish to teach Genetics through experimentation. Improvements in the manual will be largely based on the feedback from the users.

This work is supported by the DBT star project and we have set up a '*Drosophila* Resource centre' that trains students and provides stocks to affiliated colleges of Delhi University. We aim to broaden this base and make Genetics learning interesting to students.

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Acknowledgements

The manual has been a product of an exercise spread over more than three years and now entering its last lap with fruitful publication. There have been a large number of persons who have contributed willingly for its success and we wish to record our appreciation of as many of them as possible.

We are genuinely indebted to Dr K. Nirmala, Coordinator of the department of biotechnology (DBT) Star project at Daulat Ram College. She has gone out of the way to convince the then Principal in allowing partitioning of a classroom in order to set up the *Drosophila* Resource Centre close to the biochemistry department. She has also gracefully undertaken the complete responsibility of managing the funds received from the government, leaving us with all the time to concentrate on our work.

The non-teaching staff members of the department have always been available in preparation of fly food, cleaning of fly bottles and general maintenance of the lab. On many occasions, they have gone beyond their normal call of duty to contribute their best to the project. Mr. Kuldeep Kumar routinely prepared fly food; Mr Lalit Gaur and Mr Chaman Sharma did the washing; and Mr Rajbir Giri provides guidance and overall coordination. We wholeheartedly acknowledge their support and our debt to their endeavour.

In midst of all this, it would be worthwhile to admit that the time consuming and at times, laborious and repetitive exercise would not have seen the light of the day without the dedication of the students. They were willing partners in the exercise and worked before the normal college teaching begins each day.

Last, but not the least, we owe a lot to all our colleagues for their stimulating discussions during the progress of this work.

We have tried to acknowledge the contributions of as many persons as possible in the publication of the manual. However, if any individual has been left out by oversight it is only incidental and not an attempt to belittle his or her contribution. We hope this inadvertent error is overlooked by ever willing participants.

Exercise No. XI and XIII have been published in ‘Classroom’ section of ‘Resonance: Journal of Science Education’ by the authors. **Ref.:** Neeru Dhamija and Sunita Joshi, **Rediscovering Genetics with Drosophila**; Resonance (February 2015) 20(2): pp. 177-183. We have been granted permission to reproduce these exercises in the lab manual from the publisher.

We acknowledge the web resources from where the four figures cited below have been taken.

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- (ii) **Fig. 15.1** Yellow mouse (“Agouti Mice” by Randy Jirtle and Dana Dolinoy - E-mailed by author. Licensed under CC BY 3.0 via Wikimedia Commons – https://commons.wikimedia.org/wiki/File:Agouti_Mice.jpg#/media/File:Agouti_Mice.jpg)
- (iii) **Fig. 16.1** Dimples By Jack Hills (Jack Hills’ personal facebook account) [Public domain], via Wikimedia Commons
- (iv) **Fig. 17.1** Incontinentia pigmenti “Maculae Bloch-Sulzberger syndrome” by - Kitakawa et al. Incontinentia pigmenti presenting as hypodontia in a 3-year-old girl: a case report Journal of Medical Case Reports 2009, 3:116doi:10.1186/1752-1947-3-116. Licensed under CC BY 2.0 via Wikimedia Commons - https://commons.wikimedia.org/wiki/File:Maculae_Bloch-Sulzberger_syndrome.jpg#/media/File:Maculae_Bloch-Sulzberger_syndrome.jpg

Sunita Joshi
Neeru Dhamija

Certificate

This is to certify that Ms./Mr. _____, of B.Sc (H) _____/ Life Sciences, _____ College was trained at the _____ for a period of _____ weeks / months in the year _____. She / He is familiar with the basic tools of handling and maintaining flies. She/He can independently initiate genetic crosses, collect data and interpret the underlying genetic principles.

The experiments undertaken by her / him during the training period have been signed in the content pages.

Course Coordinator(s)

Drosophila Project Under Star Project Scheme (DBT)
B.Sc. Final Yr Students (2012-2013)

S. No.	Name	Department	Duration
1.	Anukampa Pandey	Biochemistry	4 months
2.	Deepika Paliwal	Biochemistry	4 months
3.	Dhriti Nagar	Biochemistry	4 months
4.	Garima Dayal	Biochemistry	4 months
5.	Gunjeet Kaur Maghu	Biochemistry	4 months
6.	Hemlata	Biochemistry	4 months
7.	Indu	Biochemistry	4 months
8.	Laxmi Chaurasia	Biochemistry	4 months
9.	Mansi Gupta	Biochemistry	4 months
10.	Neha Mehta	Biochemistry	4 months
11.	Pooja	Biochemistry	4 months
12.	Pooja Patwal	Biochemistry	4 months
13.	Priya Bhatnagar	Biochemistry	4 months
14.	Priyanka Swaminathan	Biochemistry	4 months
15.	Renuka Saraf	Biochemistry	4 months
16.	Ruchika Aggarwal	Biochemistry	4 months
17.	Sagolsem Chandrika Devi	Biochemistry	4 months
18.	Shainan Hora	Biochemistry	4 months
19.	Shalaka Bhawal	Biochemistry	4 months
20.	Shashi	Biochemistry	4 months
21.	Simran Kaur	Biochemistry	4 months
22.	Sonia	Biochemistry	4 months
23.	Sudeshna Roy Chowdhury	Biochemistry	4 months
24.	Tripti Khanna	Biochemistry	4 months
25.	V.B. Poornima	Biochemistry	4 months
26.	Vandana	Biochemistry	4 months