A PROPOSAL for a PROGRAM of GRADUATE STUDIES in CELL, MOLECULAR and DEVELOPMENTAL BIOLOGY LEADING to MS and Ph.D. DEGREES

PREPARED FEBRUARY, 1998
UNIVERSITY OF CALIFORNIA, RIVERSIDE
TABLE OF CONTENTS

Section I: Introduction
1. Aims and Objectives of the Program.................................................... p. 4
2. Historical Development of the Field and Strength of the Field on the UCR Campus................................................................. p. 5
3. Timetable for the Development of the Program......................... p. 7
4. Relationship to and Support from other Programs at UCR.. p. 8
5. Relationship to other Programs within the UC System....... p. 8
6. Administration of the Program.............................................................. p. 9
7. Plan for Evaluation of the Program........................................................ p. 9

Section 2: Graduate Program............................................................. p. 10
1. Undergraduate Preparation for Admission.......................... p. 10
2. Foreign Language............................................................................... p. 11
3. Program of Study............................................................................... p. 11
4. Field Examination............................................................................... p. 13
5. Ph.D. Qualifying Examination.......................................................... p. 14
6. Thesis and/or Dissertation................................................................. p. 14
7. Final Examination............................................................................... p. 14
8. Explanation of Special Requirements over and above Graduate Division Minimum Requirements.................................................. p. 15
9. Relationship of Master’s and Doctoral Programs............... p. 15
10. Special Preparation for Careers in Teaching......................... p. 15
11. Sample Program.................................................................................. p. 16
12. Normative Time from Matriculation to Degree......................... p. 17
Section 3: Projected Need......................................................... p. 18

1. Student Demand for the Program........................................ p. 18
2. Opportunities for Placement of Graduates............................ p. 18
3. Importance to the Discipline.............................................. p. 19
4. Ways in which the Program will meet the Needs of Society... p. 19
5. Relationship of the Program to Research and/or Professional Interests of the Faculty................................. p. 20
6. Program differentiation...................................................... p. 20

Section 4: Staff........................................................................ p. 21

Section 5: Courses.................................................................... p. 23

Section 6: Resource Requirements............................................ p. 25

1. FTE faculty.......................................................................... p. 25
2. Library Acquisition............................................................. p. 25
3. Computing Costs............................................................... p. 25
4. Equipment............................................................................ p. 25
5. Space and other Capital Facilities....................................... p. 26
6. Other Operating Costs....................................................... p. 26

Section 7: Graduate Student Support........................................ p. 27

Section 8: Changes in Senate Regulations.................................... p. 27
SECTION I
INTRODUCTION

1. Aims and Objectives of the Program

Cell, molecular, and developmental biology have emerged in the past two decades at the forefront of the biological sciences. The interface between these disciplines has become an increasingly productive arena for new discoveries and significant advances, and a contemporary graduate program should encompass each of these areas. The goal of the proposed graduate program is to provide coherent training for students in the fields of cell, molecular, and developmental biology by uniting in a single degree granting program the expertise of faculty currently dispersed in numerous biological sciences departments and graduate programs.

UCR is fortunate to have a distinguished faculty in cell, molecular, and developmental biology, but its strength in these disciplines is disguised because this faculty is scattered among multiple departments and Ph.D. programs. As UCR is still a relatively small campus, none of these programs is large enough to house sufficient numbers of scientists in these fields to attain the recognition that might otherwise occur were a single, coordinated program to be formed. The proposed program will strengthen these disciplines at UCR and provide a pedagogically sound mechanism for training students. Currently, graduate students at UCR interested in cell, molecular or developmental biology are trained under the aegis of the Cell and Molecular Biology track in the Biology graduate program and under more loosely organized cell and development foci in the Botany and Biomedical Sciences graduate programs. In addition, students receive training in molecular biology or molecular genetics through the Biochemistry or the Genetics graduate programs. Accordingly, the potential that exists at UCR for students to benefit from a range of training and research opportunities in these disciplines is not currently realized. Cohesive training in these three areas, which utilizes the resources currently available on this campus, would be possible in a graduate program specifically designed to address this need. UCR graduates are well trained, yet may be disadvantaged in competing for jobs in a market that places a high premium on the benefits derived from interdisciplinary training programs that meld cell, molecular and developmental biology. Moreover, because no formal program by that name exists, UCR may be disadvantaged with respect to recruitment of excellent, focused graduate students, as those with an interest in this degree may not recognize that such expertise is available on this campus.

Faculty in 11 different biological sciences departments/graduate programs at UCR have recently organized to form a graduate research umbrella
(GRU) in Cell, Molecular, and Developmental Biology. The GRU recruits students into participating graduate programs that house faculty doing research in the areas of cell, molecular and developmental Biology and sponsors a seminar series (Seminar in Cell, Molecular and Developmental Biology) that brings in distinguished speakers in these three disciplines. The GRU is not a degree conferring program, however, and so cannot provide training nor a coherent course of study for students. A degree program is the next logical step for this group to undertake to ensure that cell, molecular and developmental biology thrive on this campus.

The proposed graduate program in cell, molecular and developmental biology on the UCR campus will be distinctive because it will offer students a balanced exposure to microbial, plant, and animal systems. Because the research interests of the faculty in the proposed program span areas from reproduction in mammals to control of gene expression in flowering plants, from mechanisms of channel gating in neurons to host-parasite interactions in plant and animal systems, students will gain an understanding of and an appreciation for both the unifying themes and unique features that characterize the behavior of molecules, cells, and developmental pathways in a variety of organisms. Moreover, because faculty from both basic and applied (medical and agricultural) departments will participate in this program, students will become fully cognizant of the range of opportunities available in these fields. Students graduating from the proposed program will have received excellent training and should be competitive for research, teaching, and related scientific careers.

2. Historical Development of the Field and Strength of the Field on the UCR Campus

Modern cell biology can trace its origins to the development of the electron microscope and its application in the 1950s and 1960s to the study of cell ultrastructure. The perfection of cell fractionation procedures in the 1960s and ensuing use of biochemical methods in the 1970s to study these fractions contributed greatly to understanding the function and even the mechanisms underlying functions of many of the newly described cell components. Immunological and molecular approaches in the 1980s and 1990s have greatly refined and expanded our understanding of cells, as has the reemergence of the light microscope as an analytical tool, and the field is currently flourishing as new discoveries are made and new techniques developed to pursue these discoveries.

Molecular biology can trace its own roots to the discovery of DNA as the genetic information in the 1920s, the solving of the structure of DNA in 1952, the deciphering of the genetic code and the elucidation of the flow of information from DNA to protein in the 1960s, to the development of cloning, sequencing, and other techniques in the ensuing three decades. Molecular biology now underpins major advances in all other areas of biology.
The field of developmental biology originated in embryological studies conducted at the turn of the century, but, despite its longer history, is more in its infancy as a modern field than are cell or molecular biology. Until recently, developmental biology was largely a descriptive field of interesting phenomena. In the past decade, however, the use of genetics and cell and molecular biological approaches has made tractable many difficult problems in development, and an elucidation of the signaling molecules and the molecular mechanisms by which cells develop along precise developmental pathways has propelled this field into the limelight.

All three disciplines, cell, molecular and developmental biology, have now become inextricably interwoven with each other, and a graduate program today would be remiss if it did not incorporate them into a single course of study. Research in cell, molecular and developmental biology is inarguably undergoing an explosive phase of growth. These fields bridge the gap between biochemistry and organismal biology and share the common goal of understanding the mechanisms controlling cell behavior, from deciphering how specific interactions between molecules can regulate gene expression to understanding how expression of specific genes can control how cells interact to form tissues and organs during development.

On the UCR campus, cell, molecular and developmental biology have become foci in the Biology, Biomedical Sciences, and the Botany and Plant Sciences programs and molecular biology has been a strength of the Biochemistry and interdepartmental Environmental Toxicology and Genetics programs. Within these various programs considerable strength in cell, molecular and developmental biology has emerged, but no specific graduate program exists which adequately encompasses the three areas and is of sufficient size to earn us a national reputation. The GRU has served to bring the faculty in these different programs together, but a graduate program is the next necessary step to solidify this effort and provide the appropriate training and degree for students doing research in these areas. Interdisciplinary, interdepartmental programs are the likely training model for future growth on this campus if we are to utilize to the fullest extent possible the expertise that exists here. This campus has a successful history of such interdepartmental graduate programs, i.e., the Genetics Program, the Environmental Toxicology Program, and the more recent Microbiology Program, which have each pooled the varied talents of faculty from multiple departments into a single graduate program for the benefit of all participants. We hope to build on this model, and the enthusiasm demonstrated for our GRU from a wide range of faculty and students makes us optimistic that our proposed graduate program will be successful.
3. **Timetable for the Development of the Program**

We anticipate recruiting students via the new GRU this year (1997-98) for entry into existing, participating Ph.D. programs for the 1998—99 academic year. The GRU has developed a recruitment poster (see Appendix I), which was sent to colleges and universities this past fall (1997). We have also established a web site (http://cnas.ucr.edu/~cmd/cmdgru.htm) that describes the GRU and its training opportunities for studies in cell, molecular and developmental biology and developed a recruitment packet (see Appendix II). Students recruited via the GRU may seek to transfer to the new program when it is approved, and a number of current graduate students, training with faculty within the GRU, have already indicated that they would be interested in transferring into this program. Table I provides a timetable for anticipated enrollments in the new graduate program.

<table>
<thead>
<tr>
<th>Year of program</th>
<th>New students Min-max</th>
<th>Students transferring from other UCR PhD programs Min-max</th>
<th># graduating</th>
<th>Cumulative Min-max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5-10</td>
<td>0-15</td>
<td>0</td>
<td>5-25</td>
</tr>
<tr>
<td>2</td>
<td>5-10</td>
<td>0</td>
<td>0-5</td>
<td>5-35</td>
</tr>
<tr>
<td>3</td>
<td>5-10</td>
<td>0</td>
<td>0-5</td>
<td>5-45</td>
</tr>
<tr>
<td>4</td>
<td>5-15</td>
<td>0</td>
<td>0-5</td>
<td>5-60</td>
</tr>
<tr>
<td>5</td>
<td>5-15</td>
<td>0</td>
<td>0-5</td>
<td>5-75</td>
</tr>
</tbody>
</table>

Graduate students in the Cell, Molecular and Developmental Biology graduate program will be supported from a variety of sources. Training grants, research assistantships, Graduate Division Fellowships, and teaching assistantships will be utilized. Undergraduate courses in cell, molecular and developmental biology enroll among the largest number of students in the college, and thus there will be ample opportunity for students in this new program to be supported by teaching assistantships when fulfilling their teaching requirement or when other sources of support are unavailable.
4. Relation to and Support from other Programs at UCR

A reorganization of faculty into an interdisciplinary Ph.D. program providing training in Cell, Molecular and Developmental Biology or a subset of these disciplines has been recommended by a series of committees, including a distinguished external Blue Ribbon Committee (see Appendix III) charged with evaluating the biological sciences on this campus. The establishment of the GRUs has been the first step towards the goal of reorganization of graduate training. In addition to the GRU in Cell, Molecular and Developmental Biology, the other GRUs established are in Biochemistry and Molecular Biology, Ecology and Evolutionary Biology, and Environmental Sciences. Graduate courses in biochemistry, genetics and molecular biology offered by faculty in the Biochemistry and Molecular Biology GRU and by faculty in the Genetics Program and Microbiology Program will augment and enhance the curriculum in the proposed program.

Existing graduate programs in the College of Natural and Agricultural sciences vary considerably in their structures and missions. As such, implementation of a new Cell, Molecular and Developmental Biology degree program will differentially impact current programs of study. As the proposed program represents an expansion of the existing Cell and Molecular Biology track in the Biology graduate program, it is anticipated that participating Biology faculty will shift their membership into the new program with little noticeable impact on the two other tracks, Physiology and Ecology/Evolution, that operate, relatively independently, within the Biology graduate program. Faculty in other programs such as Botany and Plant Sciences, Biomedical Sciences, Biochemistry, Plant Pathology, Environmental Toxicology, Genetics or Microbiology may retain membership in their current programs in addition to participating in the proposed program. In so doing, these latter faculties will be drawing from independent applicant pools, and the relevant curricula, expertise and training for students admitted into the different programs will necessarily differ. Letters supporting the proposed program have been obtained from chairs or directors of existing UCR graduate programs most likely to be impacted (see Appendix IV).

5. Relationship to Other Programs within the UC System

A number of UC campuses have graduate programs in the broad disciplinary areas of cell, molecular or developmental biology. Both UCLA and UCSB have graduate programs that encompasses all three areas. Both UCB and UCSD offer a Ph.D. in Molecular and Cellular Biology, UCD and UCI offer a program in Cell and Developmental Biology and UCSF has a Ph.D. program in Cell Biology. Descriptions of these various programs indicate that all three areas are major components of the training despite the absence of one name or another from the title of the degree programs. Because of the central role that these disciplines hold in the biological sciences, all research universities
involved in graduate training in the biological sciences would be well served by providing a degree program in cell, molecular and developmental biology. Our program would be distinguished by its balance among microbial, plant and animal systems and the exposure to both basic and applied research problems.

6. Administration of the Program

The program will be administered by a director and will have a graduate advisor and supporting committees that will advise and make decisions regarding graduate admissions, curricula, and student academic progress.

7. Plan for Evaluation of the Program

The Cell, Molecular, and Developmental Biology faculty will review and evaluate the graduate program in conjunction with the review normally conducted by the Graduate Council during the third year of new graduate programs. As is the norm for all graduate programs on the UCR campus, the program will thereafter be evaluated by an outside team of experts once every 6-7 years. In its early years, the program will conduct a self-evaluation by circulating an annual survey asking participating faculty and students to critique the program and make suggestions for its improvement.
SECTION 2

GRADUATE PROGRAM

1. Undergraduate Preparation for Admission

Students admitted into the Cell, Molecular and Developmental Biology degree granting program will be expected to have completed a bachelor’s degree at a four-year accredited college or university and to have attained an undergraduate academic record that satisfies the standards established by the Graduate Division, University of California, Riverside. Students will need to have completed coursework in chemistry, physics, math, biochemistry and biology. Students with strong academic records may be admitted with coursework deficiencies, provided that these are satisfied by appropriate coursework taken during the first two years of graduate study. Entry into the program will require adequate performance on the Graduate Record Exam, including mastery of the GRE Subject Exam in Biochemistry or in Biology.

General requirements:

Undergraduate degree (B. S. or B. A.)

Specific requirements:

One year of calculus (equivalent UCR course = Math 9A-C)

One year of physics (equivalent UCR course = Phys 2 A-C with lab)

One year of inorganic chemistry including lab (equivalent UCR course = Chem 1A-C)

One year of organic chemistry including lab (equivalent UCR course = Chem 112 A-C).

One course in biochemistry (equivalent UCR course = BCH 100 or BCH 110 A or B or C).

One year of introductory biology (equivalent UCR course = Biol 5 A-C).

One course in genetics (equivalent UCR course = Biol 102)

One course in statistics (equivalent UCR course = Stat 20)
Two upper division courses in cell, molecular or developmental biology (equivalent to UCR courses BPSC135 or Biol 111, Biol 107 or BCH 110 C).

2. Foreign Language

There is no foreign language requirement.

3. Program of Study

a. Specific fields of emphasis

The program will offer a masters (MS) degree, Plan I (thesis), and a doctoral degree (Ph.D.) in Cell, Molecular, and Developmental Biology. Students enrolled in the graduate program are expected to complete a core of coursework in these three areas consisting of a one year, 3 quarter graduate course series. Students are also expected to participate in seminars and colloquia and to become informed about the major technological methods and advances that provide the essential underpinnings to new discoveries in these fields. Upon entry, each student will be assigned an advisory committee which will provide advice about an appropriate course of study for that student, based on his/her undergraduate preparation and long term interests.

b. Plans:

MS

Masters students will complete core coursework in cell, molecular and developmental biology, will enroll in at least one graduate seminar course in a specialized area of one of these fields, will enroll in the interdepartmental colloquium series in Cell, Molecular and Developmental Biology, and will undertake a research project leading to a thesis.

Ph.D.

Doctoral students will complete core coursework in cell, molecular and developmental biology, will enroll in graduate seminar courses in at least two areas among cell, molecular or developmental biology, will enroll in the interdepartmental colloquium series in Cell, Molecular and Developmental Biology, will undertake a research project leading to a dissertation, and will fulfill a two quarter teaching requirement. During their first year, Ph.D. students will be encouraged to undertake two or three laboratory rotations, each of a quarter’s duration, prior to choosing a dissertation mentor. During these rotations, the chair of the student’s advisory committee would serve as the student’s advisor.
c. Unit requirements

Masters degree: 36 units of 100 or 200 series courses of which at least 24 units must be in the graduate series (200 level) in biological sciences. A minimum of 12 units of course work other than courses in the 290 series must be completed in fulfillment of the requirements for 24 units of graduate course work.

Ph.D. degree: 36 units of 100 or 200 series courses of which at least 24 units must be in the graduate series (200 level) in the biological sciences. A minimum of 16 units of course work other than courses in the 290 series must be completed in fulfillment of the requirements for 24 units of graduate course work.

d. Required and recommended courses

Required: (MS and Ph.D.)

All students will be required to take one graduate level course in cell biology, one graduate level course in molecular biology and one graduate level course in developmental biology. Several graduate courses in each of these disciplines are currently offered as part of the curriculum in existing graduate programs at UCR. Our long range goal is to revise the current course offerings to remove unnecessary duplication and to offer a single, year long series of three graduate courses in cell, molecular and developmental biology which all students in the program will take and which will fully utilize the broad knowledge and talents of faculty participating in the program.

One graduate level course in cell biology:
   BIOL 200 A (Cell Biology) or BPSC 237 (Plant Cell Biology) or NRSC 200A (Fundamentals of Neuroscience)
One graduate level course in molecular biology:
   BIOL 200 B (Molecular Biology) or BCH 211 (Molecular Biology) or BPSC 231 (The Plant Genome) or BMSC 202 (Molecular Basis for Disease) or NRSC 200B (Fundamentals of Neuroscience)
One graduate level course in developmental biology:
   BPSC 232 (Plant Development) or BIOL 222 (Developmental Genetics), or ENTM226 (Insect Development)

Required (Ph.D.)

At least one of the following or any course from the above list other than the three used to fulfill the above requirement:

   BCH 210 (Biochemistry of Macromolecules)
   BCH 212 (Signal Transduction and Biochemical Regulation)
   BIOL 203 (Cellular Biophysics)
BIOL 211 (Selected Techniques in Microscopy)
BIOL 221 (Microbial Genetics)
BMSC 201 (Modern Methods in Biomedical Research)
BMSC 224 (Medical Immunology)
BMSC 225AB (Medical Microbiology)
BPSC 201 (Methods in Plant Biology)
BPSC 233 (Molecular Responses of Plants to the Environment)
BPSC 236 (Plant Microtechnique)
ENTM 208 (Biochemical and Molecular Host-Parasite Relationships)
ENTM 232 (Insect Molecular Biology)
ENTX 211 (Environmental and Molecular Carcinogenesis)
NEM 225 (Developmental Genetics of Caenorhabditis elegans)
PLPA 215 (Genetics of Fungi)
PLPA 219 (Molecular Plant Virology)

**Required (MS and Ph.D.)**

Graduate Seminar in Cell, Molecular and Developmental Biology (BCH, BIOL, BMSC, BPSC, ENTM, ETX, NEM, NRSC, PLPA 257)

This course can be repeated for credit and is required of each student in the program each quarter that a student is in residence and the seminar is offered (currently, fall quarter brings in distinguished outside speakers, winter quarter is “in-house” speakers, spring quarter is a one day retreat during which graduate students will present their research. All graduate students in the program who have been in residence more than three quarters will be required to present an annual seminar of their research findings, normally during this spring quarter retreat.

**Required (MS and Ph.D.)**

Graduate seminar courses in areas of specialization in which students present talks on special topics (e.g. BIOL 281 [Seminar in Cell Development, Structure and Function], BPSC 240 [Special Topics in Plant Biology], NRSC 289 [Special Topics in Neurosciences], PLPA 250 [Seminar in Plant Pathology]). One seminar course required of Masters students, two of Ph.D. students.

4. **Field Examination**

none
5. Ph.D. Qualifying Examination

a. Written examination

Students in the Ph.D. program must pass a written qualifying examination that covers the three disciplines: cell, molecular and developmental biology. A written examination will be prepared and graded by participating faculty. Normally, the exam will be taken prior to completion of six academic quarters in residence.

b. Oral examination

Following successful completion of the written qualifying examination, candidates for the doctoral degree must pass an oral examination, normally within two quarters (6 months) of the date of their written exam. The oral examination will be scheduled only after the candidate has written a proposal detailing the rationale, specific aims and approaches to be undertaken for her/his dissertation research. An oral examination committee, consisting of five faculty members of whom four will be members of the program and one will come from outside the program, will judge the student’s performance. The student’s dissertation advisor will not be a member of the exam committee. The committee will be chosen by the student in consultation with his/her dissertation advisor, will be nominated by the program’s Graduate Advisor, and will be appointed by the Dean of the Graduate Division. All members of the examination committee must be Academic Senate members. Successful completion of the oral examination and required course work by the student will result in his/her advancement to candidacy.

6. Thesis and/or Dissertation

The MS Thesis Committee or Ph.D. Dissertation Committee consists of a minimum of three Academic Senate members. All committee members should be able to provide guidance and judge the scholarship of the thesis or dissertation research. The committee will be nominated by the program’s Graduate Advisor and appointed by the Dean of the Graduate Division. A written thesis/dissertation will be completed by each student in the MS and Ph.D. program.

7. Final Examination

A candidate for the degree of MS or Ph.D. will defend his/her thesis or dissertation in a public, oral presentation at a time announced to members of the University community. Upon the candidate’s successful defense of the thesis/dissertation, the Thesis or Dissertation Committee will make a
recommendation to the Graduate Division that the MS or Ph.D. degree be conferred.

8. Explanation of Special Requirements over and above Graduate Division Minimum Requirements

None

9. Relationship of Master’s and Doctoral Programs

Students will normally be admitted either into the Master’s or into the Ph.D. program. Students in the Master’s program may petition for admission into the Ph.D. program. The program’s Graduate Advisory Committee will evaluate the petition and make a recommendation to the Graduate Division. The doctoral program includes a teaching requirement, additional course work, an oral and written qualifying examination, and a dissertation.

10. Special Preparation for Careers in Teaching

Not applicable.
11. Sample Program (Ph.D.)

Students will be able to emphasize particular areas of study while undertaking a cohesive series of courses. Faculty involved in these courses are making a concerted effort to cover the diversity of organisms, so that, as appropriate, animal, plant and microbial systems are discussed. The following sample schedules are designed to meet the needs of a student wishing to emphasize biochemical and biophysical approaches (Table II) or, instead, plant systems in cell, molecular and developmental biology (Table III). Students will be encouraged to undertake two or three quarter-long lab rotations during their first year so that they have ample opportunity to choose a lab that meets their research interests and so they can acquire exposure to a number of different approaches.

**Table II**
(sample program with emphasis in biochemistry and biophysics)

<table>
<thead>
<tr>
<th></th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st yr</td>
<td>Cell Biology (Biol 200A) (4)</td>
<td>Molecular Biology (Biol 200B or BCH 211) (4)</td>
<td>Developmental Genetics (Biol 222) (4)</td>
</tr>
<tr>
<td></td>
<td>Seminar in Cell, Molecular and Developmental Biology (CMD) (257) (1)</td>
<td>Seminar in CMD (257) (1)</td>
<td>Lab rotation (BPSC 290) (5)</td>
</tr>
<tr>
<td></td>
<td>Lab rotation (Biol 290) (5)</td>
<td>Lab rotation (BCH 290) (5)</td>
<td>Seminar in CMD (257) (1)</td>
</tr>
<tr>
<td></td>
<td>Electives or seminar (2-4)</td>
<td>Elective or seminar (2-4)</td>
<td>Elective or seminar (2-4)</td>
</tr>
<tr>
<td>2nd yr</td>
<td>Biochemistry of Macromolecules (BCH 210) (4)</td>
<td>Cellular Biophysics (Biol 203) (4)</td>
<td>Seminar in Cell Development, Structure and Function (Biol 281) (2)</td>
</tr>
<tr>
<td></td>
<td>Seminar in CMD (1)</td>
<td>Seminar in CMD (1)</td>
<td>Seminar in CMD (1)</td>
</tr>
<tr>
<td></td>
<td>297 research (6)</td>
<td>297 research (6)</td>
<td>297 research (6)</td>
</tr>
<tr>
<td></td>
<td>elective courses/seminar (1-4)</td>
<td>elective course/seminar (1-4)</td>
<td>elective courses/seminar (3-4)</td>
</tr>
<tr>
<td>3rd to 5th yrs</td>
<td>299 research (dissertation research) (8-11)</td>
<td>299 research (dissertation research) (8-11)</td>
<td>299 research (dissertation research) (8-11)</td>
</tr>
<tr>
<td></td>
<td>Seminar in CMD (1)</td>
<td>Seminar in CMD (1)</td>
<td>Seminar in CMD (1)</td>
</tr>
<tr>
<td></td>
<td>elective courses/seminars</td>
<td>elective courses/seminars</td>
<td>elective courses/seminars</td>
</tr>
</tbody>
</table>

16
### Table III
Sample schedule with emphasis in plant systems

<table>
<thead>
<tr>
<th></th>
<th>Fall</th>
<th>Winter</th>
<th>spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; yr</td>
<td>Plant Cell Biology (BPSC 237) (4)</td>
<td>Plant Development (BPSC 232) (4)</td>
<td>Developmental Genetics (Biol 222) (4)</td>
</tr>
<tr>
<td></td>
<td>Plant Genome (BPSC 231) (4)</td>
<td>Seminar in CMD (1)</td>
<td>Lab rotation (PLPA 290) (5)</td>
</tr>
<tr>
<td></td>
<td>Seminar in CMD (1)</td>
<td>Lab rotation (BPSC 290) (5)</td>
<td>Seminar in CMD (1)</td>
</tr>
<tr>
<td></td>
<td>Lab rotation (BPSC 290) (3)</td>
<td>Elective or seminar (2-4)</td>
<td>Elective or seminar (2-4)</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; yr</td>
<td>Biochemistry of Macromolecules (BCH 210) (4)</td>
<td>Seminar in CMD (1)</td>
<td>Graduate seminar (2)</td>
</tr>
<tr>
<td></td>
<td>Seminar in CMD (1)</td>
<td>Elective courses/seminar (5)</td>
<td>297 research (6)</td>
</tr>
<tr>
<td></td>
<td>297 research (6)</td>
<td>297 research (6)</td>
<td>Seminar in CMD (1)</td>
</tr>
<tr>
<td></td>
<td>elective courses/ seminar (1-4)</td>
<td></td>
<td>elective course(3-4)</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt;-5&lt;sup&gt;th&lt;/sup&gt; yrs</td>
<td>299 research (thesis research) (8-11)</td>
<td>299 research (thesis research) (8-11)</td>
<td>299 research (thesis research) (8-11)</td>
</tr>
<tr>
<td></td>
<td>Seminar in CMD (1)</td>
<td>Seminar in CMD (1)</td>
<td>Seminar in CMD (1)</td>
</tr>
<tr>
<td></td>
<td>elective courses/seminars</td>
<td>elective courses/seminars</td>
<td>elective courses/seminars</td>
</tr>
</tbody>
</table>

12. **Normative Time from Matriculation to Degree**

A typical student will be expected to complete the masters program in 2 years and the doctoral program in 5 years.
SECTION 3

PROJECTED NEED

1. Student Demand for the Program

The National Research Council recognizes cell and developmental biology and cell and molecular biology as major disciplines in the biological sciences (see Appendix V), and specifically ranks Ph.D. programs in these areas. There is enormous excitement in these fields which attracts students who seek to be part of the discovery process. Moreover, a range of career opportunities await individuals with training in these fields; jobs can be obtained in industry as well as in academia, and in the public as well as in the private sector. The proposed program would be an evolution of the current Ph.D. track in Cell and Molecular Biology in the Department of Biology. Moreover, there are students in other Ph.D. programs at UCR whose research interests falls into these disciplines. For example, the Department of Botany and Plant Sciences currently has an NSF training grant in this area which has supported 12 students (see Appendix VI). An interdepartmental degree program would martial faculty efforts and resources, enhance faculty and student interactions and productivity, and likely augment the overall reputation of these fields on this campus. Such activity would then generate even greater interest among potential students who will likely be attracted to this campus when such a program is evident and when information on the range of opportunities available is more widely disseminated. While we currently are able to attract students to these fields, a formal program will provide greater educational and training opportunities and will be substantially more attractive to students seeking a degree in cell, molecular and developmental biology.

2. Opportunities for Placement of Graduates

There is a high demand in both industry and academia for scientists with training in cell, molecular and developmental biology. While faculty positions are always at a premium, a high proportion of those advertised are for individuals with expertise in the fields in which our students will be trained. Our program should produce students that are well equipped to fill a number of different types of positions. Many of the positions advertised in industry are for scientists with an MS degree with training in molecular biology or cell culture or antibody production or a number of other areas within cell, molecular or developmental biology in which our students will receive training. Thus, we anticipate that students receiving this degree will have excellent job prospects. The American Society for Cell Biology currently has about 7200 members, the Developmental Biology Society currently has about 1200 members and the Society for Neuroscience has a large number of members who use cell, molecular and developmental biology approaches to study the behavior of
neurons. A recent search of *Science*’s web site job postings revealed that during a one month window, 400 positions were advertised in these fields, of which 100 were for tenure track/professional positions and 300 were for postdoctoral positions. A few examples of these positions from recent issues of *Science* can be found in Appendix VII).

3. Importance to the Discipline

The traditional fields in the biological sciences that have divided the discipline along taxonomic lines (e.g., plants, vertebrates, insects, etc.) make little sense at the level of molecules, cells, and the developmental pathways that give rise to multicellular organisms where research is based on fundamental mechanisms that are common to all or most organisms. A Ph.D. program that will provide interdisciplinary training within these fields and across taxa, in which the importance of these disciplines to agriculture as well as medicine are clearly articulated, will provide our students with a depth and breadth of knowledge that will make them well qualified to participate in the development of these fields. The variety of faculty membership in the proposed program makes this goal a feasible one.

4. Ways in which the Program will meet the Needs of Society

In the last two decades, many of the most important advances in both medicine and in agriculture have come from cell, molecular or developmental approaches. For example, an understanding of the basis for hypercholesterolemia, a condition that is characterized by a high rate of fatal heart attacks, came from cell and molecular biological studies that lead to the discovery of the basic cellular process of receptor mediated endocytosis and the existence of LDL receptors in cell membranes. Cell, molecular and developmental biology analysis of the cell cycle has led to the discovery and function of genes that when aberrant lead to abnormal cell growth and, accordingly, cancer. Molecular and developmental biology approaches to disease resistance have led to the discovery of genes in plants that confer resistance to specific pathogens, and biotechnological manipulation of the plant genome has led to increased crop production. Students in our program receiving training in these disciplines will be fully able to contribute to increasing our understanding in these fields, by participating either in basic or applied research.
5. Relationship of the Program to Research and/or Professional Interests of the Faculty.

A large number of faculty members at UCR are engaged in research encompassing the disciplines of cell, molecular and developmental biology. A Graduate Research Umbrella that includes this faculty has recently been established on this campus, and an interdepartmental colloquium series, bringing in distinguished outside speakers, specifically under the auspices of this umbrella, is now in its second year. The faculty is scattered in diverse departments, and the interdepartmental Ph.D. program will be a very effective mechanism for facilitating productive interactions among this faculty and for generating an enriched atmosphere for training graduate students. Because we are a small campus, interactions within this group are especially important and have proven to be quite effective.

6. Program Differentiation

Several of the UC campuses have programs in Cell and Molecular Biology (UCB and UCSD) or Cell and Developmental Biology (UCI, UCD) or Cell Biology (UCSF) or Cell, Molecular and Developmental Biology (UCLA, UCSB). Ours will encompass these disciplines with a balance of plant, animals and microbial systems and an emphasis on both basic and applied research. While a Cell, Molecular and Developmental Biology program would be justifiable on each of the UC campuses, our program may be unique in its integration of Agricultural Experiment Station faculty, Biomedical Sciences faculty, and basic science faculty. This interdepartmental program will provide students with a range of opportunities and an excellent exposure to this science in its many facets.
SECTION 4

STAFF

The Cell, Molecular and Developmental Biology faculty is self identified from among 8 biological science departments on the Riverside campus. Each member has a research interest in one or more of these disciplines. See appendix for Biographical Sketches (Appendix VIII).

Biochemistry
- Helen Henry, Professor
- Anthony Norman, Professor
- Stephen Spindler, Professor

Biology
- Katherine Atkinson, Associate Professor
- Richard Cardullo, Associate Professor
- Leah Haimo, Professor
- Bradley Hyman, Associate Professor
- Manuel Martins-Green, Assistant Professor
- Dmitri Mazlov, Assistant Professor
- Walter Metzner, Assistant Professor
- Irwin Sherman, Professor Emeritus
- Prudence Talbot, Professor
- Raphael Zidovetzki, Professor

Biomedical Sciences
- MaryLou Oster Granite, Professor
- Richard Luben, Associate Professor
- Neil Schiller, Professor
- Daniel Straus, Professor

Botany and Plant Sciences
- Julia Bailey-Serres, Associate Professor
- Elizabeth Bray, Associate Professor
- Timothy Close, Associate Professor
- Darleen DeMason, Professor
- Robert Heath, Professor
- Tony Huang, Professor
- Elizabeth Lord, Professor
- Monica Madore, Associate Professor
- Gene Nothnagel, Professor
- Patricia Springer, Assistant Professor
- Linda Walling, Associate Professor

Entomology
- Peter Atkinson, Associate Professor
- Nancy Beckage, Professor
- David Eastmond, Associate Professor
- Brian Federici, Professor
- Andrew Grosovsky, Associate Professor
Sarjeet Gill, Professor
Frances Sladek, Assistant Professor

Nematology
James Baldwin, Professor
Isgouhi Kaloshlan, Assistant Professor

Neurosciences
Michael Adams, Professor
Scott Currie, Assistant Professor
Margarita Curras, Assistant Professor
Glenn Hatton, Professor

Plant Pathology
Salomon Bartnicki-Garcia, Professor Emeritus
Dennis Focht, Professor
Howard Judelson, Assistant Professor
Noel Keen, Professor
A.L. N. Rao, Assistant Professor

Pending positions: A search to fill two positions, an open rank position and an assistant professor level position, both in Developmental Biology with appointment in the Department of Biology, is underway in the 1997-1998 academic year for appointment in the 1998-1999 academic year.
SECTION 5

COURSES

Biochemistry
BCH 210, Biochemistry of Macromolecules (3)
BCH 211, Molecular Biology (3)
BCH 212, Signal Transduction and Biochemical Regulation (3)
BCH 222, Advanced Biochemistry Laboratory (1-3)
BCH 230, Advanced Topics in Biochemistry (1-3)

Biology
BIOL 200AB, Cell, Molecular and Developmental Biology (4-4)
BIOL 203, Cellular Biophysics (3)
BIOL 211, Selected Techniques in Microscopy (5)
BIOL 221, Microbial Genetics (4)
BIOL 222, Developmental Genetics (3)
BIOL 262, Advances in Cell, Molecular and Developmental Biology (1-2)
BIOL 281 Seminar in Cell Development, Structure and Function (2)

Biomedical Sciences
BMSC 201, Modern Methods in Biomedical Research (3)
BMSC 202, Molecular Basis for Disease (3)
BMSC 224, Medical Immunology (4)
BMSC 225AB, Medical Microbiology (5-5)
BMSC 222, Special Topics in Biomedical Sciences (2)

Botany and Plant Sciences
BPSC 201, Methods in Plant Biology (1-2)
BPSC 231, The Plant Genome (4)
BPSC 232, Plant Development (4)
BPSC 233, Molecular Responses of Plants to the Environment (4)
BPSC 236, Plant Microtechnique (4)
BPSC 237, Plant Cell Biology (4)
BPSC 239, Plant Metabolism (3)
BPSC 240, Special Topics in Plant Biology (2)

Entomology
ENTM 208, Biochemical and Molecular Host-Parasite Relationships (4)
ENTM 226, Insect Development (3)
ENTM 232, Insect Molecular Biology (3)
ENTM 281, Research Seminar in Molecular Entomology (1)

Environmental Toxicology
ENTX 211 Environmental and Molecular Carcinogenesis (3)

Nematology
NEM 225 Developmental Genetics of Caenorhabditis elegans (2)

Neurosciences
NRSC 200AB, Fundamentals of Neuroscience (3-3)
NRSC 289 Special Topics in Neuroscience (2)

Plant Pathology
PLPA 215 Genetics of Fungi (3)
PLPA 219, Molecular Plant Virology (3)

Cross-listed courses:
Seminar in Cell, Molecular and Developmental Biology (1) (BCH, BIOL, BPSC, ETOM, NRSC, PLPA 257)
Colloquium in Recombinant DNA (1) (BCH, BIOL, BPSC, ETOM, PLPA 261)

Catalogue descriptions of all courses are in appendix (Appendix IX). The courses are all currently offered (some on alternate years) and are all staffed.
SECTION 6
RESOURCE REQUIREMENTS

1. FTE Faculty

Although no additional faculty positions are sought, new or replacement positions, when awarded to departments with faculty in this program, can be utilized, when filled in an appropriate area, to enhance this program. A half-time graduate student affairs staff member would greatly facilitate the smooth running of an interdepartmental graduate program. In addition, a stipend for the director of the program will be requested.

2. Library Acquisition

The UCR library currently subscribes to the major journals and purchases the important monographs in the disciplines of cell, molecular and developmental biology. The new Sciences Library will be completed shortly and will greatly enhance the campus’s library and computing facilities (see Appendix X).

3. Computing Costs

Computer facilities, utilized by both faculty and graduate students, are present in all departments. Most faculty possess one or more computers to use in both research and other activities, and many of these are accessible to students. Some departments provide computer facilities specifically for the use of graduate students. A number of computers to be integrated into an interdepartmental light microscope facility (see “Equipment” below) has been requested on a federal grant application with matching funds to be provided by UCR.

4. Equipment

While the campus has recently acquired a state of the art electron microscope facility (see Appendix XI), a comparable light microscope facility is needed to support research in cell, molecular and developmental biology. A proposal has been submitted by faculty in the Cell, Development and Molecular Biology GRU to the NSF for a major instrumentation grant, with matching funds approved by the UCR administration, to purchase microscopes and computers that will be used to establish a general-use digital light microscope facility (See Appendix XII).
5. Space and other Capital Facilities

The proposed interdepartmental program in Cell, Molecular, and Developmental Biology will exist in current space, albeit office space for the graduate student affairs officer and a conference room for seminars and group meetings will be sought.

6. Other Operating Costs

The interdepartmental graduate program will be widely advertised each year via targeted mailings of posters describing the program and yearly updating of our web site. The former will require funds to produce and mail the posters ($~3000), the latter will be undertaken by a staff or faculty member. The costs for a poster and web site for the new GRU in Cell, Molecular, and Developmental Biology have been provided by the college Dean’s office and Graduate Division. A colloquium series, Graduate Seminar in Cell, Molecular, and Developmental Biology, is held one quarter each year with distinguished outside speakers ($3000), and is funded by the college Dean’s office. In-house speakers will be featured during the second quarter of each year, and a retreat, during which graduate students will speak, will be held the third quarter of each year ($1500).

It is anticipated that the new program, evolving as it will from the current track in Cell and Molecular Biology in the Department of Biology, will not require a major new input of resources. It is anticipated that the faculty in Biology who participate in the track will, instead, participate in the interdepartmental program. Faculty can be members of this program but can retain membership in other existing Ph.D. programs.
SECTION 7

GRADUATE STUDENT SUPPORT

Graduate students in the proposed program will be supported by a combination of sources. Current training grants from NSF in plant growth and development and a GAANN award for graduate training in the biological sciences now support several graduate students in the areas of cell, molecular or developmental biology and can be used to support graduate students entering the new program. Additional proposals will be submitted to federal agencies, as appropriate, to acquire training grants specifically for this program. Other support will come from research assistantships and teaching assistantships, the latter of which will provide substantial support due to the large undergraduate workload in cell, molecular and developmental biology of courses with laboratory or discussion sections. The departments with faculty participating in this program will work in partnership with the Graduate Division and the College of Natural and Agricultural Sciences Dean to provide funding to support students.

SECTION 8

CHANGES IN SENATE REGULATIONS

No changes in Academic Senate Regulations are envisioned.