

Biotechnology is primarily the application of DNA technology. This technology uses DNA sequences from any organism or synthesized and modified genes for transfer to cells across species boundaries to obtain a desired outcome. It has a wide range of applications including medicine, agriculture, forensics and the environment, as well as industrial applications in most of these areas. With this technology, a laboratory may produce vaccines, antibiotics, genetically modified cell lines or nutritionally enriched food products. This technology has the potential to reduce environmental pollution. Crops with genes imported from another source can increase crop yield, be more insect resistant and make its own fertilizer. Transgenic crops may one day reduce tillage farming and thus reduce soil erosion. Both embryonic and adult stem-cell technology in the health sciences relies on biotechnology strategies.

The U.S. Department of Labor reports that while the biotechnology industry has historically employed Ph.D.s and Master Degree graduates, the growing industry trend is to seek baccalaureate and associate degree graduates who can perform routine but essential technical tasks.

The Department of Biological Sciences at Kingsborough Community College currently offers an A.S. in Biology. This curriculum gives graduates a foundation essential for further study in any specialized area of study in biology. Biotechnology is currently offered as a concentration within the A.S. in Biology.

A proposal for an Associate of Science (A.S.) in Biotechnology has been developed by the Department of Biological Sciences and the Office of Academic Affairs of Kingsborough Community College, in collaboration with the Department of Biology and the Office of the Provost, Brooklyn College. The purpose of the new degree will be to prepare Kingsborough graduates to assist in biotechnology research, begin a career in this developing scientific field and earn a Baccalaureate (B.A. or B.S.) in Biology at Brooklyn College.

The A.S. in Biotechnology is designed for those who wish to build their academic skills and gain the essential general knowledge for future higher degrees in the biological sciences, while at the same time begin to develop the specialized skills and acquire the specialized knowledge for future work in biotechnology. The joint registration of this associate degree with Brooklyn's two baccalaureate degrees in biology will ensure graduates the smoothest transfer possible and the greatest potential for continued academic success.

The faculty of the Department of Biology at Brooklyn College is committed to this educational partnership with the Department of Biological Sciences at Kingsborough. Brooklyn's baccalaureate programs in biology allow for specialization in a number of fields. To facilitate post-baccalaureate studies for Brooklyn College graduates, articulation agreements have been established with graduate and doctoral programs in biology and health-related professions. KCC graduates who successfully complete a baccalaureate in biology at Brooklyn College will have these articulation opportunities for further study available to them.

Kingsborough's new program will be directed by a biotechnologist who is currently teaching biotechnology foundations and basic applications to A.S. in Biology majors interested in concentrating in this field. Among his accomplishments, Dr. Sarwar Jahanjir has developed a domesticated stock of transgenic lake sturgeon and has obtained U.S. FDA approval for a recombinant vaccinia virus containing the human interleukin-2 gene and its application in human vaccination against melanoma. Dr. Cathy McEntee, who has studied the regulation of gene transcription in yeast mitochondria, will also teach biotechnology major

courses. Both Dr. Jahanjir and Dr. McEntee have been faculty participants in CSTEP grants and are committed to recruiting and mentoring more nontraditional students into biotechnology studies.

A dedicated standard biotechnology laboratory of about 800 square feet working area has been created to provide students with essential laboratory training in this field. The acquisition of additional equipment and supplies is planned and will be ready for the first class of A.S. in Biotechnology majors. Opportunities to expand the laboratory space and available equipment will be sought as the program develops.

## **1. Purpose and goals**

Biotechnology is primarily the application of DNA technology both practical and theoretical. This technology uses DNA sequences from any organism or synthesized and modified genes for transfer to cells across species boundaries to obtain a desired outcome. It has a wide range of applications including medicine, agriculture, forensics and the environment, as well as industrial applications in most of these areas. With this technology, a laboratory may produce vaccines, antibiotics, genetically modified cell lines or nutritionally enriched food products. This technology has the potential to reduce environmental pollution. Crops with genes imported from another source can increase crop yield, be more insect resistant and make its own fertilizer. Transgenic crops may one day reduce tillage farming and thus reduce soil erosion. Both embryonic and adult stem-cell technology in the health sciences relies on biotechnology strategies.

The proposed Associate in Science (A.S.) in Biotechnology has been developed by the Department of Biological Sciences and the Office of Academic Affairs of Kingsborough Community College, in collaboration with the Department of Biology and the Office of the Provost, Brooklyn College. The purpose of the new degree is to prepare Kingsborough graduates to assist in biotechnology research, begin a career in this developing scientific field and earn a Baccalaureate (B.A. or B.S.) in Biology at Brooklyn College. The joint registration of this associate degree with Brooklyn's two baccalaureate degrees in biology will ensure graduates the smoothest transition to baccalaureate-level study

The Department of Biological Sciences at Kingsborough Community College currently offers an A.S. in Biology. This curriculum gives graduates a foundation essential for further study in any specialized area of study in biology. Options for elective biological course work provides academic preparation for transfer to baccalaureate study in pharmacy, physician assistant, occupational therapy and other health-related career fields which require a foundation in biology. The A.S. in Biology also offers an option in marine biology. The Department also offers the A.A.S. in Physical Therapist Assistant.

Brooklyn College offers a Bachelor of Arts and a Bachelor of Science in Biology. Both programs lead to a broad understanding of biological principles and, at the same time, allow for specialization in a number of biological fields. The B.A. specifies 35-41.5 required credits in the major while the B.S. degree specifies 48-50.5. The B.A. degree offers a full major in Biology while providing room for students to take more courses outside the Biology Department. The B.S. requires more advanced courses in Biology, Chemistry and other science and mathematics courses which are often required for admission to post-graduate professional programs.

Opportunities for research for either the B.A. or B.S. major in Biology are available through faculty-mentored original student projects in the junior and senior year of the curriculum. Brooklyn's graduates routinely go on to graduate and doctoral studies in various fields of specialization in biology or a variety of health and other professions. Brooklyn College already has a number of articulation agreements with professional schools in different health-related fields which guarantee students acceptance to the entering class at these schools assuming a high level of performance during their undergraduate education.

The faculty of the Department of Biology at Brooklyn College is committed to this educational partnership with the Department of Biological Sciences at Kingsborough Community College and is ready to provide the baccalaureate component of a jointly registered Associate of Science (A.S.) in Biotechnology leading to the Bachelor of Arts (B.A.) or Bachelor of Science (B.S.) in Biology. This jointly offered program

will facilitate closer planning of the curriculum within and between these degree programs to allow for the maximum coordination of course credits for completion of the requirements for both the A.S. and B.A. or B.S. degrees. A student entering the A.S. Program in Biotechnology at Kingsborough will be well-prepared for continuation towards either the B.A. or B.S. degree in Biology at Brooklyn College and will ensure Kingsborough-Brooklyn graduates the ability to go on to advanced study in any biological, health or other biologically-based field, if this is their goal.

## **2. Need for the Curriculum**

The biological sciences are progressing at an incredible rate particularly in the field of biotechnology. Japan, Germany, Canada, India and many other nations have thriving biotechnology enterprises in areas of health, agriculture, forensics and the environment. The United States needs to progress at a faster rate in order to retain its leadership in this highly competitive field. The discovery and development of assisted-fertilizations, antibiotics, vaccines, heart-bypass and organ-transplant medications using older methodologies have lost their competitive edge compared with more current gene and cell technologies utilized in these same areas.

Currently, New York and the New York Biotechnology Association (NYBA) are working together to make the State a premier location for biotechnology. While, the US DOL expects employment in the biotechnology industry to grow 30.8% by 2012, the NY DOL projects it to grow 26.7% in the State by 2010.

In 2004, President Bush announced the High Growth Job Training Initiative grant. Under this grant, nine projects totaling more than seventeen million dollars were funded for developing an entry-level workforce in biotechnology. New York launched several such initiatives to promote the biotechnology industry within the State and invested more than \$27 million in science and technology initiatives in NYC in three years (2000-2003). These include \$20 million to create the New York Structural Biology Center at City University which is designed to conduct and develop new therapeutic approaches to human diseases and to identify molecules for use in drug development. Other notable centers include Columbia University Center for Advanced Technology (CAT), The State University of New York CAT, SUNY Downstate Biotechnology Incubator, and Albert Einstein Biotechnology Center.

New York State's biotechnology industry is generally located in New York City and the lower Hudson Valley. According to a LEK Consulting and NYBA survey of the biotechnology industry, 65% of New York's biotechnology companies are located in New York City. It is also notable that in NY State, for every one public biotechnology company there are three private ones. A Summer 2008 publication of the New York City Economic Development Corporation reported that there are currently over 125 commercial bioscience companies throughout the five boroughs.

According to an OTA (Office of Technology Assessment) report, there are at least 60 American colleges and universities, including eight in New York, which provide training and education in biotechnology and offer a Certificate, an A.S. or higher degrees. Many of these institutions are community colleges. (In New York, Monroe Community College offers the A.S. in Biotechnology.) According to the US DOL, the American biotechnology industry faces shortages of workers who have knowledge of GMP (Good Manufacturing Practice), QC (Quality Control) and industry regulations. The US DOL report also noted that while the biotechnology industry has historically employed Ph.D.s and Master Degree graduates, the growing industry trend is to seek baccalaureate and associate degree graduates who can perform routine but essential technical tasks. The US DOL and the White House have emphasized that community colleges need to develop

biotechnology and life science programs to meet industry demands. Academic institutions, in collaboration with biotechnology industries, are reaching out to high schools and introducing students to the field and curricular expectations.

Highly qualified and enthusiastic faculty is committed to offering the A.S. in Biotechnology. The major will be strongly supported by courses offered by the Physical Sciences Department, and the Mathematics and Computer Sciences Department. The program's general education component will be supported by existing courses in liberal arts, one in health education and in pre-requisite courses for the major.

### **3. Students**

Enrollment in biology courses at KCC has exceeded 1,800 seats per semester. Most of the students enrolled are fulfilling major requirements for the A.S. in Biology, A.A.S. in Physical Therapist Assistant, A.A.S. in Nursing, A.A.S. in Surgical Technology or they are non-health science majors fulfilling the general education requirements for their degree. Kingsborough currently offers a biotechnology concentration for students who can transfer to Brooklyn College or York College or other 4-year colleges for BA/B.S. in Biology degrees. However, a significant number may not achieve their goal of entering allied health sciences programs due to limited seats in high-demand baccalaureate programs and they may become interested in biological research and development while enrolled in the pre-requisite biology courses for these majors. A.S. in Biology majors have expressed interest in biotechnology and some have participated in KCC faculty-led biotechnology-related research projects. It is noteworthy that a teacher from the on-campus Leon Goldstein High School has referred a student who is interning with KCC faculty for biotechnology-related research. The college sees these students as potential biotechnology majors, particularly among first-time freshmen.

Approximately 65% of our students are female, 33% of degree students are over 25, and 68% are over 22 years old. Our students speak 68 languages and come from 110 countries. The combined minority enrollment exceeds 50%. The average household income of 61% of our students is less than \$25,000, while 65% of our students balance school with work, and 36% work more than 20 hours a week. Eleven percent of our students are single parents and 18% support children.

Despite financial and other obstacles, many students persist towards the completion of a degree or certificate. KCC six-year graduation rate is 34%, the highest among the CUNY community colleges.

The estimated yearly enrollments for biotechnology programs for the first five years are shown in the Table below:

| <b>Estimated Yearly Enrollment for the Proposed A.S. in Biotechnology Program</b> |                      |                      |                          |                          |                          |
|-----------------------------------------------------------------------------------|----------------------|----------------------|--------------------------|--------------------------|--------------------------|
|                                                                                   | 1 <sup>st</sup> Year | 2 <sup>nd</sup> Year | 3 <sup>rd</sup> Year     | 4 <sup>th</sup> Year     | 5 <sup>th</sup> Year     |
| Semester I                                                                        | 8                    | 8                    | 8                        | 8                        | 8                        |
| Semester II                                                                       | 14                   | 14                   | 14                       | 14                       | 28                       |
|                                                                                   |                      |                      |                          |                          |                          |
| Semester III                                                                      | 0                    | 22                   | 22                       | 22                       | 22                       |
| Semester IV                                                                       | 0                    | 20                   | 20 + 4 <sup>†</sup> = 24 | 20 + 5 <sup>†</sup> = 25 | 20 + 5 <sup>†</sup> = 25 |
| Total                                                                             | 22                   | 42                   | 46                       | 47                       | 47                       |
| Graduated                                                                         | 0                    | 16                   | 19                       | 20                       | 20                       |

Retention is calculated from KCC's own findings based on general rate of retention at various levels. Hence, retention from 1<sup>st</sup> to 2<sup>nd</sup> Semester is calculated at 75%, from 2<sup>nd</sup> to 3<sup>rd</sup> Semester is calculated at about 80%, and from 3<sup>rd</sup> to 4<sup>th</sup> Semester is calculated at 90%, with adjustments. The graduation rate is calculated at 80% and the 20% uncompleted students are added to the following year 4<sup>th</sup> Semester as indicated by †.

#### **4. Curriculum**

To earn the A.S. in Biotechnology, students will prepare solutions and reagents, demonstrate aseptic techniques, prepare bacterial and bacteriophage cultures, and be familiar with the latest theoretical and practical tools used in biotechnology laboratories, including molecular and cellular techniques and instrumentation. Students will gain knowledge of the structure, function, isolation, characterization, cloning and expression of DNA molecules, isolate and culture mammalian cells, generate mammalian stem cells, and learn the process of cell cloning. They will be able to read and develop statistical tables and graphs, use computer software for preparing reports and processing data. Students will work effectively in teams, demonstrate excellent oral and written communication skills, be familiar with potential job opportunities in the biotechnology industry, and complete a biotechnology independent study with either a CUNY professor or elsewhere within the biotechnology industry through an internship. Furthermore, students will complete general education courses in English, health education and a choice of three courses from the humanities, the social and/or behavioral sciences.

An outline listing the requirements for the degree are on the following page.

# Proposed A.S. in Biotechnology

**Total Credits: 60**

## *Requirements for Matriculants*

### COLLEGE REQUIREMENTS 10 Cr (Credits)

Successful completion of CUNY/ACT Tests in Reading and Writing and the COMPASS Math Skills Test with passing examination scores or developmental courses may be required.

|           |        |
|-----------|--------|
| ENG 01200 | (4 cr) |
| ENG 02400 | (3 cr) |
| HPE 01200 | (3 cr) |

### DEPARTMENT REQUIREMENTS §

#### **Departmental requirements (Proposed):**

##### **Biology: 20 Cr**

|                                                                                        |                 |
|----------------------------------------------------------------------------------------|-----------------|
| BIO 13 General Biology I                                                               | (4 cr, 6 hrs)   |
| BIO 14 General Biology II                                                              | (4 cr, 6 hrs)   |
| BIO 50 General Microbiology or Bio 59 Genetics                                         | (4 cr, 6 hrs)   |
| BIO 58 Recombinant DNA Biotechnology or BIO 57 Cell & Tissue Culture, and Cell Cloning | (4 cr, 6 hrs) * |
| BIO 63 Molecular and Cellular Biology                                                  | (4 cr, 6 hrs) * |

##### **Chemistry: 8 Cr**

|                             |              |
|-----------------------------|--------------|
| CHM 11 General Chemistry I  | (4 cr, 6 hr) |
| CHM 12 General Chemistry II | (4 cr, 6 hr) |

##### **Mathematics and Computer Science: 6-7 Cr**

|                                                                                                                                |                    |
|--------------------------------------------------------------------------------------------------------------------------------|--------------------|
| MAT 20 Elements of Statistics                                                                                                  | (3 cr, 3 hrs.)     |
| BIO/CIS 60 (Proposed) Bioinformatics or BA 60 or CP 11 or TEC 25<br>(Students electing to take Bio/Cis 60 need to take Mat 14) | (3-4 cr, 3-4 hrs.) |

### GROUP REQUIREMENTS - 9 Cr (9 cr, 9 hrs.)

A minimum of three credits must be in Basic Courses and no more than one course in any one group I – IV.

- I. Performing and Visual Arts  
(Excluded are Art & Music Studio, Theatre Production & Technique courses)
- II. Language and Literature  
Foreign Language - Literature – Philosophy
- III. Social Sciences  
History- Economics – Political Science
- IV. Behavioral Sciences  
Anthropology - Psychology - Sociology

### ELECTIVES 6-7 Cr – Sufficient to meet required total of 60 credits

\* New courses. Descriptions are on page 15. For syllabi see Appendix A.  
§ Consultation with the Department Advisor is required.

Graduates of the A.S. in Biotechnology will be deemed to have automatically fulfilled the lower tier core requirements for a Brooklyn College baccalaureate degree with the exception of the foreign language requirement. Students will be required to complete two upper tier courses, from two of the three groups of courses approved effective September 2006. It will be recommended that they select from among the course groups *Exploring Literature* and *Exploring Global Connections*.

Graduates of the A.S. degree program who have not completed at least one year of foreign language study or established an equivalent proficiency may be asked to complete six (6) to eight (8) credits of foreign language coursework or establish an equivalent proficiency in addition to their normal degree requirements. Proficiency may be established based upon high school coursework, native language abilities or examination.

## **B.A. Degree Requirements for the Biology Major:**

### **All of the following Lecture Courses (2 credits each)**

- Bio 17 – Cell and Molecular Biology (waived for students completing KCC Bio 63)
- Bio 29 – Organismic Biology I (Plants) (waived for students completing KCC Bio 13 and 14)
- Bio 34 – Animal Physiology OR Bio 34.1 – Comparative Physiology (either course waived for students completing KCC Bio 13 and 14)
- Bio 38 -- Evolution and Ecology
- Bio 45 -- Organismic Biology II (Animals)
- Bio 52 – Microbiology (waived for students completing KCC Bio 50)
- Bio 58 – Genetics (waived for students completing KCC Bio 59)

### **All of the following Laboratory Courses (2 credits each)**

- Bio 17.1 -- Eukaryotic Cell Biology and Physiology Lab (waived for students completing KCC Bio 63)
- Bio 29.1W – Plant Form and Function Lab (satisfies the BC Writing Across the Curriculum Requirement for the Biology Major)
- Bio 45.1 -- Animal Form and Function Lab
- Bio 52.2 -- General Microbiology Lab (waived for students completing KCC Bio 50)

**Choose from the Elective Courses below in order to satisfy the residency requirement of at least 18 credits taken in the Department of Biology; courses may be added or deleted in the future.**

- Bio 15 – Field Studies in Botany 4 credits
- Bio 25 – Field Studies in Zoology 4 credits
- Bio 26 – Developmental Biology Lecture 3 credits
- Bio 27.5 – Molecular Biology of Development 4 credits
- Bio 33 – Bioinformatics 2 credits (not open to students completing KCC Bio/CIS 60)
- Bio 39.1 – Cell Culture Techniques 3 credits (not open to students completing KCC Bio 57)
- Bio 55.1 – Recombinant DNA Lecture 3 credits (not open to students completing KCC BIO 58)
- Bio 62.5 – Ecology 4 credits
- Bio 73.1, 73.2 –Research I and II (or 83.1, 83.2 – Departmental Honors Courses) 3 credits each

## **Chemistry Requirements**

### **The following Chemistry Courses or their equivalents are required**

- Chem 1, 2 – General Chemistry I and II 5 credits each (waived for students completing KCC CHM 11 and CHM 12)
- Chem 50 – Organic Chemistry for Health-related Professions 5 credits

## **Mathematics Requirements**

### **The following Mathematics Courses or their equivalents are required**

- Math 2.9 – Precalculus Mathematics 3 credits
- Math 3.3 – Calculus I 3 credits

## **B.S. Degree Requirements for the Biology Major:**

### **All of the following Lecture Courses (2 credits each)**

- Bio 17 – Cell and Molecular Biology (waived for students completing KCC Bio 63)
- Bio 29 – Organismic Biology I (Plants) (waived for students completing KCC Bio 13 and 14)
- Bio 34 – Animal Physiology OR Bio 34.1 – Comparative Physiology (either course waived for students completing KCC Bio 13 and 14)
- Bio 38 -- Evolution and Ecology
- Bio 45 -- Organismic Biology II (Animals)
- Bio 52 – Microbiology (waived for students completing KCC Bio 50)
- Bio 58 – Genetics (waived for students completing KCC Bio 59)

### **All of the following Laboratory Courses (2 credits each)**

- Bio 17.1 -- Eukaryotic Cell Biology and Physiology Lab (waived for students completing KCC Bio 63)
- Bio 29.1W – Plant Form and Function Lab (satisfies the BC Writing Across the Curriculum Requirement for the Biology Major)
- Bio 45.1 -- Animal Form and Function Lab
- Bio 52.2 -- General Microbiology Lab (waived for students completing KCC Bio 50)

**Choose from the Elective Courses below in order to satisfy the residency requirement of at least 24 credits taken in the Department of Biology; courses may be added or deleted in the future.**

- Bio 15 – Field Studies in Botany 4 credits
- Bio 25 – Field Studies in Zoology 4 credits
- Bio 26 – Developmental Biology Lecture 3 credits
- Bio 27.5 – Molecular Biology of Development 4 credits
- Bio 33 – Bioinformatics 2 credits (not open to students completing KCC Bio/CIS 60)
- Bio 39.1 – Cell Culture Techniques 3 credits (not open to students completing KCC Bio 57)
- Bio 55.1 – Recombinant DNA Lecture 3 credits (not open to students completing KCC BIO 58)
- Bio 62.5 – Ecology 4 credits
- Bio 73.1, 73.2 –Research I and II (or 83.1, 83.2 – Departmental Honors Courses) 3 credits each

## **Chemistry Requirements**

### **The following Chemistry Courses or their equivalents are required**

- Chem 1, 2 – General Chemistry I and II 5 credits each (waived for students completing KCC CHM 11 and CHM 12)
- Chem 51,52– Organic Chemistry I and II 5 credits each

## **Mathematics Requirements**

### **The following Mathematics Courses or their equivalents are required**

- Math 2.9 – Precalculus Mathematics 3 credits
- Math 3.3 – Calculus I 3 credits

**Highly Recommended Additional Courses for Majors intending to earn advanced degrees in selected fields. Department faculty should be consulted:**

- General Physics I and II 5 credits each

**Course distribution for A.S. in Biotechnology by semester:**

| Semester I         |               | Semester II         |               |
|--------------------|---------------|---------------------|---------------|
| Fall               | Winter module | Spring              | Summer module |
| ENG 12 - 4 cr      |               | ENG 24 - 3 cr       |               |
| BIO 13 - 4 cr      |               | BIO 14 - 4 Cr       |               |
| CHM 11 - 4 cr      |               | CHM 12 - 4 cr       |               |
| HPE 12 - 3 cr      |               | MAT 20 - 3 cr       |               |
|                    |               | Gr I-IV Req. - 3 cr |               |
| Total Credits = 15 |               | Total Credits = 17  |               |

| Semester III                                   |               | Semester IV                    |        |
|------------------------------------------------|---------------|--------------------------------|--------|
| Fall                                           | Winter module | Spring                         | Summer |
| BIO 50 or 59 - 4 cr                            |               | BIO 56 or Bio 57 - 4 cr        |        |
| BIO 63 - 4 cr                                  |               | Elective (BIO 58 or 57) - 4 cr |        |
| BIO 60 or alternate 3-4 cr                     |               | Elective - 2-3 cr              |        |
| Gr. I - IV Req. - 3 cr                         |               | Gr. I-IV Req - 3 Cr.           |        |
| Total credits = 14-15                          |               | Total credits = 13-14          |        |
| Total credits completed in four semesters = 60 |               |                                |        |

**Course distribution for B.A. Degree in Biotechnology by semester:**

| Semester V                            |        | Semester VI                     |                                               |
|---------------------------------------|--------|---------------------------------|-----------------------------------------------|
| Fall                                  | Winter | Spring                          | Summer                                        |
| BIO 29.1W – 2 cr                      |        | BIO 27.5 – 4 cr                 |                                               |
| Elective:<br>( BIO 52** or 58 – 2 cr) |        | BIO 38 – 2 cr                   | (* BIO 15 – 4 cr., is only offered in summer. |
| CHM 50 – 5 cr                         |        | Elect (BIO 39.1 or 55.1) – 3 cr | It may be taken in place                      |
| MAT 2.9 – 3 cr                        |        | MAT 3.3 – 3 cr                  | of elective otherwise                         |
| BIO 52.2** – 2 cr if needed           |        | * Elective – 3 cr               | taken in Fall or Spring.)                     |
| * Elective – 3 cr                     |        |                                 |                                               |
| Total Credits = 15 or 17              |        | Total Credits = 15              |                                               |

| Semester VII       |        | Semester VIII      |                         |
|--------------------|--------|--------------------|-------------------------|
| Fall               | Winter | Spring             | Summer                  |
| BIO 33 – 2 cr      |        | BIO 26 – 3 cr      | (* BIO 25 – 4 cr ., is  |
| BIO 45 – 2 cr      |        | BIO 62.5 – 4 cr    | only offered in summer. |
| BIO 45.1 – 2 cr    |        | BIO 73.2 – 3 cr    | May be taken in place   |
| BIO 73.1 – 3 cr    |        | * Electives – 5 cr | of elective taken in    |
| * Electives – 6 cr |        |                    | Fall or Spring.)        |
| Total Credits = 15 |        | Total Credits = 15 |                         |

**Total credits at Brooklyn College = 60 credits**

**Course distribution for B.S. Degree in Biotechnology by semester:**

| Semester V                |        | Semester VI        |                          |
|---------------------------|--------|--------------------|--------------------------|
| Fall                      | Winter | Spring             | Summer                   |
| BIO 29.1W – 2 cr          |        | BIO 27.5 – 4 cr    |                          |
| BIO 52 or 58 – 2 cr       |        | BIO 38 – 2 cr      | ( * BIO 15 – 4 cr., is   |
| CHM 51 – 5 cr             |        | BIO 33 – 2 cr      | only offered in summer.  |
| MAT 2.9 – 3 cr            |        | CHM 52 – 5 cr      | It may be taken in place |
| BIO 52.2 – 2 cr if needed |        | MAT 3.3 – 3 cr     | of elective taken in     |
| * Elective – 3 cr         |        |                    | Semester V.)             |
| Total Credits = 15 or 17  |        | Total Credits = 16 |                          |

| Semester VII            |        | Semester VIII      |                          |
|-------------------------|--------|--------------------|--------------------------|
| Fall                    | Winter | Spring             | Summer                   |
| BIO 45 – 2 cr           |        | BIO 26 – 3 cr      | (* BIO 25 – 4 cr., is    |
| BIO 45.1 – 2 cr         |        | BIO 62.5 – 4 cr    | only offered in summer.  |
| BIO 83.1 – 3 cr         |        | BIO 83.2 – 3 cr    | It may be taken in place |
| BIO 39.1 or 55.1 – 3 cr |        | PHY 2 – 5 cr       | of elective taken in     |
| PHY 1 – 5 cr            |        |                    | Semester V.)             |
|                         |        |                    |                          |
| Total Credits = 15      |        | Total Credits = 15 |                          |

**Total credits at Brooklyn College = 60 credits**

## Description of New Courses:

### **BIO 58 Recombinant DNA Biotechnology: Lecture and Laboratory (4 cr, 6 hrs)**

**Lecture:** The theory behind the techniques used in the recombinant DNA biotechnology laboratory, including the molecular biology of DNA and gene expression. In addition, the basics of transgenics, stem cell research, cell and gene therapy, gene therapy versus organ transplantation. Also included are DNA vaccine, animal cloning and bioethics. Each student will make two presentations on an area of current biotechnology research.

**Laboratory:** Students will perform DNA extraction, isolation, characterization, reconstruction, transformation, southern blotting, western blotting, primer design, PCR amplification, DNA fingerprinting, DNA sequencing, RFLP and gene mapping. They will practice growing bacterial cells using aseptic techniques and wash, clean and sterilize laboratory wares. They will learn to transfer genes across species boundaries and determine the expression of foreign genes. This includes gel preparation, electrophoresis, DNA labeling, southern hybridization, immunohybridization using non-radioactive chemoluminescent reagents.

### **BIO 57 General Cell Culture, Tissue Culture and Cell Cloning (4 cr, 6 hrs)**

Students will learn plant cell, insect cells (as a special case), and other animal cell and tissue culture techniques. Students will learn to establish and maintain cell cultures *in vitro*. Cell morphology *in vitro*, tissue culture, callus formation, cytochemistry, immuno-cytochemistry, autoradiography, chromosome spread preparation and karyotyping, western blotting, ELSIA and cell reader applications as well as direct or indirect techniques for cell separation for cell cloning will be studied. The students will be able to take photographs of cells using a microscope and develop them for record keeping and analysis. They will be trained to initiate primary cell culture from either chicken embryos or other organisms of their choice as a small independent project on cell culture. Each student will be asked to read, analyze and critically present one current biotechnology publication in the classroom.

### **BIO 63 Molecular and Cellular Biology: Lecture and Laboratory (4 cr, 6 hrs)**

Principles and problems of the structure and functions of cell components are covered. Emphasis will be placed on the molecular composition of cells and the molecular mechanisms a cell uses to grow and divide. Students will perform experiments and computer exercises designed around fundamental questions in eukaryotic cell biology with a strong emphasis on current biochemical and biomolecular techniques.

**Syllabi for the following new courses are in Appendix A.**

## **Articulation with Brooklyn College:**

The faculties of the Department of Biological Sciences, Kingsborough Community College, and the Department of Biology, Brooklyn College, have collaborated on the articulation of the A.S. in Biotechnology curriculum with the B.A. and B.S. in Biology curricula at Brooklyn College. This was facilitated through close consultation with Arthur Zeitlin, Department Chairperson, Professors of Biology, Peter Pilchman and Sarwar Jahangir, and Associate Dean Loretta DiLorenzo with Brooklyn College Professors of Biology, John Blamire and Ronald Eckhardt, and the Office of the Provost, Brooklyn College. The total of 60 credits required for the A.S. in Biotechnology will transfer to Brooklyn College and an additional 60 credits at Brooklyn College to complete the requirements for B.A. or B.S. in Biology.

## **5. Faculty**

For over 15 years Dr. Sarwar Jahangir has taught in universities and colleges in the United States, Canada, India and Bangladesh. His research has focused on molecular genetics. As a result of funding from the National Oceanic and Atmospheric Association (NOAA), he developed a domesticated stock of transgenic lake sturgeon from a bacterial gene. He developed a biotechnology laboratory at Richard Stockton College of New Jersey. He has served as an advisor to Bangladesh Agricultural University in the development of a biotechnology course and laboratory. He was a visiting Assistant Professor at Wabash College, Indiana, teaching classical, molecular and advanced genetics involving biotechnology. He was again funded by NOAA for silver hake stock determination using microsatellite DNA. He was a visiting professor at Brooklyn College where he studied dedifferentiation of melanocytes in vitro for use in human neurotherapy. Currently, he is Assistant Professor of Biology at KCC and is teaching, conducting research and developing the biotechnology curriculum. His current research seeks to identify microsatellite DNA in bluefish for population determination. He is also co-funded for a CSTEP grant. Recently, he completed a research project at St. Vincent's Medical Center and NY Medical College, developing a recombinant vaccinia virus containing human interleukin-2 gene and obtaining US FDA approval for its application in human vaccination against melanoma (skin cancer).

Dr. Jahanjir will teach BIO 58, *Recombinant DNA Biotechnology* (4 cr. 6 hrs), and BIO 57, *Cell & Tissue Culture, and Cell Cloning*, (4 cr 6 hrs) and also work as the Director for the Biotechnology program. Other courses in the Biotechnology program are regularly offered and will not draw other faculty from their current teaching responsibilities. Some adjunct teaching may be required to cover Professor Jahanjir's current departmental teaching load when he assumes the directorship of the program.

Dr. Cathy McEntee has an excellent record of teaching molecular and cellular biology at Brooklyn College. Dr. McEntee completed her graduate work at the Medical College of Pennsylvania. She studied the regulation of gene transcription in yeast mitochondria under Dr. Hudson, who served as her graduate advisor. Dr. McEntee completed her postdoctoral research in the Department of Molecular Biology at Princeton University under the guidance of Dr. James Broach, studying trehalase in yeast. Before joining the Department of Biology, she was the Director of Research and Program Coordinator for the STEP and CSTEP programs at Brooklyn College.

Professors Jahanjir and McEntee will be enthusiastically supported by their current department chairperson, Dr. Arthur Zeitlin, and all their colleagues in the Department of Biological Sciences.

## **6. Facilities, Laboratory Equipment and Supplies**

A biotechnology laboratory of about 800 square feet working area has been created to provide students with essential laboratory training in this field. Each laboratory bench has all the following supply-line connections: hot water, ambient temperature water, reverse osmosis water, double-distilled and de-ionized sterile water, gas, a vacuum line, and air (moisture, dust and lint free). We have one refrigerated high speed Sorvall centrifuge and a fixed angle rotor with adaptor, a desktop high speed refrigerated Perkin Elmer centrifuge, sets of precision micropipettes, agarose electrophoretic systems, one PAGE electrophoretic unit, a Miniblotter Western Blotting apparatus, one PCR Sprint Thermal Cycler, DNALinker, UV Transilluminator with camera, Polaroid gel photographic units, autoradiography cassettes, Mettler Toledo Precision Balance, a pH meter, LabConco Water purification Station, two laminar flow hoods for mammalian cell culture, one bacteria cell culture hood, inverted microscopes connectable through USB cable to PC computers, one temperature adjustable shaker, temperature adjustable incubators for cell culture, -80oC freezer, -23oC walk-in freezer room, 4oC walk-in refrigerated room, vacuum pump, glassware beakers, flasks, pipettes, cylinders, petridishes, centrifuge tubes, microwave ovens and an electric sealer. A UV\vispectral photometer, purchased for a non-related grant, will also be used by biotechnology students.

Additional and ongoing instructional supplies and equipment which should cost no more than \$10,000 per year will be funded through a combination of Perkins and College funds.

Six students are currently participating in biotechnology research as a result of a C-STEP, NSF, Brooklyn Gateway or LSAMP grant.

## **7. Biotechnology information resources**

The library will continue to subscribe and hold current biotechnology newsletters, magazines and periodicals with current editions available at the reference desk. Incorporated into the Department's plans for the curriculum, the Program Director will arrange for guests from the biotechnology industry and academia to speak with biotechnology majors at periodic, regularly scheduled events.

## **8. Cost Assessment**

As shown in the following table, the cost for the program in the initial year will be high. This will include expenses for laboratory renovation, equipment, chemicals, reagents, glass and plastic ware purchases. In subsequent years, costs will be greatly reduced. Consistently recurring costs, such as for glassware and plastic ware, will plateau from the 2<sup>nd</sup> to the 5<sup>th</sup> year, provided the cost of laboratory items do not increase too sharply and unexpectedly. The faculty salary was calculated based on average adjunct teaching costs with a 2.5% annual increase. The total expenses calculated will be \$390,087 for five years which averages \$78,018 annually.

In the table below, the anticipated revenue has been calculated on a full-time basis. In this model, students are expected to complete 15 credits per semester. The revenue earnings will increase further depending on the number of part-time majors. Additionally, there is a potential for out-of-State students to enroll in these programs, increasing revenue more. During the initial year, KCC will have a revenue loss. However, by the second year, KCC will have a net revenue gain from the new programs. The revenue gains will continue to rise

until the fourth year and plateau by the fifth year. These revenue gains will offset the cost of initial and ongoing supply and equipment needs.

**PROJECTED<sup>1</sup> EXPENDITURES FOR THE PROPOSED PROGRAM**

| <b>Expenditures</b>        | <b>1<sup>st</sup> Year</b> | <b>2<sup>nd</sup> Year</b> | <b>3<sup>rd</sup> Year</b> | <b>4<sup>th</sup> Year</b> | <b>5<sup>th</sup> Year</b> |
|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| Faculty <sup>3</sup>       |                            |                            |                            |                            |                            |
| New Resources <sup>4</sup> | \$10,000                   | \$10,750                   | \$11,557                   | \$12,424                   | \$13,356                   |
| Equipment <sup>5</sup>     |                            |                            |                            |                            |                            |
| New Resources <sup>4</sup> | \$ 252,000                 | \$28,500                   | \$19,500                   | \$16,000                   | \$16,000                   |
| Other <sup>6</sup>         |                            |                            |                            |                            |                            |
| New Resources <sup>4</sup> | \$ 0                       | \$ 0                       | \$ 0                       | \$ 0                       | \$ 0                       |
| Total                      |                            |                            |                            |                            |                            |
| New Resources <sup>4</sup> | \$262,000                  | \$39,250                   | \$31,057                   | \$28,424                   | \$29,356                   |

<sup>1</sup> The inflation rate used for projections is 0.075 over five years.

<sup>3</sup>Include fringe benefits.

<sup>4</sup>New resources means resources engendered specifically by the proposed program. The new resources from the previous year should be carried over to the following year, new resources with adjustments for inflation, if a continuing cost.

<sup>5</sup>Include here equipment which is not a capital expenditure.

<sup>6</sup>Specify what is included in "other" category, (e.g., library staff and additional acquisitions, student services staff, administrative or clerical staff, facilities, student financial aid).

**PROJECTED<sup>1</sup> REVENUE RELATED TO FOR THE PROPOSED PROGRAM**

| <i>REVENUES</i>                           | 1 <sup>st</sup> Year           | 2 <sup>nd</sup> Year            | 3 <sup>rd</sup> Year            | 4 <sup>th</sup> Year            | 5 <sup>th</sup> Year            |
|-------------------------------------------|--------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| <b><i>TUITION REVENUE<sup>3</sup></i></b> |                                |                                 |                                 |                                 |                                 |
| 01. FROM EXISTING SOURCES <sup>4</sup>    | -----                          | -----                           | -----                           | -----                           | -----                           |
| 02. FROM NEW SOURCES <sup>5</sup>         | 22 X \$1,540X 2<br>= \$ 67,760 | 42 X \$1,540X 2<br>= \$ 129,360 | 46 X \$1,540X 2<br>= \$ 141,680 | 47 X \$1,540X 2<br>= \$ 144,760 | 47 X \$1,540X 2<br>= \$ 144,760 |
| <b>03. TOTAL</b>                          | <b>\$ 67,760</b>               | <b>\$ 129,360</b>               | <b>\$ 141,680</b>               | <b>\$ 144,760</b>               | <b>\$ 144,760</b>               |
| <b><i>STATE REVENUE<sup>6</sup></i></b>   |                                |                                 |                                 |                                 |                                 |
| 04. FROM EXISTING SOURCES <sup>4</sup>    |                                |                                 |                                 |                                 |                                 |
| 05. FROM NEW SOURCES <sup>5</sup>         | 22 X \$2,350<br>= \$ 51,700    | 42 X \$2,350<br>= \$ 98,700     | 46 X \$2,350<br>= \$ 211,500    | 47 X \$2,350<br>= \$ 213,850    | 47 X \$2,350<br>= \$ 213,850    |
| <b>06. TOTAL</b>                          | <b>\$ 51,700</b>               | <b>\$ 98,700</b>                | <b>\$ 108,100</b>               | <b>\$ 110,450</b>               | <b>\$ 110,450</b>               |
| <b><i>OTHER REVENUE<sup>7</sup></i></b>   |                                |                                 |                                 |                                 |                                 |
| 07. FROM EXISTING SOURCES <sup>4</sup>    |                                |                                 |                                 |                                 |                                 |
| 08. FROM NEW SOURCES <sup>5</sup>         | -----                          | -----                           | -----                           | -----                           | -----                           |
| <b>09. TOTAL</b>                          |                                |                                 |                                 |                                 |                                 |
| <b><i>GRAND TOTAL<sup>8</sup></i></b>     |                                |                                 |                                 |                                 |                                 |
| 10. FROM EXISTING SOURCES <sup>4</sup>    |                                |                                 |                                 |                                 |                                 |
| 11. FROM NEW SOURCES <sup>5</sup>         |                                |                                 |                                 |                                 |                                 |
| <b>12. TOTAL</b>                          | <b>\$ 119,460</b>              | <b>\$ 228,060</b>               | <b>\$ 249,780</b>               | <b>\$ 255,210</b>               | <b>\$ 255,210</b>               |

<sup>1</sup> The inflation rate used for projections is 2%.

<sup>3</sup> Tuition for Full-Time City-resident matriculates 2004-2005.

<sup>4</sup> Existing sources means revenue that would have been received by the institution even if the proposed program were not approved.

<sup>5</sup> New sources means revenue engendered by the proposed program. The revenue from new sources from the previous year should be carried over to the following year as revenues from new sources with adjustments for inflation, if a continuing source of revenue.

<sup>6</sup> Public institutions should include here regular State appropriations applied to the program. Independent institutions should estimate Bundy aid generated by degrees awarded in the program.

<sup>7</sup> Specify what is included in "other" category.

<sup>8</sup> Enter total of Tuition, State and other Revenue, from Existing or New Sources.

## **Outcomes Assessment**

Student learning and other outcomes of the A.S. in Biotechnology will be reviewed and assessed as part of the Department of Biological Sciences Assessment Plan for all programs and courses. The plan includes the articulation of course objectives and the identification of measures to determine the degree to which they have been achieved. Each year, the Biotechnology Program Director and faculty will focus on selected learning outcomes to assess and, based on the results, plan strategies for improving them.

In the fifth year of the program, the A.S. in Biotechnology will be subject to the same formal periodic review established by the college for all academic programs. The formal review process consists of a self-study based on established guidelines. These self-studies include: enrollment figures, students' skill levels, course performance data, student retention rates, number of certificates or degrees awarded and job placement or transfer trends among program graduates. A self-study report is submitted by the department to an outside evaluator who then visits the program on-site and submits a written evaluation of the two-day visit to the college. Based on the evaluator's recommendations for improving the program, a plan of action will be implemented. These annual and periodic assessments will be ongoing.