

ARTICULATION GUIDELINES

with CASE HISTORIES for COMMUNITY COLLEGE
BIOTECHNOLOGY PROGRAMS

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INTRODUCTION

WHAT IS AN ARTICULATION AGREEMENT?

"*Articulation*" is an umbrella term relating to the various methods by which a student can receive credit for skills and knowledge mastered usually in the form of course work. An articulation agreement recognizes that the education received in one institution is equivalent to that at another institution, and that a student who has successfully completed a course or courses at one place, will not have to repeat this course at the second place. There are both informal and formal articulation agreements. This document concentrates on formal agreements.

"*Articulation agreements*" are the formal agreements between educational institutions for the transfer of course credit taken in one school to another school. Typically, these are documents of several pages that describe the course or courses taught at one school, to be accepted by the other. An articulation agreement will spell out the limitations or conditions that are placed upon acceptance of the course credits, and is duly signed by the appropriate school officials.

There are a number of reasons that articulation agreements are useful for all parties involved. For the student, there is the assurance that course work will not have to be repeated with its concomitant higher cost. Furthermore, a transferring student can enter at a higher level, assured that the competencies and knowledge gained in the one course will be sufficient preparation for other required courses, thus shorten the time period it takes to achieve a marketable degree or certificate.

For the educational institutions, articulation agreements are a useful means of attracting students to their campus, either by the promise of credit at the next higher level of education or by the awarding of credit for articulated courses.

Thus, an articulation agreement between two educational institutions is advantageous for everyone involved: the two institutions who gain from the greater number of students attracted and the students themselves, who have greater flexibility in their educational choices and hence greater probability of success. Johnson¹, in her book, Tailoring Tech Prep to an Urban Community College: An Examination of Processes for Change, makes persuasive arguments for the use of articulation agreements for tech prep courses for the above named reasons.

Articulation agreements fall into three broad levels: horizontal or lateral, vertical and reverse. An example of a *horizontal* articulation is a formal agreement between a community college or 2-year school and another community college or 2-year school. A *vertical* articulation is one in which the agreement is between a lower-level educational institution and an upper-level institution. There are therefore two types of vertical agreements involving community or technical colleges: high school to college and two-year to four-year.

Agreements between high schools and colleges are the original source for the term articulation agreement and usually involved students entering a workforce program. The articulation between a community college and a four-year university is often called *transfer credit* instead, since the student is typically transferring from the lower level to higher-level educational institution. Characteristically, each of these two types of vertical articulations is different, therefore each will be considered separately.

In our definition, a *reverse* articulation is one in which credit for a lower-division course is given upper-division credit. Typically, this means that credit earned in a two-year college at the sophomore-level transfers to a four-year school as a junior or senior level course. Reverse articulations agreements are beginning to be established between schools although our search has produced no formal reverse articulations in biotechnology. However, some schools have established assessment tests of students who are turning to biotechnology as a career option after training and education in other science fields. These students can receive credit for their education and/or work experience, thereby turning the assessment test into an informal reverse articulation.

BACKGROUND RESEARCH ON BIOTECHNOLOGY ARTICULATIONS

Articulation agreements have traditionally been in the field of workforce or tech prep. As stated in the Articulation Handbook of El Paso County Community College District, "Tech Prep programs are designed to utilize the best parts of advanced skills and & articulations while minimizing the negative aspects. This is accomplished by designing Tech Prep programs with employment exit points and by providing college credits for competencies mastered²."

The two criteria of a Tech-Prep program, which are the use of competencies, and employment exit points, readily lend itself to articulation agreements. The problems associated with the quality and depth of teaching at one institution versus another is minimized by the use of competency-based curricula. The North Harris Montgomery Community College District Articulation Manual³ argues strongly for the use of competency-based curricula because of the following reasons:

- The competencies required for entry-level employment are identified through a formal process and are subsequently validated by business and industry

- The competencies must be sequenced in a logical order
- The competencies have predetermined performance measures
- Industry provides information to be used in measuring student success
- Learner outcomes are usually defined and listed
- Instructional materials are usually well planned and laid out in a systematic format

This model was first established for the traditional Tech Prep programs such as graphic arts or auto mechanics. Biotechnology programs, a recent development in education these past fifteen years, are also an appropriate for the Tech Prep model. They too require employment exit points and have identifiable competencies. Even though many biotechnology programs are more academically oriented than most traditional Tech Prep programs, virtually all biotechnology programs are oriented towards finding employment for the graduating student in the bioscience industry.

Since employment exit points depend on the cooperation of industry, successful biotechnology programs enlist the aid of their local biotechnology industries in helping to establish and run the programs. As a result, most programs use the elements of competency-based instruction, such as a logical sequence of performances that have well defined measures of success as determined by industry. This orientation, whether or not termed "competency-based" instruction, contributes to a sound foundation for establishing articulation agreements in biotechnology. What has worked for articulating other Tech Prep programs has every indication of working for biotechnology programs as well.

In researching this document, we contacted many biotechnology programs around the country, especially those from institutions associated with [Bio-Link](#). We asked for copies of articulation agreements, both vertical and horizontal as well as articulation manuals. The response was very good: this office received a number of agreements from seven different institutions (many institutions had multiple agreements) and two articulation manuals. These have formed the basis of the analysis presented below.

We have organized this document into a description of each type of articulation followed by case studies illustrating the several paths that different institutions have taken to establish articulation agreements. We describe the advantages and disadvantages of each of these case studies as well as the environment or context in which each case study exists. This document may therefore be read in two ways. One type of reading will provide an overview of the kinds of biotechnology articulation agreements that exist today and indicate the future of these agreements. The other way to read this document is as a manual, with suggestions of how community/technical colleges can write articulation agreements for themselves that best fit their individual needs and circumstances. By being aware of the strengths and weaknesses of the different types of articulation

agreements, institutions can avoid pitfalls and take advantages of the best practices from around the nation.

II.

VERTICAL ARTICULATION AGREEMENTS

HIGH SCHOOL → 2-YEAR COLLEGE

High school students who have successfully mastered outcomes/skills in an articulated high school course or courses may apply for and receive credit in a course or courses with matching competencies at the college level after meeting the conditions established ahead of time. These programs are usually designed to shorten the length of time a student needs to finish both the high school and community college program and/or it is an advanced-skills program where the student is in a *2 + 2 cycle* (programs that are designed to prepare the student to enter the second two years to be taught at the community/junior college). These are becoming popular with biotechnology programs both because the technology is expanding so rapidly and because it is well suited to Tech Prep.

The benefits to the high school student who is enrolled in an articulated course are that both money and time are saved. Completion of part of a college-level program means less time before entering the workforce and less money needed for higher education. Furthermore, there are the intangible benefits of greater motivation. In the Austin area, our preliminary evidence indicates that the existence of articulation agreements between the high schools and [Austin Community College](#) has increased enrollment at the secondary level in biotechnology. The students report that they can see the connection between their course work and both further education and employment. They find this highly motivating, especially for the student who might not otherwise have considered a career in science.

However, articulation agreements between community colleges and high schools are not without their pitfalls and problems. Competition or "turfism" is a frequent barrier to successful articulations. Secondary teachers chafe at the idea that they must train students to some predetermined level, and then have them judged by others. This is a legitimate complaint, and one that many high schools find overwhelming.

Another problem with high school to college articulations is that overly ambitious plans and expectations are difficult to sustain over a long period². Furthermore, there are problems if too many or too advanced competencies are attempted. This can frequently lead to the articulation process dissolving. Once articulations break down, they are extremely difficult to resuscitate.

With these benefits and pitfalls of articulation in mind, let us examine more closely several different types of articulation agreements between high schools and community

colleges. [Table I](#) is a summary of the articulation agreements between high schools and two-year colleges used in this study. There are several different ways that two-year colleges have managed their articulations. If there is a strong industry presence and a thriving biotechnology program, the articulations appear to be more informal such as in [Case Study #1](#). Some rural high schools offer an Agricultural Biotechnology course to their students as presented in [Case Study #2](#). Lastly, the turfism problem is expertly dealt with in [Case Study #3](#), in which *credit-in-escrow* is used in articulations. The varied techniques to maximize the mutual benefits as well as their solutions to minimizing the problems will be emphasized in each of the case studies.

TABLE I:

ARTICULATION AGREEMENTS BETWEEN 2-YEAR AND HIGH SCHOOLS

2-yr college	High School district/school	Biotech Credit Hours	Max. # credits accepted	Min. Grade	Term limits	Notes
City College of San Francisco	S.F. Unified School District	3	6			HS can co-enroll at CCSF
Austin Community College	Bastrop Indep. School District	3	6	75	2 yrs.	For Agricultural biotech in HS
Austin Community College	Georgetown ISD	3	6	75	2 yrs.	
Austin Community College	Elgin Indep. School District	3	6	75	2 yrs.	For Agricultural biotech in HS
Madison Area Technical College	15 high schools		3	B	3 yrs.	Flexible to accommodate range of HS courses
Madison Area Technical College	Madison Metropolitan School District	3	3	B	27 mos.	Credits awarded depend on HS curriculum
Madison Area Technical College	WI Youth Apprenticeship Program		At least 11		3 yrs.	Requires both classes and internship

CASE STUDY #1:

[SAN FRANCISCO UNIFIED SCHOOL DISTRICT TO CITY COLLEGE OF SAN FRANCISCO, CALIFORNIA](#)

[Appendix A](#) contains the brief articulation agreement between the San Francisco Unified School District (of which San Mateo is a part) and the City College of San Francisco (CCSF). CCSF is a two-year college with a well-established biotechnology program. Rather than hammer out individual articulation agreements with each of a number of area high schools in different districts, CCSF chose to have a brief agreement and to support a collaborative.

The collaborative, called [Gene Connection](#), links twenty-one high schools from the greater San Francisco area with local and national bioscience industries such as Genetech, Sigma/Aldrich, and Perkin Elmer Applied Biosystems. There is a "smorgasbord of labs and activities" geared to the high school level that includes isolation of DNA, agarose gel electrophoresis, PCR profiling and a study of lactose intolerance. There are four kits, maintained by two part-time biotechnology educators, which may be sent out to the classrooms. In 1999, Gene Connection served a total of 8,932 students and 78 teachers. While some of these labs were taught in courses such as AP biology and chemistry, others were taught in specified biotechnology courses. A flyer for Gene Connection is included in [Appendix A](#).

The year course that is taught in biotechnology in San Francisco high schools is similar to ones found at two-year colleges. Therefore, evidence indicates that the students coming out of this type of program would be as well prepared as any from a higher institution. CCSF appears to agree with this analysis, granting college credit to high school graduates who have successfully completed this Principles of Biotechnology course.

The articulation agreement, signed in 1998, is a single page long. One provision states that high school students who complete a year each of biology and Principles of Biotechnology may have CCSF's Biology 11 requirement waived. There is no minimum grade required and there is no expiration date. Secondly, there are no details about the numbers of high school students permitted into the college course, the minimum grades, or the logistics of transportation and transfer of credit to the high school transcript.

These items are considered useful in an articulation agreement since they improve the chances for success in a post-secondary institution.

The other provision of the brief articulation agreement states that high school students who have completed prerequisites in chemistry, biology, physics, and mathematics will be permitted to take CCSF's "Briefing in Genetic Engineering" course during their junior or senior years. Thus, high school students co-enroll in the community college course. This is a common clause in agreements in which the only location of a course is at the post-secondary institution.

Nevertheless, this type of brief articulation agreement appears to work very well in the greater San Francisco area with its strong industry support and well-established programs. The large number of high school students and teachers served by the collaborative is impressive. However, CCSF's brief agreement can pose problems since many of the details of size, minimum grade requirements, term limits and course curricula information are not spelled out in the agreement. This can lead to misunderstandings that are very difficult for successful articulations. Furthermore, there can be problems if high school students try to take their credentials beyond their local area. Other colleges may not recognize their biotechnology courses if there is no detailed sanction from the area two-year college. However, since CCSF has wisely written in a yearly review, they will be able to take advantage of this opportunity to improve their agreement by providing greater information.

CASE STUDY #2:

[BASTROP HIGH SCHOOL](#) AND [AUSTIN COMMUNITY COLLEGE](#) (ACC), TEXAS

A formal agreement between the Bastrop Independent School District and [Austin Community College](#) was signed in March 2000. Bastrop is a small (pop: 4800) rural community about 40 miles southeast of Austin. The high school has had an Agricultural Biotechnology course in place for the past eight years. The [Texas Essential Knowledge and Skills](#) (TEKs) and the biotechnology agricultural competencies are used for the basis of this course. TEKs are the state-wide standard for content and competencies that have been established for each course.

Agricultural biotechnology contains different elements than the more common biotechnology course, which we term "*industrial biotechnology*." Agricultural biotechnology places an emphasis on animals and plants. There are units, for example, in which PCR analysis is used to examine cattle breeding stock and plants are used in two units: tissue culture and plant field studies. There is concomitantly less emphasis on chemistry for example, as there is in the more traditional industrial biotechnology courses, and discussions of careers focus more on field work and less on bench work.

Since there is a different emphasis between the high school course and the community college course, the articulation agreement must focus on the competencies mastered. If both courses teach the same competencies, then the two courses may be articulated, even if the method by which these competencies are taught are different. This was the foundation of the articulation agreement between Bastrop High School and Austin Community College.

The agreement, presented in [Appendix B](#), contains the basic elements of a good articulation agreement. The articulating courses are spelled out, a minimum grade for receiving college credit is delineated and there is annual review of the agreement to

resolve any problems. In addition, there is a time limit of 48 months between taking the high school course and receiving credit in the college. This is a common provision that takes into account both the changing nature of the technology and the student's memory. Best of all, the credit is given as *credit-in-escrow*. Credit-in-escrow is when college credit for a course or courses is awarded after successful completion of the next college course in the sequence. The advantages of credit-in-escrow are that 1) "turfism" is reduced among the two educational institutions, 2) secondary faculty do not feel that responsibility for success rests solely with them, 3) student success is incumbent on the student where it best belongs, and 4) college concerns about the competence of the incoming students are reduced.

In addition to these standard elements of a good agreement, there are several other special conditions. One of these conditions is to require professional development of the high school teachers, not only because the biotechnology field is moving so rapidly, but also because, agricultural teachers frequently do not have the advanced degrees that are commonplace for teachers of academic subjects such as biology or chemistry. However, the professional development is funded in part with the Bio-Link grant, with no provision for when the grant runs out. "Educational institutions that begin articulation efforts with temporary funding must plan for continued financial support."² This will need to be addressed in the next review.

Another special condition is that the competencies established for the community college biotechnology course be aligned with competencies in the high school course. Equipment and supplies must also be kept current. Using competencies when articulating related courses with different emphases is fundamental as discussed above. Without competencies as a special condition the high school agricultural biotechnology course could not articulate with the community college industrial biotechnology course.

Lastly, there is included in the articulation agreement a six-year plan. This plan spells out the required and recommended courses for students between the ninth grade and completion the associate's degree. Cooperatively-developed six-year plans are strongly recommended for articulations between high schools and post-secondary schools according to the Recommendations of the Committee for the Development of Statewide Articulation Guidelines⁴, and as such, represent how future agreements of this type should appear.

CASE STUDY #3:

[MADISON AREA TECHNICAL COLLEGE \(MATC\) AND MADISON METROPOLITAN SCHOOL DISTRICT, WISCONSIN](#)

One of the best articulation agreements around is that for Madison Area Technical College. Rather than develop individualized articulation agreements with each of the area high school, MATC uses a standardized Curriculum Alignment/Articulation Agreement

form ([Appendix C](#)). Right now 11 area high schools are listed as having articulation agreements with MATC in biotechnology.

This agreement has embedded all the important elements of a good articulation. The courses are listed for each agreement with a maximum of 3 credits of advanced standing given. Depending on the curriculum in the high school course(s), a student may receive 1, 2, or 3 credits. However, a student may receive only 1 specific credit towards Molecular Biology. Since this is a 3 credit MATC course, the student must still complete the course, but at a reduced fee. A "B" or better at the high school is specified as the minimum grade, which may be changed according to the needs of both MATC and the articulating high school. Time limits of 27 months following graduation are imposed in order to maintain student currency. If the time limit has expired, the student may take competency based "test out" examinations.

Originally the high schools agreed to adhere to specific competency-based curriculum for their articulated courses including biotechnology. However, this has recently been modified to be more flexible and to accommodate the wide range of students and curricula in the high school biotechnology classes. This flexibility is a trade-off for rigid adherence to competencies, which are often impossible in the high school environment. However, high schools should still maintain the appropriate facilities and resources and, if possible, include lab practicals and lab notebooks.

MATC, and not the high schools, is expected to review and adjust periodically this articulation agreement. This is the only negative in this document and it is small. A stronger document would allow for both the high school and the technical college to review and adjust the articulation agreement, thereby maintaining the lines of communication.

This is an outstanding example of how community and technical colleges can work together to develop an articulation agreement that serves the needs of each institution and the students. As discussed below, statewide articulation agreements are the wave of the future and will become more prevalent in the ensuing years. Wisconsin has provided a model by which to do this.⁸

III

VERTICAL ARTICULATION AGREEMENTS

2-YEAR → 4-YEAR COLLEGE

Articulation agreements between two-year and four-year institutions may be divided into three categories depending on whether both schools offer biotechnology programs or whether only one institution does so. The three categories are:

- A. Both two-year and four-year colleges have biotechnology programs.
- B. The two-year college has a biotechnology program and the four-year college does not.
- C. The two-year college does not have a biotechnology program and the four-year college does.

Each of these categories is incorporated into [Table II](#), the summary of articulation agreements between two-year and four-year institutions that we used in generating this report. Each category is also highlighted in a Case Study so that the advantages and disadvantages may be more fully discussed.

The agreements between two-year and four-year institutions share many of the advantages and problems of the other vertical articulation agreements between the secondary and post-secondary institutions. One advantage with this type of vertical articulation, usually called *transfer*, is that a larger pool of students is reached. This pool of students typically represents the non-traditional student who is reentering the workplace after a hiatus, and is from a traditionally underrepresented population, and/or students who need retooling for today's marketplace.⁵ Other advantages include an increased validation of the education received at a two-year college⁶, greater communication and effectiveness between the two types of institutions, and high student (and parent) satisfaction since money and time are saved. Thus, the collaboration between the two-year and four-year colleges produces results that are amenable to all.

As with the other vertical articulations, such agreements between two-year and four-year colleges are sometimes fraught with "turfism," especially if both institutions teach biotechnology and therefore view the other as a competitor for students. Also, the four-year college will typically limit the number of course credits that may be transferred and these credits will nearly always be in the lower division. Lastly, concerns about the qualifications of the two-year faculty will sometimes prove a problem in these articulations⁵. Analysis of the case studies will highlight some of the solutions found for these problems.

TABLE II:

SAMPLE ARTICULATION AGREEMENTS BETWEEN 2-YEAR AND 4-YEAR INSTITUTIONS

2-yr college	4-yr college	Biotech Credit Hours	Max. # credits accepted	Min. Grade	Term limits	Exam	Meet Counselor?	Notes
Madison Area Technical College	Univ. of Wisconsin River Falls	28	49	B or better				A.S. degree transfers for U Wisc Biotech major
Madison Area Technical College	Univ. of Wisconsin Whitewater	22	55	B or better				A.S. degree transfers for U Wisc Biotech major
Madison Area Technical College	Univ. of Wisconsin Madison							Agreement allows 4-yr student to get credit for 4 MATC biotech courses
Madison Area Technical College	Edgewood College	34	52					Agreement allows 4-yr student to get credit for 2 MATC biotech courses
Madison Area Technical College	Upper Iowa University	8-15	30 or 60					30 or 60 credits allowed for one or two year degrees
Mass Bay Comm. College	University of Mass, Boston	8	63			Yes		12 hrs in Biology require Validation Exam
Mass Bay Comm. College	Purdue University	8	65	2.0 GPA	3 yrs			
Mass Bay Comm. College	Boston University Metro	0	80	C min.			Yes	
Mass Bay Comm. College	University of New Haven	a.	60	C min.				Biotech/Forensic Science

Mass Bay Comm. College	Worcester State College	24	64					Majority of biotech courses must be at Worcester State
Anoka-Ramsey Comm. College	St. Cloud State University	8	61					Joint admissions option/Bio-med transfers to Biology
Genesee Comm. College	Rochester Inst. of Tech	0	67	2.5 GPA	3 yrs.		yes	No biotech at CC; students transfer to biotech at RIT
Seattle Central Comm. College	Evergreen State	b.	90 qtr hrs	2.5 GPA			Yes	Transfer 4 of the 6 Biotech specific classes
Seattle Comm. Colleges	13 Public WA Colleges & Univ.		90 qtr hrs					Blanket agreement On web only
Montgomery College	Univ. Houston-Downtown	12	66					
N.H. Community Technical College	Rochester Inst. of Tech	b.	65	2.75 GPA				A.S. degree transfers to biotech B.A. program
Monroe Community College	Rochester Inst. of Tech	b.	42	2.75 GPA				A.S. degree transfers to biotech B.A. program
City College of San Francisco	Cal State U at San Jose	c.						
City College of San Francisco	Rochester Inst. of Tech							

- a. Only 4 Biotech course numbers given
- b. All program courses are included
- c. Chemistry and Biology are articulated for Biotech

CASE STUDY #4:

MADISON AREA TECHNICAL COLLEGE AND UNIVERSITY OF WISCONSIN (River Falls and Whitewater Campuses), WISCONSIN

Madison Area Technical College (MATC) has the reputation of having an excellent Biotechnology Lab Technician program that has been established for many years. Located in the heart of a thriving biotechnology industry, MATC offers an Associate in Applied Science Degree in two years. MATC has what they call program-to-program articulation agreements with both University of Wisconsin--Whitewater and University of Wisconsin--River Falls which are very similar to each other. Both campuses offer a baccalaureate degree in biotechnology. Therefore this articulation agreement is between a two-year college and a four-year university, both of which have biotechnology programs. This is the first category of this kind of vertical articulation agreement. The example of the agreement between MATC and UW--River Falls is given in [Appendix D](#).

This articulation agreement is strictly unidirectional, addressing only those students who transfer from MATC to the University. (However, the agreement between Edgewood and UW-Madison and MATC are bi-directional, allowing 4 year students to take selected MATC courses for credit.) The entire A.A.S. degree program transfers if students get a "B" or better in their biotechnology courses and "C" or better in the related courses such as Chemistry or Applied Biochemistry. Students must complete sixty credits of course work at UW-River Falls in order to obtain their baccalaureate degree from either the College of Arts and Sciences or the College of Agriculture Food and Environmental Sciences.

This is a model articulation agreement between two educational institutions both of which have biotechnology programs. There is a four-year plan in the form of the two-year associate degree courses that will be accepted by the university and the upper level courses that are needed to obtain the baccalaureate degree. The minimum acceptable grades are spelled out.

There are only two minor quibbles with this agreement. First, there are no time limits set on when the transfer must take place. In theory that means that a student who attended MATC any time after May 1, 1996 can transfer to the university anytime, even though their course work is outdated. Secondly, there are no provisions for regular review of the agreement. El Paso's Articulation Manual stated it best when it said, "all articulation programs require continuous follow-up and improvement."³ But these are minor points and any two-year college with a biotechnology program looking to articulate with a four-year college also with a program would do well to follow in the footsteps of Madison Area Technical College's agreements with the University of Wisconsin River Falls or Whitewater.

CASE STUDY #5:

MASSACHUSETTS BAY COMMUNITY COLLEGE (MBCC) AND UNIVERSITY OF MASSACHUSETTS BOSTON (UMB), MASSACHUSETTS

Mass Bay Community College is a mid-sized two-year college located in suburban Boston. Among its more than sixty certificate and degree programs, MBCC offers an Associate in Science Degree in Biomedical Laboratory Techniques in Biotechnology. This program is completed in six semesters; there are four semesters of general education and biotechnology courses and two summer sessions of research internships in one of the many biotechnology industries that are located nearby.

In short, MBCC offers a good solid program in biotechnology, similar to many others around the nation. What makes MBCC noteworthy is the number and variety of articulation agreements. [Table II](#) lists some of the many agreements between MBCC and four-year institutions, not just in Massachusetts or even in New England, but throughout the United States. And the number continues to grow. Each of these articulation agreements is individualized to accommodate the given four-year college/university. Minimum grades are different, and biotechnology credits differ, as do the maximum allowed credits. There are also accommodations for term limits, counseling and exams depending on the requirements of the individual four-year university. Individualized agreements do a better job of accommodating the admissions and graduation requirements of the participating four-year institutions. Reproduced agreements are often easier to set up and are easier for students to understand and use.

Among MBCCs many articulation agreements is the one with the University of Massachusetts Boston ([Appendix E](#)), which also has a biotechnology program. This particular agreement was chosen because among its other conditions is the existence of a validation exam. This exam is to be designed jointly by faculty at both institutions and will cover material in three of UMBs lower division biotechnology courses: Molecular Biology, Biochemistry and Introduction to Immunology. There will be a review of this exam for continuation or elimination after twenty Massachusetts Bay Community College students have taken the exam.

An exam as a condition for entry from a two-year program to a four-year program is not uncommon in Tech Prep and is frequently used to alleviate concerns about the competence of the incoming students³. However, it is unusual in biotechnology, and this agreement is the only one with this stipulation of those that were gathered for this study.

Nevertheless, a validation exam may be an option when developing an agreement with an institution that is very hesitant to award credit.

CASE STUDY #6:

[ANOKA-RAMSEY COMMUNITY COLLEGE](#) (ARCC) AND [ST. CLOUD STATE UNIVERSITY](#), MINNESOTA

The articulation agreement between Anoka-Ramsey Community College, and St. Cloud State University is an example of the second category of articulations: those between a two-year college with a biotechnology program and a four-year college without such a program ([Appendix F](#)). This is a relatively common occurrence around the country, especially in the wake of the Bio-Link grant that has encouraged the start-up of new biotechnology programs at community/technical colleges. Furthermore, with its history of Tech Prep courses and its ability to start new programs with relative ease, two-year colleges find it easier to rapidly establish biotechnology programs that interface with industry than does a four-year institution.

Anoka-Ramsey Community College is a small two-year institution located in Minnesota and serving the Twin Cities area. About half of its 6000+ enrolled students will transfer to a four-year college. Thus, articulation agreements between the community college and the four-year institutions become important to the transferring students. ARCC offers an Associate in Applied Science degree with a specialty for the [Biomedical Technician](#).

In its articulation agreement with St. Cloud, all the general education courses and the six program courses transfer. The Biomedical Technician courses all transfer as biology electives for a major in biology including the internship course. Thus, a total of 61 credits, including 18 major credit hours, are applicable to St. Cloud State University. The only stipulation is that transfer students must fulfill the remaining requirements for graduation from St. Cloud with a baccalaureate degree as a Biomedical Technologist.

This is a very straightforward articulation agreement that stresses cooperation between the two educational institutions. Each is encouraged to offer jointly sponsored courses when appropriate, and both will work together to develop registration and financial aid procedures to facilitate concurrent enrollment. This collaborative tone resonates throughout the agreement. There is no suspicious discussion of minimum grades or testing required of the students (except as those meeting the admissions requirements). There is no worry about the teaching credentials of the faculty at either institution. And there is no concern about reviewing or terminating this agreement (but is this attitude dependent on the identity of the individuals involved. people move on or die). Civility and mutual respect are the hallmarks of this agreement between ARCC and St. Cloud.

CASE STUDY #7:

[GENESEE COMMUNITY COLLEGE](#) (GCC) AND [ROCHESTER INSTITUTE OF TECHNOLOGY](#) (RIT), NEW YORK

This lengthy articulation agreement represents an agreement between a community college that does not have a biotechnology program and a four-year college that does

([Appendix G](#)). Developed in 1996, this is a blanket agreement listing how each one of GCC's courses articulates with courses and programs at RIT. Among these is a Mathematics/Science associates degree that is articulated with a baccalaureate degree in Biotechnology or in Biomedical Computing among other sciences.

A student transferring into RIT's College of Applied Science where Biotechnology is located must have a grade point average of 2.5 and transfer credit will only be applied in those courses with a grade of C or better. Up to 67 credits may be transferred. Unlike the other vertical articulations discussed above, RIT reserves the right to issue specific year status of students until after evaluation of the courses completed at GCC. Thus there is no automatic acceptance of associate degree students into the upper division as there is with such places as U. Wisconsin River Fall and U. Mass Boston. There are term limits of three years to avoid the problem of students waiting too long before transferring.

A GCC student can earn credits in liberal arts courses and physical education as well as up to 30 credits in math (2 courses), biology (2 courses), chemistry (2 courses) and computer science (1 course). Students following the recommended course schedule will receive junior standing at RIT and therefore will not lose time in transferring. These recommended courses will provide the foundation for taking the biotechnology courses offered at RIT.

Thus, an agreement may be reached between a two-year college without a biotechnology program and a four-year institution with a program that is beneficial for all parties. The major caveat is that the counselors of the two-year college need to be fully aware of the conditions of the agreement and be prepared to guide the students choices of courses so as to take maximum advantage of this kind of vertical agreement.

One final note is that RIT has just formed an articulation agreement with City College of San Francisco and has expressed an interest in doing this with other two-year biotechnology programs across the nation. The idea of individualized articulation agreements between institutions across a nation is a futuring trend that should be encouraged.

CASE STUDY #8:

[SEATTLE COMMUNITY COLLEGES](#) AND [WASHINGTON PUBLIC COLLEGES AND UNIVERSITIES](#), WASHINGTON

The agreement between [Seattle Community Colleges](#) and thirteen Washington Public Colleges and Universities is an example of a general blanket agreement ([Appendix H](#)).

This agreement, found only on the web, briefly reviews the statewide Policy of Inter-College Transfer and Articulation to which Seattle Community Colleges subscribe. The policy states that the listed colleges will recognize the Associate of Arts (A.A.) degree as

satisfying general education requirements and will grant junior status upon transfer. Therefore, at least most of the courses taken at Seattle, up to 90 credits, will be accepted by one of the participating four-year institutions.

There are some stipulations that are spelled out in this agreement. One of these stipulations is that some colleges and universities may require additional courses and/or will impose other admission standards. For example, the policy states that the University of Washington requires five credits in English composition and an additional writing course. Therefore each four-year institution, while mandated to accept the credits from the participating two-year college, has some flexibility in including additional stipulations to admission and granting of junior status. The responsibility for determining these additional stipulations rests with the student and not on the colleges involved.

In addition to spelling out the responsibility of the student to determine the admission requirements of the four-year institution, the policy also spells out the right of the student to review and appeal any decision made by the four-year college/university.

This articulation agreement is different from other vertical agreements in several important ways. First, it is an informal agreement. There are no signature pages from both the parties involved as is the case with formal agreements. This agreement is available only on the web and is more a statement of state-wide policy rather than a true articulation agreement. Furthermore, there is no indication of term limits, minimum acceptable grade or a listing of courses that will be accepted by the four-year institution, all of which are important elements of formal agreements.

The other major difference between this agreement and others is that the responsibility for ensuring that credit will be given at the college or university rests solely with the student. There are no exams given, no consultation with counselors mandated and no detailed list of accepted courses. The policy does spell out exactly how to ensure that credit will be given if the A.A. degree is awarded (and instructs the students to contact the four-year institution of choice about the special requirements for transfer of courses without the A.A. degree.

Just as the students have more responsibility with this kind of articulation, so does the student have more rights than is usual in a formal agreement. There is the right to review and appeal to the transfer officer of the sending institution. This, too, is unique to this document.

This kind of informal articulation or transfer of credit may become more prevalent as more and more states write state-wide articulation agreements between its two-year and four-year educational institutions. This is discussed more fully in section V below. But without such state-wide agreements, it would be very difficult to require the four-year college to accept two-year credits in such a blanket form. Furthermore, without formal authorization by the appropriate personnel, this document does not have the weight of the institutions behind it. Thus, this kind of informal web-based transfer of credit would not

be the first choice for most technical or community colleges wishing to articulate with four-year colleges or universities.

III

HORIZONTAL ARTICULATION AGREEMENTS

TWO-YEAR TO TWO-YEAR COLLEGES

Horizontal or lateral articulation agreements are relatively rare, mostly because there are few students who will transfer from one two-year community or technical college to another. Without the demand, there is little desire to form agreements. However, North Carolina has a particularly cooperative community college system as evidenced by the collaborative agreement plan between [Alamance Community College](#) and [Piedmont Community College](#). In 1998 these two colleges signed an articulation agreement for biotechnology. [Table III](#) summarizes this horizontal articulation agreement and that of between Alamance and Guilford, which is nearly identical.

TABLE III: HORIZONTAL ARTICULATION AGREEMENTS

C.C. 1	C.C. 2	Credits included	agreement	conditions	Notes
Alamance	Piedmont	29	1yr → 1 yr	Annual review	
Alamance	Guilford	29	1yr → 1 yr	Annual review	Identical to above

CASE STUDY #9:

[ALAMANCE COMMUNITY COLLEGE](#) (ACC) AND [PIEDMONT COMMUNITY COLLEGE](#) (PCC), NORTH CAROLINA

A horizontal articulation agreement is relatively rare unless each institution can contribute in complementary ways to the agreement. In this case, one community college (Alamance) has facilities, curriculum, faculty and an established program in biotechnology. The other community college was just beginning such a program but could not bring to the table facilities, marketing resources and staff. These are spelled out in the beginning of the articulation agreement, presented in [Appendix I](#).

The first year of study will be undertaken at PCC or ACC. Then for the second year at PCC, students can transfer from PCC to ACC to complete the second year and earn an associate degree in biotechnology from ACC. This statement along with the course listing at each community college and the condition of annual review comprise the meat of the

agreement. The rest of the agreement deals with admission and financial aid policies, faculty location and other relatively mundane matters. All in all, this is a very straightforward agreement.

But why have such a horizontal agreement? Are not both community colleges in competition for the same pool of students? The answer is that Alamance has a biotechnology program already in place. There is approved biotechnology curriculum, which also meets the criteria for accreditation of the Commission of Colleges. Alamance also agrees to teach the second year of the program leading up to the associate degree. In contrast, Piedmont is just beginning a biotechnology program so Piedmont will recruit the students and teach them the first year of the program.

There are two beneficial results to Piedmont providing instruction in the first year and leaving the second year to Alamance. First, the first year of their biotechnology programs is much less expensive than the second, so Piedmont Community College has the opportunity to develop its biotechnology program one year at a time and so avoid a large outlay of cash at the start. This makes starting a new biotechnology program much more feasible financially to the often cash-poor community colleges.

The second advantage of this horizontal agreement is that offering the first year at two different campuses increases the total number of students who will enter biotechnology. By allowing students from Piedmont to transfer to Alamance, this will also increase the size of the second year class and therefore the number of graduating students entering the workforce. North Carolina has a vigorous and growing biotechnology industry, so increasing the number of educated technicians is advantageous to both the community colleges and the industry.

The articulation agreement has wisely established an annual review process and a phased-out termination process. That way there can be regular adjustments made to this agreement as enrollment levels, staffing needs and program status shift over time.

Thus a horizontal articulation agreement is mutually advantageous when there is a community or technical college with an established biotechnology program and a nearby institution, which is just beginning such a program. This kind of agreement can result in more students receiving their associate degree and entering the workforce with a minimal amount of financial outlay. There are two important criteria that need to be observed for this kind of arrangement to succeed. The first is that the two community colleges must be relatively close to each other. Students from one college will be reluctant to drive long distances to the other to complete their degrees, and so drop-out statistics would climb. The second criterion is that observed by Alamance and Piedmont: the inclusion of an annual review to adjust the agreement as the needs of the colleges, the students and the faculty change.

IV INVERSE ARTICULATIONS

Credit through testing is another example of articulation. Many community colleges have implemented challenge exams from the beginning as standard practice. A student can receive credit for skills and knowledge learned from on-the-job experiences or from previous training³.

Although not usually formalized into an articulation agreement, the administration of an assessment exam is a useful tool in being able to award course credit for people who are entering biotechnology programs from other fields of endeavor. This is particularly valuable in attracting and educating returning adults who were trained in other areas but who are now attracted to biotechnology with its widening array of job opportunities. As Knoell puts it, the potential payoff is both to the workforce, which needs managers who have had work experience as technicians and education in management, and to workers who are ready for advancement into supervision and management.⁶

CASE STUDY #10:

[AUSTIN COMMUNITY COLLEGE'S](#) ASSESSMENT TEST, TEXAS

When we began our biotechnology program at [Austin Community College](#) in the fall of 1999, we were struck by the number of students who were enrolling in the Introduction to Biotechnology course with advanced training and even advanced degrees. When queried about their reasons for taking such a basic course in spite of their education, all these students cited a desire to retrain and retool. Allied health graduates wanted to move away from the clinical environment into the laboratory. Science graduates wanted to find rewarding work in a new, exciting field. And current employees in industry wanted to be able to update and expand their skills. Furthermore, the laboratory-oriented, competency-based instruction that is the usual component of biotechnology instruction was very popular to returning students who had concentrated in theory.

We developed an assessment test to act as a reverse articulation. Successful completion of the test allowed the advanced student to obtain credit for up to the entire first year of the program. This test ([Appendix J](#)) is divided into five sections each representing a first year course in the biotechnology program at ACC. The five sections are:

- Cell and Molecular Biology
- Microbiology
- General Chemistry
- Introduction to Biotechnology

- Basic Laboratory Techniques

The first three are co-requisite courses in science that are typically taken in the first year. The Introduction to Biotechnology is a semester course containing a lab. As the first of the biotechnology courses, it is predominately a survey course providing an overview of the concepts and techniques of biotechnology. It is followed by the second biotechnology course in the sequence, Basic Laboratory Techniques. Because there is so much chemistry performed in our area industry, Basic Laboratory Techniques is taught as a combination of bio-organic chemistry and solutions.

The assessment test is designed as predominately a multiple-choice test with some essay questions and problems. It is offered to any student who asks for it. These are most those who have an advanced degree in science and/or workforce experience. Students may test out of one or more courses. Although they have tested out of a course, some students will still take or audit that course if there has been considerable time since the last educational experience or confidence levels are low.

Thus, an assessment test is a useful tool in placing students at the appropriate level of study as well as saving them time and money. As with the articulation agreements, assessment tests should be customized to the institution and workforce environment in a given locale. The competencies for employment in one area may be different than those for another area if the industries vary. Therefore the courses offered in one biotechnology program will differ slightly from another to best accommodate the needs of the bioscience industry. With different courses comes the need for different assessment exams.

V

SUMMARY AND A GLIMPSE INTO THE FUTURE

Articulation agreements are useful documents to allow credit for education that is received at one institution to be accepted at another. Typically this takes the form of a vertical agreement in which credit is earned at a lower educational institution and is transferred to the higher institution. In the world of tech prep this usually means that a student will begin technical courses in high school and complete his or her education in a technical or community college. This 2+ 2 arrangement with its accompanying articulation agreement is very common for the vocational path.

When biotechnology programs began to be offered in community and technical colleges within the past decade, they were usually considered under the Tech Prep umbrella since biotechnology contained many of the usual elements of a tech prep program. The courses dealt with competency-based instruction and employment was the desired outcome. But biotechnology also contained considerable amount of science content, and as such, should also be considered an academic program. In actuality, biotechnology programs

straddle both tech prep and academia. The technical elements with its emphasis on lab techniques and its employability outcomes are closely aligned with the aims of a tech prep program whereas biotechnology's content and theory in the advancing ideas of biology and chemistry also identify it as a rigorous academic field. And while tech prep has a long history of vertical articulations with high schools, academia has a history of vertical articulations with four-year colleges and universities. Thus, we find both kinds of articulation agreements existing for biotechnology.

Vertical agreements in biotechnology between high schools and two-year colleges are less common, predominately because of logistical reasons. The high school teachers must receive training in this new field. Since this is done one teacher at a time in workshops and college-level courses supplemented with industry internships, this is a slow process. However, there has been considerable progress recently and more and more high schools contain well-trained teachers of biotechnology. The other roadblock to putting biotechnology into the high schools is that biotechnology courses are very expensive. Lab equipment costing thousands of dollars and used only once or twice a semester prevent many cash-strapped high school administrations from embracing biotechnology programs. But here, too, there has been progress through the generous contributions of industry, from state and national grants and from equipment loans by higher institutions. With the initiation of biotechnology courses into the high schools, comes the need to articulate with the area community and technical colleges as with other tech prep programs.

Vertical articulation agreements between two-year and four-year institutions are a common feature of academic programs around the country. Traditionally, community colleges were feeders for the local university. Students would take one or two years of post-high school work and then would transfer to a four-year college to complete the requirements for a baccalaureate degree⁶. Articulation agreements to allow this transfer of credit were prevalent. The addition of biotechnology programs into either or both two-year and four-year institutions does not change the availability or the usefulness of articulation agreements. These agreements may look somewhat different depending on which institution has biotechnology programs, but there are still many transfer articulation agreements.

Horizontal or lateral articulation agreements are new but useful documents for community colleges to be able to pool resources and draw more students into the program. And reverse articulations, still mostly informal, are good tools to help attract the returning student who has workforce experience and/or academic credentials in a related field.

In short, because of the nature of biotechnology programs and the kinds of students they attract, different kinds of articulation agreements must be drawn up with different kinds of institutions. These agreements benefit the students and the educational institutions and are therefore useful documents in building strong biotechnology programs.

Examination of different articulation agreements reveals that the best ones have several features in common. Most especially, they spell out the conditions under which credit will be accepted in such a way as to maximize the advantages and minimize the pitfalls. [Table IV](#) lists of some of the most useful features of articulation agreements and the reason for their inclusion, and can be used as a checklist when forming agreements.

**TABLE IV:
USEFUL FEATURES OF ARTICULATION AGREEMENTS**

Feature	Advantages
List of accepted courses	-students can plan in advance -misunderstandings reduced -content spelled out
Minimum accepted grade Sometimes GPA	-maintain program quality -improved student success in advanced courses
Term limit Credit expiration often 3 years	-keep students current -improved student success in advanced courses
Division of responsibilities	-reduces competition -maximizes use of resources
Regular review Often annually with both parties	-monitor agreement -change where necessary -maintain currency -reduce problems
Professional development Provided at both levels	-improve instruction -maintain teacher currency of advancing techniques
Credit-in-escrow Credit given after success in advanced courses. May also be a test.	-reduces concern about different content at different locations -reduces concern about teacher preparedness -student success incumbent on student

LOOKING TOWARDS THE FUTURE

Articulation agreements are very useful documents. However, they are very labor-intensive. Most educational institutions have several employees whose only job is to establish and maintain articulation agreements. Each agreement must be hammered out individually and most are completely rewritten each time. Articulation manuals that help schools and colleges to guide this process must also be written. And all these documents must be regularly reviewed and changed. All of this takes considerable effort and time. In many cases, there is the sense that institutions are re-inventing the wheel with each articulation agreement. Plus, there is variability between documents; some are too short and do not spell out all the necessary conditions while some are too long and cumbersome thereby reducing their effectiveness.

To alleviate these problems, state articulation committees are beginning to be established. At least four states, Texas⁴, California⁷, North Carolina and Wisconsin⁸ have created articulation committees. These committees are made up of articulation officers drawn from different institutions and different regions. Their task is to standardize the articulation process within their state. This includes writing a state-wide articulation manual, establishing the best practices for articulation agreements, writing state-wide articulation agreements that can be used as the basis for individual agreements or as stand-alone documents, and encouraging the state-wide collaboration between the different educational institutions with regards to articulations. Wisconsin the most advanced of the states, already uses state-wide articulations in its tech prep courses.

The establishment of defined criteria and state-wide standards will greatly improve the articulation process and dramatically increase the number of articulation agreements. This in turn will bring benefits to both the educational institutions involved. This will likely result in improved communication, stronger programs and more students who are better served in their educational endeavors.

This vision of state-wide and even national articulations is tantalizing but is in the future. Meanwhile, individual schools and colleges will establish their own articulation agreements drawing on their experience and their knowledge of community needs. They will discover that when they establish vertical articulations or even horizontal or reverse ones, their programs will benefit, their institutions will benefit and their students will benefit.

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