National Network for Mathematical and Computational Biology

A Proposal Submitted to

Science and Engineering Research Board

SCIENCE AND ENGINEERING RESEARCH BOARD

FORMAT FOR SUBMISSION OF PROJECTS

(To be filled by applicant)

{Sections 101 to 192 to be on separate sheet(s)}

101. Project Title : **National Network for Mathematical and Computational Biology**

102. Broad Subject : Mathematical Sciences

103. Sub Area : Mathematical Science

104. Duration in months : 60 months

105. Total cost : Rs.

106. FE Component : –

107. Project Category : Virtual Network

111. Principal Coordinator : Govindan Rangarajan

112. Designation : Professor

113. Department : Mathematics

114. Institute Name : Indian Institute of Science

115. Address : Department of Mathematics
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116. Date of Birth : September 18, 1963

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118. Coordinator, Chennai Node :

119. Designation :

120. Department :

121. Institute Name :

122. Address : Department's name
Institute's name
City and pin code

123. Date of Birth :

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124. Telephone :

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125. Coordinator, Delhi Node :

126. Designation :

127. Department :

128. Institute Name :

129. Address : Department's name
Institute's name
City and pin code

130. Date of Birth :

Sex (M/F):

131. Telephone :

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e-mail :

132. Coordinator, Guwahati Node :

133. Designation :

134. Department :

135. Institute Name :

136. Address : Department's name
Institute's name
City and pin code

137. Date of Birth :

Sex (M/F):

138. Telephone :

Fax :

Gram :

e-mail :

139. Coordinator, Kanpur Node :

140. Designation :

141. Department :

142. Institute Name :

143. Address : Department's name
Institute's name
City and pin code

144. Date of Birth :

Sex (M/F):

145. Telephone :

Fax :

Gram :

e-mail :

146. Coordinator, Kolkata Node :

147. Designation :

148. Department :

149. Institute Name :

150. Address : Department's name
Institute's name
City and pin code

151. Date of Birth :

Sex (M/F):

152. Telephone :

Fax :

Gram :

e-mail :

153. Coordinator, Mohali Node :

154. Designation :

155. Department :

156. Institute Name :

157. Address : Department's name
Institute's name
City and pin code

158. Date of Birth :

Sex (M/F):

159. Telephone :

Fax :

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160. Coordinator, Pune Node : LS Shashidhara

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167. Coordinator, Roorkee Node :

168. Designation :

169. Department :

170. Institute Name :

171. Address : Department's name
Institute's name
City and pin code

172. Date of Birth :

Sex (M/F):

173. Telephone :

Fax :

Gram :

e-mail :

174. Coordinator, Vishakapatnam Node :

175. Designation :

176. Department :

177. Institute Name :

178. Address : Department's name
Institute's name
City and pin code

179. Date of Birth :

Sex (M/F):

180. Telephone :

Fax :

Gram :

e-mail :

Project Title : National Network for Mathematical and Computational Biology

Registration No. ..... (to be filled by SERB)

Principal Investigator : Govindan Rangarajan

Institution : Indian Institute of Science, Bangalore.

191. Project summary (maximum 150 words) : The National Network for Mathematical and Computational Biology would be implemented through ten nodes distributed across the country. The nodes would be located at Bangalore (principal node), Chennai, Delhi, Guwahati, Kanpur, Kolkata, Mohali, Pune, Roorkee and Vishakapatnam. Each node would organize activities such as short workshops, visitors programme, study groups, compact courses, hosting student interns, lectures at nearby colleges and universities etc. In addition, all the nodes would join together in organizing an instructional school and national/international conference annually. Experts from both within India and abroad will be invited to act as resource persons in all the above activities. Participation will be invited from all over India for all the activities. Special attention would be given to research scholars, teachers and scientists from colleges and universities.

192. Key words (maximum 6) : Mathematical Biology, Theoretical Biology, Computational Biology, Workshops, Conferences, Visitors Programme, Study Groups, Seminar Circuit, Instructional Schools, Outreach Programmes.

200. Technical details :

210. Introduction (under the following heads) :

211. Origin of the proposal :

Mathematics, physics and engineering are playing an increasingly greater role in biology. This has given rise to an important interdisciplinary area of mathematical, theoretical and computational biology. Recognizing its importance, DST had funded a Centre for Mathematical Biology at the Indian Institute of Science, Bangalore in 2007 to facilitate research and human resource development in this area. In the last two years, this Centre has co-organized instructional workshops and conferences throughout India. When a group of leading researchers working in the area met in Bangalore and Pune, it was strongly felt that this activity should be further strengthened in all parts of India. It was felt that the best way to achieve this is to start a national network for mathematical and computational biology with constituent nodes spread all across India.

212. Definition of the problem :

There is an urgent need for training of students and faculty in the interdisciplinary area of mathematical and computational biology. There is also a need to get experts both from within the country and from around the world to come and give series of lectures on cutting-edge areas and interact with the participants. A nationally distributed programme which fosters interdisciplinary training and human resource development is highly desirable.

213. Objectives :

- The overall objective is to develop the field of mathematical and computational biology in India. More specific objectives are given below.
- Development of virtual network nodes in 10 places across India.
- Development and maintenance of a web page for this programme at IISER Pune.
- Creating a strong visitors programme involving scientists from within India and abroad.
- Providing student internships for carrying out projects at various nodes.
- Developing a mathematical biology seminar circuit.
- Conducting Study Groups (where experimental biologists propose problems they are interested in to a group of mathematicians/ physicists/ engineers/ theoretical biologists)
- Delivering lectures in nearby colleges/universities at each node.
- Organizing one or two short workshops every year for local students/ researchers at each node.

- Organizing compact courses (where one instructor gives a series of 6-10 lectures on a specific topic starting from basics and leading up to research-level topics)
- Organizing alternately one national or international conference every year.
- Organizing one instructional school every year.
- Developing a mathematical/computational biology multimedia course for use by universities.

220. Review of status of Research and Development in the subject :

221. International status :

Mathematics has been used in Biology since antiquity. Specifically, areas such as, Ecology, Epidemiology and Evolutionary Biology, have been favorite hunting ground for mathematician and mathematical statisticians. For example, Ronal Ross developed the mathematical model for Malaria towards the end of 1800. There was a good mix of experimental studies and relevant theoretical modeling in ecology where mathematicians aimed to develop models that explained species growth and competition data from laboratory experiments, field data derived from companies collecting furs of animals, or incidence data of the Bombay Plague of 1700s. There was a clear inclusion of theoretical studies in biological disciplines in early 19th century. As more information of the workings of biological systems and their parts became elucidated through new experimental procedures (e.g., molecular biology), models to describe them also became more and more complex, not only in terms of increased number of variables but also due to inclusion of highly nonlinear terms describing real biological interactions. During that time the divide between experiment and theory increased, and theoreticians were primarily part of Mathematics departments continuing to perform intricate analytical studies of complex models. It was also clear that these complexities would require involvement of high level of computational resources, which were not a common thing in the Maths departments. But as a discipline Mathematical Biology was establishing itself in several places in the world. Separate journals on mathematical and theoretical biology were started in the 1970s, and several departments and societies of Mathematical Biology were set up in USA, European countries, Canada, Japan, etc. To name a few - Centre for Mathematical Biology at University of Oxford, UK and Department of Theoretical Biology at University of Chicago, USA are the some of the pioneers. Even other mathematical societies like the Society of Industrial and Applied Mathematics (SIAM), USA, ICIAM, etc have separate sessions devoted to Mathematical Biology along with plenary talks in their yearly meetings. Over the past two decades, when bioscientists decided to sequence the genomes of organisms, it led to the development of new disciplines like Bioinformatics and Computational Biology where theoreticians (both mathematicians,

statisticians, physicists, and computer scientists) were deeply involved in developing algorithms, databases, and models for managing, analyzing and studying the large amount of sequence information generated through the high throughput experiments. During the past few years, mathematical and computational methods to study large number of biological images have been in the forefront of research. So mathematical biology today is a living discipline with very bright future in both basic and applied studies. The workforce required to handle the analysis of biological data and then modeling such systems is very large. Mathematical Biology, thus, is a discipline of the future and needs to be promoted in a big way.

222. National status :

Mathematics have been one of the oldest subjects developed and studied in India. In 18th and 19th centuries, british scientists like Ronald Ross and J B S Haldane worked in India doing experiments and developing models of infectious disease and evolution. Mathematics and Statistics were considered together in those times (even now most Mathematics departments are Math-Stat departments), and it was P C Mohalanobis, the founder of Indian Statistical Institute in Kolkata who promoted Biostatistics as a separate area of study in the ISI. ISI, Kolkata was the home of a small but one of the first Mathematical Biology units in India. The department of Mathematics in Calcutta university and later in Jadavpur university (in Calcutta) and IIT Kharagpur saw mathematical biologists in Maths departments. Researchers in Mathematical Biology were active in IIT Kanpur, IISc Bangalore, and Gwalior University existed in 1970 and 80s in the Mathematics departments. But because of high specialization in biology, and a highly exclusive system of study in the under and postgraduate programs in India, the distance between Biology and Mathematics widened. The Mathematical Biologists remained satisfied with doing theoretical analysis of models, often old models with few modifications, and biologists hardly got any training in mathematics. Few centers of study (e.g., NCBS, Bose Institute, CCMB, etc) closer to biology departments also evolved during the past two decades. Due to inclusion of biology as "soft matter" in the Physics departments, several places (IISc, IMSc, IOP, etc) started to develop theoretical groups working on biological systems. Few mathematics departments (in IITs) have courses in mathematical biology. New undergraduate courses developed in institutions (IISERs, IISc, etc) are aiming for a more interdisciplinary scientific educational programme.

It is only during the past few years that the biologists have realized in India that mathematics and computation is an essential tool in understanding biological systems. The departments of Science and Technology and Biotechnology have been encouraging Mathematical and Computational Biology in their programmes. This is an opportune moment to develop Mathematical Biology in to a strong interdisciplinary discipline which not only includes theoretical expertise from all branches of mathematics and statis-

tics, but also from physicists, computer scientists, and engineering disciplines to an integrated platform to study biological systems. The primary requirements are many folds - development of manpower, wide dissemination of the interdisciplinary nature of mathematical biology to students, stronger interactions with experimental biologists, frequent workshops and meetings to develop collaborations, etc. The foremost requirement is to develop a nation-wide network to consolidate this area so that all the above can be done more effectively through common mechanisms by including more people.

223. Importance of the proposed project in the context of current status :

224. Review of expertise available with proposed investigating group/institution in the subject of the project :

All the investigators are leading practitioners in the area of mathematical and computational biology. They also have considerable experience in developing this subject in India through workshops and conferences.

225. Patent details (domestic and international) : Not applicable.

230. Work plan :

231. Methodology :

Description of the Nodes:

- Bangalore Node: This will serve as the principal node for the whole network. Indian Institute of Science, Bangalore would be the nodal institution. This node would co-opt interested faculty from neighbouring institutions such as NCBS, JNCASR, RRI, Bangalore University and its constituent colleges, ISI Bangalore etc.
- Chennai Node:
- Delhi Node:
- Guwahati Node:
- Kanpur Node:
- Kolkata Node:
- Mohali Node:
- Pune Node: This node will coordinate activity primarily in the region surrounding the twin cities of Mumbai and Pune. Participating institutes would include, but not limited to, IISER Pune, NCL, IIT Bombay and Piramal Life Sciences. The Pune node will also coordinate the development of a website for the network. Participating members include:
  i. Anu Raghunathan, NCL, Pune
  ii. Chandrika Rao, Piramal Life Sciences, Mumbai
  iii. Chetan Gadgil, NCL, Pune

iv. Ganesh Viswanathan, IIT Bombay, Mumbai
v. K. V. Venkatesh, IIT Bombay, Mumbai
vi. L S Shashidhara, IISER Pune
vii. Pranay Goel, IISER Pune
viii. Ram Rup Sarkar, NCL, Pune

- Roorkee Node:
- Vishakapatnam Node:

Web pages for the Network:

A website representing both activities carried out by the nodes and the network as a whole would provide a useful rallying point for the larger community to contribute to the development of the subject.

The general plan of the website is to use a center-and-spokes model: Central pages would lie at the intersection of the nodes, and Nodal pages would be updated by each node to reflect local activity.

Central pages would typically contain information regarding:

i. General information about the virtual network: its goals, members, and overall structure.
ii. Institutes that are part of the nodes.
iii. Various FAQs.
iv. News and events, activities of the network, job listings, projects, meetings, discussion fora etc.
v. Research and training: Research carried out in the country and internationally, career information, training conducted by the virtual community, a library, online courses.

Nodal pages would typically be responsible for updating, amongst other things:

i. Job opportunities in their groups.
ii. Student projects, meetings, schools, training in their node. This would include, for example, a meeting website.
iii. Articles of interest to the community.
iv. Videos for the online courses.

Instructional School:

This would be a 2-3 week instructional school that would be held annually at various locations. The initial few days would concentrate on introducing biology to mathematicians, physical scientists and engineers and introducing mathematics to biologists. The remaining period would focus on lecture modules spanning the entire spectrum of mathematical and computational biology. Computer lab sessions would also be conducted. These schools would be aimed at senior undergraduate and postgraduate students, research scholars and postdoctoral fellows. The primary goal of these schools would be human resource development.

National Conference:

Three national conferences would be organized during the course of this project. They will be held every alternate year and at locations distributed throughout India. These conferences would bring together researchers and students from all over India to discuss the recent developments in the area of mathematical, theoretical and computational biology.

International Conference:

Two international conferences would be organized during the course of this project. These conferences would bring together researchers from both India and abroad and students from all over India to discuss cutting-edge research in the area of mathematical, theoretical and computational biology.

Visitors Programme:

Seminar Circuit:

Study Groups:

Short Workshops:

Course on Mathematical Biology:

Student Internships:

Lectures at Nearby Colleges/Universities:

232. Organisation of work elements :

Every year, each node would organize activities such as short workshops, visitors programme, study groups, compact courses, hosting student interns, lectures at nearby colleges and universities etc. In addition, all the nodes would join together in organizing an instructional school and national/international conference annually. A web page for the whole network would be developed and hosted by IISER Pune.

233. Time schedule of activities giving milestones :

1–12 months: First Year Programmes and a National Conference

13–24 months: Second Year Programmes and an International Conference

25–36 months: Third Year Programmes and a National Conference

37–48 months: Fourth Year Programmes and an International Conference

49–60 months: Fifth Year Programmes and a National Conference

234. Suggested plan of action for utilization of research outcome expected from the project :

The lectures and courses given under the various programmes would be put up on the web and also distributed to all those who request for them.

300. Budget Estimates : Summary

Broad details of estimated expenditure for activities jointly organized by all nodes:

For 1 year

Budget for Instructional School:

Number of young researchers: 40

Number of resource persons: 10

Duration: 10-12days

Sl. No.	*Budget Head*	*Amount (Rs.)*
1.	TA for participants @ 3,000/- per participants × 40 TA for resource persons @ 25,000/- per person × 10	 1,20,000/- 2,50,000/-
2.	Hospitality for participants) @ 1,000/- per day × 14 × 40 Hospitality for resource persons @ 4,000/- per day × 7 × 10	 5,60,000/- 2,80,000/-
3.	Honorarium @ 3,000/- (per lecture) × 72 ×	2,16,000/-
4.	Resource material @ 5,000/- × 40	2,00,000/-
5.	Contingency	3,00,000/-
6.	Rental of venue @ 10,000/- × 12	1,20,000/-
7.	Video recording of lectures	2,00,000/-
8.	20% Over Head	4,50,000/-
	Total	26,96,000/-

Budget for National conference

Number of invited speakers: 15

Number of out-station participants: 50

Duration: 3 days

Sl. No.	*Budget Head*	*Amount (Rs.)*
1.	TA @ 25,000/- per speaker × 15	3,75,000/-
	TA @ 3,000/- per participant × 50	1,50,000/-
2.	Hospitality for invited speakers @ 4,000/- per day × 4 × 15	2,40,000/-
	Hospitality for participants @ 1,000/- per day × 4 × 50	2,00,000/-
3.	Secretarial help	40,000/-
4.	Stationary & contingency	1,00,000/-
5.	Rental of venue	30,000/-
6.	20% Over Head	2,27,000/-
	Total	13,62,000/-

Budget for International conference

Number of invited speakers: 20

Number of out-station participants: 100

Duration: 3 days

Sl. No.	*Budget Head*	*Amount (Rs.)*
1.	TA @ 25,000/- per speaker × 20	5,00,000/-
	TA @ 3,000/- per participant × 100	3,00,000/-
2.	Hospitality for invited speakers @ 4,000/- per day × 4 × 20	3,20,000/-
	Hospitality for participants @ 1,000/- per day × 4 × 100	4,00,000/-
3.	Secretarial help	40,000/-
4.	Stationary & contingency	3,00,000/-
5.	Rental of venue	40,000/-
6.	20% Over Head	3,80,000/-
	Total	22,80,000/-

Broad details of estimated expenditure for each node:

For Pune Node

Budget summary over **5 years**:

	(in lakhs of Rs.)
School / Study Group / Workshop / Symposium etc. (15 lakhs/year)	75
Website (for 5 years; including AMC)	10
Travel (0.5 lakhs × 8 persons = 4 lakhs/year)	20
Students (8 lakhs/year) a. 10 UG (upto MS) = 10K/mnth x 5 mnths = 5 lakhs/yr; Tot =25 lakhs, b. 5 RA = 3 lakhs/yr at same rate as above, but to allow for 6 months projects. Tot=15lakhs	40
Contingency research grants (20K/student x 15students /year = 3 lakhs/year)	15
Net contingency (10%)	15
Total	1.75 crores

In addition, we commit to hosting 1 international/national scale meeting in the 5 year period.

For Kanpur Node

For 1 year

Yearly Budget for Lectures at nearby Colleges/Universities

Number of programme: 2

Number of speakers: 2

Duration: 3 days

Sl. No.	*Budget Head*	*Amount (Rs.)*
1.	Travel @ 5,000/- × 2 × 2	20,000/-
2.	Hospitality @ 3,000/- per day × 4 × 3	36,000/-
3.	20% Over Head	11,000/-
	Total	67,000/-

Yearly Budget for visitors programme

Number of foreign visitors:

Number of national visitors:

Duration of long term visitors:

Duration of short term visitors:

Sl. No.	*Budget Head*	*Amount (Rs.)*
1.	TA for international visitor @ 1,20,000/- ×	
2.	TA for national visitor @ 30,000/- ×	
3.	Hospitality + Honorarium @ 80,000/- per month ×	
4.	20% Over Head	
	Total	

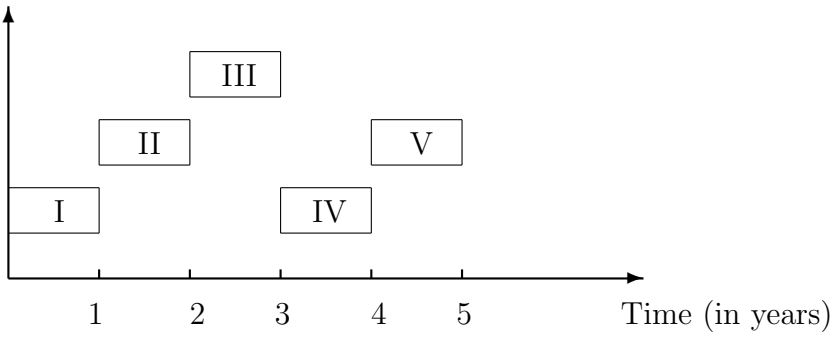
Yearly Budget for internship programme

Number of interns:

Duration of interns:

Sl. No.	*Budget Head*	*Amount (Rs.)*
1.	TA @ 3,000/- ×	
2.	Hospitality (@ 10,000/- per student per month) 10,000/- × ×	
3.	Internship @ 5,000/- (per month) × ×	
4.	20% Over Head	
	Total	

410. Time Schedule of Activities through BAR Diagram :



I. First Year Programmes and National Conference
II. Second Year Programmes and International Conference
III. Third Year Programmes and National Conference
IV. Fourth Year Programmes and International Conference
V. Fifth Year Programmes and National Conference

420. List of Facilities Being Extended by Parent Institution(s) for the Project Implementation :

A) Infrastructural Facilities :

Sr. No.	Infrastructural Facility	Yes/No/ Not required Full or sharing basis
1.	Workshop Facility	Not required
2.	Water & Electricity	Yes
3.	Laboratory Space/ Furniture	Yes
4.	Power Generator	Yes
5.	AC Room or AC	Not required
6.	Telecommunication including e-mail & fax	Yes
7.	Transportation	Yes
8.	Administrative/ Secretarial support	Yes
9.	Information facilities like Internet/ Library	Yes
10.	Computational facilities	Sharing basis
11.	Animal/ Glass House	Not required
12.	Any other special facility being provided	No

B) Equipment available with the Institute/ Group/ Department/ Other Institutes for the project :

Equipment available with	Generic Name of Equipment	Model, Make & year of purchase	Remarks including accessories available and current usage of equipment
PI & his group	Desktop Pentium 4	Assembled locally 2000	Adequate
PI's Department	Desktop Pentium 3 & 4	Assembled locally 2000-2004	Mainly for Students' use
Other Inst In the region	Similar to our department		For their own use

430. Detailed Bio-data of the Investigator(s)/Co-Investigator(s) :

Bio-datas of the Principal Coordinator and Coordinators of the various nodes are enclosed.

500. Any other relevant matter :