Massachusetts Department of Elementary & Secondary Education

Office for Career/Vocational Technical Education

Vocational Technical Education Framework

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Manufacturing, Engineering & Technology Services Occupational Cluster

Biotechnology (VBIOT)

CIP Code 150401

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Mitchell D. Chester, Ed.D.
Commissioner

July 2014

Dear Colleagues,

I am pleased to present to you the *Massachusetts Vocational Technical Education Frameworks*, adopted by the Department of Elementary and Secondary Education in June 2014. These frameworks, one for each of the 44 vocational technical programs, include standards in multiple strands representing all aspects of the industries that students in the vocational technical education program are preparing to enter.

The frameworks also include a crosswalk between the technical standards and relevant standards in Massachusetts Curriculum Frameworks to support effective integration of academic and technical content.

The comments and suggestions received during revision of the 2007 *Massachusetts Vocational Technical Education Frameworks* have strengthened these frameworks. We will continue to work with schools and districts to implement the 2014 *Massachusetts Vocational Technical Education Frameworks* over the next several years, and we encourage your comments.

I want to thank everyone who worked with us to create challenging learning standards for Massachusetts students. I am proud of the work that has been accomplished.

Sincerely,

Mitchell D. Chester, Ed.D.
Commissioner of Elementary and Secondary Education

Introduction

Overview & Organization and Key Changes

Overview

The Massachusetts Department of Elementary and Secondary Education understands the necessity of maintaining current Vocational Technical Education Frameworks which ensure career/vocational technical education students across the Commonwealth are taught the most rigorous standards aligned to the needs of business and industry.

With the advent of the Massachusetts Teaching & Learning System the Office for Career/Vocational Technical Education (CVTE) recognized the significance of including career/vocational technical education in the system and developed a comprehensive plan for including vocational technical education. The plan was designed in a Two Phase Process. Phase One included the revision of strands two, three, and six, of all of the Vocational Technical Education Frameworks. Phase Two consisted of three major components (projects) all equally crucial;

1. The revision of Strands One, Four, and Five to complete the revision of all six strands of the Vocational Technical Education Frameworks;

2. Statewide Professional Development on all revised strands, with training on strands two, three, and six delivered fall 2013, and training on strands one, four, and five delivered spring 2014;

3. The creation and development of additional Model Curriculum Unit (MCU) Teams.

The Office for Career/Vocational Technical Education Framework Team, with support from consultants, began Phase One in the 2012-2013 school year, to revise three of the six strands contained in all of the Vocational Technical Education (VTE) Frameworks. The state was organized into "Collaborative Partnerships" comprised of teams of project administrators, highly qualified subject matter educators, and business and industry partners, whose task was to revise Strand Two – Technical, Strand Three – Embedded Academics, and Strand Six – Technology Literacy. Each team met with a vocational advisory committee which included business and industry representatives and postsecondary education professionals, whose mission was to review and revise the team's draft document during the revisionary process. Once strand two was revised, academic teachers (typically one English Language Arts teacher, one Mathematics teacher, and one Science teacher) worked with the technical subject matter teachers to develop a crosswalk between academic curricula standards and the technical standards, and provided examples of embedded academic content.

The Office for Career/Vocational Technical Education solicited statewide input from technical and academic teachers and administrators at the annual Massachusetts Association of Vocational Administrators (MAVA)/Massachusetts Vocational Association (MVA) - Connecting for Success Conference. Each framework team met with their content colleagues and reviewed the draft revisions and obtained

valuable feedback. Additionally, all drafts were reviewed and revised by the Massachusetts Vocational Technical Teacher Testing Program, to ensure appropriate measurable language.

Project consultants designed a new template to ensure all framework teams entered new standards and additional resources in a consistent manner. The framework teams created an "Appendix" listing potential industry recognized credentials attainable by secondary students; lists of professional, student, and relevant government organizations; and useful resources and websites. ** It is important to note that although most Framework Teams provided information for the "Appendix", not all teams did. Therefore, sub-headings within the "Appendix" without information have been deleted. Disclaimer: Reference in the Appendices Section to any specific commercial products, processes, or services, or the use of any trade, firm or corporation name is for the information and convenience of the public, and does not constitute endorsement or recommendation by the Massachusetts Department of Elementary and Secondary Education.*

The Office for Career/Vocational Technical Education facilitated a comprehensive vetting process throughout the Commonwealth. During the fall of 2012 districts throughout Massachusetts solicited feedback from each Vocational Program's Advisory Committee members at the Fall Board meetings. Additionally, the Office for Career/Vocational Technical Education met with various licensing boards at the Massachusetts Division of Professional Licensure and provided the applicable draft framework to each board for review. All framework drafts were posted on the CVTE website for public comment. Comments and suggested revisions received were shared with each framework team for response and edits, as appropriate.

The Phase I Process was completed on an accelerated timetable and resulted in all Vocational Technical Education Frameworks; Stand Two and Strand Six, revised with current, rigorous, relevant standards. Strand Three has been redesigned into a crosswalk which directly correlates academic and technical standards. An appendix of useful material for technical teachers recommended by their peers was added to each framework.

Phase II of the Framework Revision Process consisted of three major projects;

1. The Strands One, Four & Five Project, to complete the revision of all six strands of the Vocational Technical Education Frameworks;
2. Statewide Professional Development on all revised strands, with training on strands two, three, and six delivered fall 2013, and training on strands one, four, and five delivered spring 2014;
3. The creation and development of additional Model Curriculum Unit (MCU) Teams.

The Strands One, Four, & Five Project began in the fall of 2013 with the formation of a leadership team and three work groups. Co-Managers led the leadership team comprised of three Strand Coordinators who facilitated work teams and reviewed, researched, and revised these common strands. All skills specific to the vocational technical program have been included into Strand Two Technical.

The Strand One Team revised the safety knowledge and skills that all students need to acquire. The team included relevant issues (i.e., bullying, climate), laws, regulations, guidelines and policies pertaining to safety.

The Strand Four Team revised the Employability Knowledge and Skills that all students need to acquire. Teams considered current research on career readiness, including the work of the College Career Readiness Task Force convened by the Department, changes in workplace, technological changes that impact how people perform their work (i.e., communications methods), and included standards that emphasize the need for lifelong learning and adaptability given the multiple career changes over and an individual's working life. The team recommended this strand be renamed to: Career Readiness.

The Strand Five Team revised the Management & Entrepreneurship Knowledge and Skills that all students need to acquire. All business owners and employees must possess management and financial skills to be productive members of society. Skills included financial knowledge and basic business management skills.

All Strand One, Four and Five Project Teams worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Massachusetts Career and Technical Student Organizations to crosswalk standards to national Career & Technical Student Organizations Curricula, as applicable.

The Office for Career/Vocational Technical Education contracted the MAVA Consultant Team to work closely with the office to complete all of the work accomplished during Phase II of the Project.

A remarkable amount of work was accomplished through the efforts of hundreds of professionals who collaborated and diligently supported this work. The Office for Career/Vocational Technical Education is grateful for all the support received from the field, particularly all of the teachers (technical and academic), administrators, advisory committee members, business and industry representatives, the Division of Professional Licensure - boards, the Massachusetts Association of Vocational Administrators, the MAVA Consultants, and the Massachusetts Vocational Association, whose contributions were tremendous.

Special thanks to all staff in the Office for Career/Vocational Technical Education and the CVTE Framework Revision Team who provided guidance and numerous contributions during Phase One of the project.

Organization and Key Changes

This section contains the following:

- Highlights of Changes to the Vocational Technical Education Frameworks; which includes a summary of changes made to each strand.
- Organization of the Frameworks – Strand Two illustrates structure of topic headings, standards and objectives, and performance examples.

Highlights of Changes to the Vocational Technical Education Frameworks:

Strand One:

Safety and Health Knowledge and Skills have been revised to contain the safety standards that are common to all programs. The Strand One Team worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Career and Technical Student Organizations (CTSO) to crosswalk standards to national CTSO Curricula, as applicable.

- No objectives were deleted, only modified.
- Language and wording was clarified.
- Additions included a focus on maintaining a safe school and workplace in terms of creating a positive climate/environment.
- Student safety credential program has been revised.
- Safety attire has been revised.
- Emergency equipment and fire safety has been revised.
- Many new Performance Examples have been included.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: "Organization of the Frameworks – Strand Two". All strands were organized in that manner, with the exception of the former Strand Three.

Strand Two:

The Technical Standards Knowledge and Skills have been revised to reflect business and industry changes since the adoption of the 2007 Vocational Technical Education Frameworks (VTEF). There are additional changes to Strand Two below:

- The Technical Knowledge and Skills (Strand Two) section contains standards specific to the particular vocational program; suffix "a" (as common to all programs) and suffix "c" (as common within a cluster) have been removed.
- Each VTEF Strand Two begins with safety and health knowledge and skills specific to the particular vocational program.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: "Organization of the Frameworks – Strand Two". All strands were organized in that manner, with the exception of the former Strand Three.

- Strand Two of the Frameworks for Animal Science, Environmental Science and Technology, and Horticulture, begin with core standards required for all participants in the programs, followed by a series of standards organized in concentrations. See the section below titled: "Organization of the Frameworks – Strand Two" for more information.
- An update to some of the vocational programs framework is the addition of advanced or supplemental standards which are noted in Strand Two by an asterisk (*). *These standards are not required, but are provided as suggestions that districts may choose to use to increase the depth of a particular topic, or add additional topics, particularly for advanced students or for those seniors who do not participate in cooperative education.* See the section below titled: "Organization of the Frameworks – Strand Two" for more information.

Strand Three:

Since the purpose of Strand Three was to correlate academic content that was *embedded* in the knowledge and skills necessary to perform certain technical skills, it was logical to highlight those connections through a crosswalk between the academic curriculum standards and the technical standards (Strand Two). The crosswalk directly correlates the English Language Arts (2011) and Mathematics (2011) Frameworks, incorporating the Common Core Standards and the Science and Technology/Engineering Frameworks. The crosswalk can be found in the appendix of each vocational framework. The crosswalk also includes performance examples which illustrate integrated academic and technical content.

- Embedded Academics has been replaced with a crosswalk between the academic curriculum standards and the technical knowledge and skills standards. The crosswalk is located in the Appendices.

Strand Four:

Employability (and Career Readiness) Knowledge and Skills focused on providing students with general knowledge and skills to be college and career ready. The Strand Four Team worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Career and Technical Student Organizations to crosswalk standards to national CTSO Curricula, as applicable.

- Language and wording were clarified.
- Additions included a focus on providing students with skills for employability/career readiness.
- Modifications included Career Exploration & Navigation, Communication in the Workplace, and Work Ethic & Professionalism.
- New Performance Examples have been included.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: "Organization of the Frameworks – Strand Two". All strands were organized in that manner, with the exception of the former Strand Three.

Strand Five:

Strand Five contains Management and Entrepreneurship Knowledge and Skills that are general for all students. The Strand Five Team worked collaboratively with staff from the Department of Elementary and Secondary Education and the Advisors of the Massachusetts Career and Technical Student Organizations to crosswalk standards to national Career & Technical Student Organizations Curricula, as applicable.

- Language and wording were clarified and organized into a logical format.
- The Strand Five Team felt that the 2007 curriculum remained valid.
- Additions included a focus on providing students with skills for management and entrepreneurship applicable to all vocational programs.
- Modifications included Starting and Managing a Business, Marketing, and Financial Concepts & Applications in Business, and Legal/Ethical/Social Responsibilities.
- New Performance Examples have been included.
- Within each strand, standards and objectives were grouped under Topic Headings, which are displayed in bold. Each standard is followed by a performance example. See the section below titled: "Organization of the Frameworks – Strand Two". All strands were organized in that manner, with the exception of the former Strand Three.

Strand Six

Strand Six Technology Literacy Knowledge and Skills has been replaced with the 2008 Massachusetts Technology Literacy Standards and Expectations Framework.

Appendix[1]

Each framework contains an "Appendix" section which includes an Embedded Academic Crosswalk, Industry Recognized Credentials, Statewide Articulation Agreements, Professional, Governmental, and Student Organizations, Resources, and relevant websites.

The Appendix[2] contains:

- Embedded Academic crosswalks for English Language Arts, Mathematics, and Science & Technology/Engineering.
- Statewide Articulations: Current statewide Articulation Agreements and/or Apprenticeship Programs available to the specific vocational program are listed on this page. The development of new statewide articulations continues, and therefore these pages will be revised as new agreements are finalized.

- Industry-Recognized Credentials: Technical Teacher Teams generated lists of credentials for the vocational programs. Program Advisory Committees throughout the state reviewed and provided recommendations through the validation process. *The credential list has been provided as a resource only and districts are not obligated to provide all of the specified credentials for students.*

- Other: These pages provide lists of reference materials, government agencies, professional and student organizations, and useful websites created by each framework team. These are intended as helpful resources for technical teachers, identified by peers. These are not recommended or required by the Department of Elementary & Secondary Education.

[1] *Note:* Although most Framework Teams provided information for the "Appendix", not all teams did. *Therefore, sub-headings within the "Appendix" without information have been deleted.*
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Organization of the Frameworks – Strand Two

The Vocational Technical Education Frameworks contain knowledge and skills covering all aspects of industry, reflected in six strands: Safety and Health, Technical, Embedded Academics, Employability, Management and Entrepreneurship, and Technological.

Within each strand, standards and objectives were grouped under topic headings, which are displayed in bold. Each standard is followed by a performance example. In the excerpt below, 2.A is the topic; 2.A.01 is the first standard and 2.A.01.01 and 2.A.01.02 are the objectives under that standard.

2.A Automotive Technology Specific Safety Practices

2.A.01 Identify and describe safety procedures when dealing with different types of automotive lifts according to current industry standards.

- 2.A.01.01 Demonstrate procedures for safe lift operations.
- 2.A.01.02 Demonstrate safe use, placement and storage of floor jacks and jack stands.

2.A.01 Performance Example:

- Student will set up lift using manufacturer's suggested lift points.

2.A.02 Demonstrate and describe safety procedures when dealing with high pressure systems including necessary ventilation according to current industry standards.

- 2.A.02.01 Describe and demonstrate the importance of safety procedures to be used when servicing high pressurized systems (fuel systems, brakes, air conditioning, suspension, hydraulic systems, etc.).
- 2.A.02.02 Describe and demonstrate safe use of oxygen/acetylene torches and electric welding equipment.
- 2.A.02.03 Demonstrate ventilation procedures to be followed when working in the lab/shop area.

2.A.02 Performance Example:

- Student will relieve fuel system pressure to perform necessary repairs.

2.A.03 Identify and describe safety procedures when dealing with electrical circuits according to current industry standards.

- 2.A.03.01 Describe safety procedures to be followed when servicing supplemental restraint systems.
- 2.A.03.02 Demonstrate safety awareness of high voltage circuits of electric or hybrid electric vehicles and related safety precautions.

2.A.03 Performance Example:

- Safely disable Supplemental Restraint System (SRS) air bag for repair using manufacturer's recommendations.

There are additional changes to some of the Frameworks Strand Two (Technical Knowledge and Skills). Specifically, Strand Two of the Frameworks for Animal Science, Environmental Science and Technology and Horticulture begin with core standards required for all participants in the programs, followed by a series of standards organized in concentrations. For example, Strand Two of the Horticulture Framework begins with the core standards required of all Horticulture students

(Topics 2.A through 2.I). These standards are followed by the three concentrations: Arboriculture (Topics 2.J through 2.L), Greenhouse Management and Floriculture (Topics 2.J. through 2.L) and Landscape and Turf Management (Topics 2.M through 2.Q).

Advanced / Supplemental Standards (Not Required)

Another variation that is new to the revised Strand Two Frameworks is the addition of advanced or supplemental standards which are noted with the use of an asterisk (*). *These standards are not required, but are provided as suggestions that districts may choose to use to increase the depth of a particular topic, or add additional topics, particularly for advanced students or for those seniors who do not participate in cooperative education.*

The following is an example from Automotive Technology, where entire topics were added:

Advanced Automotive Technology Technical Knowledge and Skills

Note: The following competencies are optional, supplementary competencies suitable for advanced students. These are not required.

2.CC Demonstrate appropriate engine repair techniques.

2.CC.01 Perform appropriate cylinder Head Repair.

2.CC.01.01* Diagnose, remove and replace cylinder head(s).

2.CC.01.02* Clean and visually inspect a cylinder head for cracks; check gasket surface areas for warpage and surface finish; check passage condition; determine necessary action.

The following is an example from the Strand Two Radio and Television Broadcasting Framework that shows the addition of an advanced objective, 2.B.04.08*:

2.B.04 Explain concepts fundamental to shooting in cinema and video.

2.B.04.01 Compare and contrast a single-camera and a multiple-camera production.
2.B.04.02 Explain the importance of shooting for the edit (i.e., match on action, sequencing, coverage).
2.B.04.03 Explain the importance of continuity.
2.B.04.04 Explain the 180° Rule line, and its application in various cinema scenarios.
2.B.04.05 Identify and establish a specific point-of-view when shooting from a script.
2.B.04.06 Analyze the methods in which specific shots can evoke emotion from an audience.
2.B.04.07 Define drop frame and non-drop frame code shooting and explain how to account for both when preparing for an edit.
2.B.04.08* Describe various cinematographic methods necessary when

2.B.04 Performance Examples:

- Students will list similarities and differences of single-camera and multiple-camera shoots.
- Students will describe multiple shooting considerations that are useful in streamlining the editing process.

shooting scenes that incorporate post-production visual effect

Manufacturing, Engineering & Technology Services Occupational Cluster

Biotechnology Framework (VBIOT)

Strand 1: Safety and Health Knowledge and Skills

1.A Fundamentals of Health and Safety

1.A.01 Describe and apply health and safety regulations.

- 1.A.01.01 Identify, describe and apply health and safety regulations that apply to specific tasks and jobs. Students must complete a safety credential program, e.g., Occupational Safety and Health Administration 10, CareerSafe and ServSafe.
- 1.A.01.02 Identify, describe and apply Environmental Protection Agency (EPA) and other environmental protection regulations that apply to specific tasks and jobs in the specific occupational area.
- 1.A.01.03 Identify, describe and apply Right-To-Know (Hazard Communication Policy) and other communicative regulations that apply to specific tasks and jobs in the specific occupational area.
- 1.A.01.04 Explain procedures for documenting and reporting hazards to appropriate authorities.
- 1.A.01.05 Identify and describe potential consequences for non-compliance with appropriate health and safety regulations.
- 1.A.01.06 Identify and list contact information for appropriate health and safety agencies and resources.

1. A.01 Performance Examples:

- List and define OSHA Health and Safety Regulations, EPA and other environmental protection regulations to occupational area.
- List and define Right-to-Know regulations and reporting of hazards and contact information for appropriate health and safety agencies.
- List the laws and rules of regulatory agencies governing sanitation and safety.
- Utilize OSHA as well as health and safety websites for purposes of research.

1.A.02 Demonstrate appropriate health and safety practices based on the specific occupational area.

- 1.A.02.01 Identify, describe and demonstrate the effective use of Safety Data Sheets (SDS).
- 1.A.02.02 Read and interpret chemical, product and equipment labels to determine appropriate health and safety considerations.
- 1.A.02.03 Identify, describe and demonstrate personal, shop and job site safety practices and procedures.
- 1.A.02.04 Demonstrate safe dress and use of relevant safety gear, personal protective equipment (PPE) and ergonomics, e.g., wrist rests, adjustable workspaces, equipment, gloves, proper footwear, earplugs, eye protection and breathing apparatus.

1.A.02.05 Demonstrate appropriate safe body mechanics, including appropriate lifting techniques and ergonomics.

1.A.02.06 Locate emergency equipment, first aid kit, SDS information directories and emergency action/response plan/escape routes in your lab, shop and classroom, including labels and signage that follow OSHA Hazard Communication Program (HAZCOM), eyewash stations, shower facilities, sinks, fire extinguishers, fire blankets, telephone, master power switches and emergency exits.

1.A.02.07 Demonstrate the safe use, storage, and maintenance of every piece of equipment in the lab, shop and classroom, e.g., the OSHA Lockout/Tagout Program (LOTO).

1.A.02.08 Describe safety practices and procedures to be followed when working with and around electricity, e.g., ground fault circuit interrupter (GFCI) and frayed wiring.

1.A.02.09 Handle, store, dispose of and recycle hazardous, flammable and combustible materials, according to EPA, OSHA and product specifications.

1.A.02.10 Demonstrate appropriate workspace cleaning, sanitation, disinfection and sterilization procedures required in specific occupational areas, e.g., Workplace Housekeeping OSHA Regulations.

1. A.02 Performance Examples:

- Identify, describe and demonstrate the use of SDS.
- List and demonstrate shop dress code, safety procedures and location of emergency equipment in labor classroom.
- Define and demonstrate safe storage and maintenance of equipment and proper disposal or recycling of hazardous, flammable and combustible materials.
- Identify, describe and demonstrate the Universal Precautions set of guidelines.

1.A.03 Demonstrate appropriate responses to situations that may threaten health and safety.

1.A.03.01 Describe First Aid procedures for potential injuries and other health concerns in the specific occupational area.

1.A.03.02 Describe the importance of emergency preparedness and an emergency action/response plan.

1.A.03.03 Describe procedures used to handle emergency situations, defensive measures and accidents, including identification, reporting, response, evacuation plans and follow-up procedures.

1.A.03.04 Identify, describe and demonstrate safety practices in specific occupational areas used to avoid accidents.

1.A.03.05 Identify and describe fire protection, protection, precautions and response procedures.

1.A.03.06 Discuss the role of the individual and the company/organization in ensuring workplace safety including transportation to and from school, school activities and the workplace.

1.A.03.07 Discuss ways to identify, prevent and report school and workplace violence, discrimination, harassment and bullying.

1.A.03.08 Demonstrate positive and appropriate behavior that contributes to a safe and healthy environment in school and the workplace.

1. A.03 Performance Example:

- Define first aid procedures and protocols used to handle emergency situations and practices used to avoid accidents.
- View safety videos and discuss the role of workplace safety.
- Attend or participate in a human rights alliance organization presentation.
- Observe and/or demonstrate the appropriate use of a fire extinguisher using the (PASS) technique: Pull, Aim, Squeeze, Sweep.
- Review and discuss specific policies, procedures and protocols regarding discrimination, harassment and bullying.
- Discuss and/or role-play proper and respectful behavior that contributes to a positive climate.
- Discuss and/or demonstrate behavior that contributes to a collaborative/teamwork environment.

Selected Websites

- Bullying Prevention and Intervention Resources : www.doe.mass.edu/bullying
- Centers for Disease Control and Prevention: www.cdc.gov
- Environmental Protection Agency : www.epa.gov
- "Lost Youth – Four Stories of Injured Young Workers"– WorkSafeBC: http://www2.worksafebc.com/Publications/Multimedia/Videos.asp?reportid=34291
- Massachusetts Department of Elementary and Secondary Education. (2011). Career/Vocational Technical Education Safety Guide: www.doe.mass.edu/cte
- Massachusetts Department of Elementary and Secondary Education: www.doe.mass.edu
- Massachusetts Emergency Management Agency: www.mass.gov/eopss/agencies/mema
- Massachusetts General Law: www.malegislature.gov
- Massachusetts Health and Human Services: www.mass.gov/dph
- Massachusetts Right to Know Law Summary: http://www.mass.gov/lwd/docs/dos/mwshp/hib397.pdf
- Safety Data Sheet: www. sdsonline.com
- National Fire Protection Association: www.nfpa.org
- Protection of Student Rights: Massachusetts General Law: https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXII/Chapter76/Section5
- Occupational Safety and Health Administration: www.osha.gov
- Readiness and Emergency Management for Schools: www.rems.ed.gov
- Safe and Healthy Learning Environments: www.doe.mass.edu/ssce/safety.html

Strand 2: Technical Knowledge and Skills

2.A Safety in the Biotechnology Laboratory

2.A.01 Complete and obtain a 10-hour OSHA certification

2.A.01.01 Complete the requirements of OSHA 10 hour certification course and receive a course completion card.

> 2.A.01 Performance Example:
> - Complete 10hr OSHA certification course.

2.A.02 Complete and obtain a CPR and First Aid Training card/credential.

2.A.02.01 Complete American Red Cross or American Heart Association Heart saver First Aid and CPR AED certification and receive a course completion card.

> 2.A.02 Performance Example:
> - Complete First Aid and CPR AED Training

2.A.03 Follow safety and emergency procedures according to OSHA standards.

2.A.03.01 Practice work habits that provide personal safety, safety for others, and protect the safety and security of the external environment.

2.A.03.02 Select and use appropriate personal protective equipment at all times.

2.A.03.03 Maintain a sanitary and clutter-free work environment.

2.A.03.04 Monitor, use, store, and dispose of materials according to established procedures.

> 2.A.03 Performance Example:
> - Students will use PPE at all times when working in the lab .according to OSHA standards.
> - Students will wipe down work areas with 70% ethanol or a freshly prepared 1/10 dilution of bleach prior to and after working with bacteria.

2.B Basic Biotechnology Knowledge and Skills

2.B.01 Demonstrate knowledge of biotechnology industry fundamentals.

2.B.01.01 Describe the major application areas of biotechnology and their products.

2.B.01.02 Describe the life cycle of products (e.g., research and development to production).

2.B.01.03 Describe the organizational structures of biotechnology companies.

2.B.01.04 Summarize the historical development of biotechnology.

2.B.01.05 Describe the social, legal, and ethical issues that affect the application of biotechnology.

2.B.01.06 Use and interpret information resources relevant to biotechnology (e.g., journals, databases, website, etc.).

2.B.01.07 Explain the different career paths in biotechnology and the jobs associated with them.

> 2.B.01 Performance Example:
> - Student will analyze a teacher provided case study which addresses the moral, ethical, and medical issues surrounding the treatment of a young child suffering from a rare genetic disorder.
> - Student teams will debate the bioethical concerns surrounding the use of genetic diagnosis, stem cells, and in-vitro fertilization.

2.B.02 Demonstrate knowledge of regulatory affairs.

- 2.B.02.01 Explain good documentation practices (e.g., signatures, dating, use of indelible ink, witnessing requirements).
- 2.B.02.02 Explain the history of pharmaceutical regulations and the Food and Drug Administration (FDA).
- 2.B.02.03 Explain the organization of the FDA (e.g., the roles of Center for Drug Evaluation and Research (CDER) and Center for Biologics Evaluation and Research (CBER)).
- 2.B.02.04 Explain the life cycle of medical products (e.g., discovery through clinical trials, New Drug Application (NDAs), Investigational New Drug (INDs).
- 2.B.02.05 Explain current Good Manufacturing Practice (cGMP) and Good Laboratory Practice (GLP) regulations.
- 2.B.02.06 Explain the regulatory agencies at the local, state and federal levels.
- 2.B.02.07 Document assay procedures and results.
- 2.B.02.08 Evaluate results of assays (e.g., determine amount of analyte in quantitative assay).
- 2.B.02.09 Prepare results in written technical reports (e.g., designated report format is used, all resources are referenced, graphs and tables are clearly labeled and explained, data is accurately analyzed) and present orally.
- 2.B.02.10 Explain the roles of the IBC and IUCAC.
- 2.B.02.11 Explain United States Department of Agriculture (USDA) an Public Health Service (PHS) Policy on the humane care and use of laboratory animals and the roles of the American Association for Laboratory Animal Science (AALAS) and Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC).

2.B.02 Performance Example:

- Prepare a PowerPoint presentation to explain the history of the FDA.
- Document assay procedure and results in a laboratory notebook

2.B.03 Demonstrate basic lab management skills.

- 2.B.03.01 Inventory supplies according to established procedures.
- 2.B.03.02 Obtain required materials.
- 2.B.03.03 Schedule work functions in an organized manner.
- 2.B.03.04 Clean and sterilize glassware and counters according to preestablished procedures.
- 2.B.03.05 Ensure that equipment is cleaned and maintained according to established preventative maintenance procedures.
- 2.B.03.06 Document lab support functions using logbooks, computer systems, forms, and other methods, according to established procedures (e.g., autoclave, pH meter, incubators and freezers).

2.B.03 Performance Example:

- An instructor designated student will act as a lab supervisor for the day.
  The student supervisor will assign lab maintenance duties (inventorying supplies, cleaning glassware, and equipment, media prep, et cetera), verify they are completed properly and review logbook entries that document all completed tasks for the day.
- Use a logbook to document use of equipment (i.e., autoclave).

2.C Biomanufacturing Fundamentals

2.C.01 Demonstrate and apply manufacturing process management techniques.

- 2.C.01.01 Identify, create and use standard operating procedures (SOPs).
- 2.C.01.02 Explain how process control data is used to monitor processes.
- 2.C.01.03 Test product to verify that it meets specifications and regulations.
- 2.C.01.04 Explain biomanufacturing lean techniques as they pertain to improved efficiency, reduction of waste and increased productivity.
- 2.C.01.05 Identify and apply the concepts of total quality management appropriate to the field.
- 2.C.01.06 Develop a comprehensive product development plan for a biotechnology product.

> 2.C.01 Performance Example:
> - Create an SOP for the operation of a piece of lab equipment.
> - Choose a biotechnology product and develop a CPDP.

2.D Solution Preparation

2.D.01 Perform basic calculations.

- 2.D.01.01 Perform calculations relating to measurements.
- 2.D.01.02 Perform calculations relating to reagent and media formulation and dilution.
- 2.D.01.03 Perform calculations relating to data acquisition and analysis.
- 2.D.01.04 Perform calculations relating to products, processing and quality control monitoring.
- 2.D.01.05 Perform calculations relating to growing cells and analyzing their growth rate.
- 2.D.01.06 Determine concentrations of solutions.
- 2.D.01.07 Graph and interpret data using electronic spreadsheet programs.
- 2.D.01.08 Perform calculations relating to dosage levels for animal studies (e.g., mg/kg, ml/kg).

> 2.D.01 Performance Example:
> - Calculate the concentration of a copper sulfate solution.
> - Create a standard curve graph using an Excel spreadsheet.

2.D.02 Prepare solutions.

- 2.D.02.01 Prepare percent, molar and molal solutions.
- 2.D.02.02 Perform dilutions and calculate resulting concentrations.
- 2.D.02.03 Perform serial dilutions.
- 2.D.02.04 Prepare agar plates and broths using appropriate techniques (filtration or autoclave).
- 2.D.02.05 Label and store reagents, solutions, and media according to established procedures.

> 2.D.02 Performance Example:
> - Students will prepare 15mL of a 7.5% Copper sulfate solution.
> - Students will perform four 1:10 serial dilutions of copper sulfate solutions.

2.E Instrumentation and Lab Assays

2.E.01 Metrology: Use measurement instrumentation.

- 2.E.01.01 Calibrate and maintain measuring instruments (e.g., balances, pH meters, thermometers, pipettes, spectrophotometers).
- 2.E.01.02 Make weight measurements with acceptable accuracy and precision.

2.E.01.03 Make volume measurements with acceptable accuracy and precision.
2.E.01.04 Make pH measurements with acceptable accuracy and precision.
2.E.01.05 Make temperature measurements with acceptable accuracy and precision.
2.E.01.06 Make spectrophotometric measurements with acceptable accuracy and precision.

2.E.01 Performance Example:
- Students will demonstrate the ability to choose and use equipment for the measurement of weight, volume, pH, temperature, wavelength and concentration.
- Students will demonstrate the ability to calibrate and maintain equipment such as pH meters, balances, thermometers, pipettes and spectrophotometers.

2.E.02 Use microscopes.
2.E.02.01 Identify microscope parts.
2.E.02.02 Demonstrate use and care of microscopes.
2.E.02.03 Differentiate between the different types of microscopes and describe their uses (compound, inverted, scanning electron, fluorescent, and stereo).
2.E.02.04 Prepare a wet mount slide.
2.E.02.05 Prepare a slide with a cross section.
2.E.02.06 Demonstrate cleaning of the microscope and lenses.
2.E.02.07 Demonstrate basic cell staining techniques to observe cell morphology.
2.E.02.08 Count cells using a hemocytometer.
2.E.02.09 Identify and describe functions of cellular organelles.

2.E.02 Performance Example:
- Students will demonstrate how to prepare a wet mount slide.
- Students will determine the number of cells using a hemocytometer when given a prepared slide.

2.E.03 Perform standard lab assays/techniques.
2.E.03.01 Isolate DNA.
2.E.03.02 Determine DNA concentration and purity.
2.E.03.03 Perform enzyme-linked immunoabsorbant assay (ELISA).
2.E.03.04 Perform western blotting.
2.E.03.05 Perform DNA fingerprinting.
2.E.03.06 Perform Polymerase Chain Reaction (PCR).
2.E.03.07 Perform gram staining.
2.E.03.08 Determine protein concentration.
2.E.03.09 Determine enzyme activity.

2.E.03 Performance Example:
- Isolate plasmid DNA from transformed bacteria and determine DNA concentration and purity using a spectrophotometer set to absorbance 260 nm for concentration and a 260/280 nm ratio to determine purity.
- Separate Bovine Serum Albumin (BSA) from a mixture of proteins using SDS polyacrylamide gel electrophoresis (SDS PAGE).

2.E.04 Perform separation techniques.
2.E.04.01 Operate centrifuges.
2.E.04.02 Use filtration devices and systems.
2.E.04.03 Use electrophoresis systems (e.g., SDS PAGE and agarose gel electrophoresis).
2.E.04.04 Use chromatography (e.g., size exclusion, affinity, HIC, ion exchange).

2.E.04.05 Compare and contrast various chromatography methods. (including size exclusion, HPLC, reverse phase, affinity, HIC, ion exchange, etc.).

2.E.04 Performance Example:
- Assemble and pour size exclusion columns of various column bed depths.
- Compare and contrast various separation techniques.

2.F Cell techniques

2.F.01 Perform aseptic technique.

2.F.01.01 Decontaminate work area prior to and after use.
2.F.01.02 Dispose of waste following appropriate decontamination procedures.
2.F.01.03 Maintain a sterile environment using a biological safety cabinet.
2.F.01.04 Operate an autoclave and explain its use in sterile technique.
2.F.01.05 Sterilize reagents, solutions, and media properly according to established procedures.

2.F.01 Performance Example:
- Students will decontaminate the biological safety cabinet prior to use.
- Students will autoclave prepared media.
- Students will filter sterilize heat–labile solutions.

2.F.02 Maintain microorganisms.

2.F.02.01 Establish clonal cultures from a colony isolation.
2.F.02.02 Culture bacteria using nutrient media on sterile agar plates and in fermentation flasks and test tubes.
2.F.02.03 Identify bacteria using staining techniques, growth on selective media, and DNA analysis.

2.F.02 Performance Example:
- Isolate a single colony from a plate and streak for isolation on another plate.
- Prepare a slide from an isolated bacterial colony and perform a gram stain to determine if the bacteria are Gram negative or positive.

2.F.03 Transform cells.

2.F.03.01 Transform bacteria with a plasmid.
2.F.03.02 Explain transformation protocols for plant, mammalian and other cells.

2.F.03 Performance Example:
- Transform Eschericia coli JM109 with a plasmid containing a gene that codes for kanamycin resistance. Plate on LB agar plates containing kanamycin.
- Write a paper (or prepare a PowerPoint) that describes techniques for transformation of plant, bacterial and mammalian cells.

2.F.04 Maintain animal cells in tissue culture.

2.F.04.01 Maintain suspension and/or attached cells.
2.F.04.02 Preserve cells using cryopreservation.

2.F.04 Performance Example:
- Students will prepare media for growing animal cells.
- Students will grow and maintain cells (contamination free) in culture and passage those cells as necessary.

2.F.05 Clone plants.

- 2.F.05.01 Prepare and sterilize explants containing meristematic tissues.
- 2.F.05.02 Place explants in appropriate growth agar.
- 2.F.05.03 Monitor daily and record amount of time to callus, shoot, root and leaf formation; document stages of development photographically.
- 2.F.05.04 Transfer to new media, if appropriate.
- 2.F.05.05 Transfer the plantlet to solid potting mixture when it is large enough.

2.F.05 Performance Example:

- Cut a young leaf off an African violet plant. Sterilize the leaf by serial passage through 70% ethanol, then bleach solutions and then rinse in sterile water. Excise a piece of leaf, 0.5 cm square, that includes a portion of the vein.
- Insert the explant in sterile, shoot elongation agar such that a cut edge is wedged approximately ¼ of the way into the media.

2.F.06 Use inverted microscopes to view cell cultures.

2.F.06 Performance Example:

- Use an inverted microscope to view attached and suspension tissue culture cells.
- Use an inverted microscope to count cells on a hemocytometer.

2.F.07 Determine the viability of cells in culture.

2.F.07 Performance Example:

- Treat cells with trypan blue and count live and dead cells on a hemocytometer. If cells take up the trypan blue, they are non-viable.. Determine the % of dead cells..
- Treat attached cells on a plate with trypan blue and locate non-viable areas.

2.F.08 Describe the use of cells in biotechnology (e.g., use of cells in cancer research, as factories to produce enzymes and drugs, and for regenerative medicine therapies).

2.F.08 Performance Example:

- Explain the differences between the use of bacteria and mammalian cells to produce recombinant proteins.
- Explain the use of skin grafts in burn victims.

Strand 3: Embedded Academics

Strand 3: Embedded Academics, a critical piece of a Vocational Technical Education Framework, are presented as Crosswalks between the Massachusetts Vocational Technical Education Frameworks and the Massachusetts Curriculum Frameworks. These Crosswalks are located in the Appendix of this Framework.

Academic Crosswalks

Appendix A: English Language Arts
Appendix B: Mathematics
Appendix C: Science and Technology/Engineering
Earth and Space Science
Life Science (Biology)
Physical Science (Chemistry and Physics)
Technology/Engineering

Strand 4: Employability and Career Readiness

4.A Career Exploration and Navigation

4.A.01 Develop a career plan and portfolio.

- 4.A.01.01 Develop and revise career plan annually based on workplace awareness and skill attainment.
- 4.A.01.02 Assess personal strengths and interest areas to determine potential careers, career pathways and career ladders.
- 4.A.01.03 Examine potential career field(s)/discipline(s) and identify criteria to select, secure and keep employment in chosen field(s).
- 4.A.01.04 Research and evaluate a variety of careers utilizing multiple sources of information and resources to determine potential career(s) and alternatives.
- 4.A.01.05 Identify training and education requirements that lead to employment in chosen field(s) and demonstrate skills related to evaluating employment opportunities.
- 4.A.01.06 Explore and evaluate postsecondary educational opportunities including degrees and certifications available, traditional and nontraditional postsecondary pathways, technical school and apprenticeships, cost of education, financing methods including scholarships and loans and the cost of loan repayment.
- 4.A.01.07 Create a portfolio showcasing academic and career growth including a career plan, safety credential, resume and a competency profile demonstrating the acquisition of the knowledge and skills associated with at least two years of full-time study in the Chapter 74 program.

4.A.02 Demonstrate job search skills.

- 4.A.02.01 Conduct a job search and complete written and electronic job applications, resumes, cover letters and related correspondence for a chosen career path.
- 4.A.02.02 Explore and evaluate postsecondary job opportunities and career pathways specific to career technical areas.
- 4.A.02.03 Identify role and use of social media and networking for staying current with career and employment trends as well as networking, job seeking and career development opportunities.
- 4.A.02.04 Demonstrate ability to use social media and networking to develop useful occupational contacts, job seeking and career development opportunities.

4.A.03 Demonstrate all phases of the job interview process.

- 4.A.03.01 Gather relevant information about potential employer(s) from multiple print and digital sources, assessing the credibility and accuracy of each source.
- 4.A.03.02 Identify employment eligibility criteria, such as drug/alcohol free status, clean driving record, etc.

4.A.03.03 Practice effective interviewing skills: appearance, inquiry and dialogue with interviewer, positive attitude and evidence of work ethic and skills.

4.A.03.04 Explore and evaluate employment benefit packages including wages, vacation, health care, union dues, cafeteria plans, tuition reimbursement, retirement and 401K.

4. A Performance Examples:

- Conduct research to analyze and present on specific careers within a cluster.
- Conduct web-based job search using sites such as Monster.com, CareerBuilder.com, Indeed.com, Snagajob.com, Simplyhired.com and others.
- Create profile on social media/networking site such as LinkedIn and/or LinkedIn University for postsecondary research and employment opportunities.
- Complete online job application.
- Conduct and videotape practice interviews for instructor and student analysis.
- Provide students with sample employment and benefit packages for evaluation.

4.B Communication in the Workplace

4.B.01 Demonstrate appropriate oral and written communication skills in the workplace.

4.B.01.01 Communicate effectively using the language and vocabulary appropriate to a variety of audiences within the workplace including coworkers, supervisors and customers.

4.B.01.02 Read technical and work-related documents and demonstrate understanding in oral discussion and written exercise.

4.B.01.03 Demonstrate professional writing skills in work-related materials and communications (e.g., letters, memoranda, instructions and directions, reports, summaries, notes and/or outlines).

4.B.01.04 Use a variety of writing/publishing/presentation applications to create and present information in the workplace.

4.B.01.05 Identify, locate, evaluate and use print and electronic resources to resolve issues or problems in the workplace.

4.B.01.06 Use a variety of financial and data analysis tools to analyze and interpret information in the workplace.

4.B.01.07 Orally present technical and work-related information to a variety of audiences.

4.B.01.08 Identify and demonstrate professional non-verbal communication.

4.B.02 Demonstrate active listening skills.

4.B.02.01 Listen attentively and respectfully to others.

4.B.02.02 Focus attentively, make eye contact or other affirming gestures, confirm understanding and follow directions.

4.B.02.03 Show initiative in improving communication skills by asking follow-up questions of speaker in order to confirm understanding.

4. B Performance Examples:

- Read and analyze technical instructions to learn what makes them effective.
- Read and analyze technical instructions to follow directions and/or solve a problem.
- Examine a technical document and use it to write a set of instructions for another student to follow and evaluate.
- Analyze websites for effective technical writing and design.
- Create brochures and presentations using software and/or Web 2.0 tools to convey technical information.
- Conduct research using the Internet, print documents, observations and interviews to create a technical guide.

4.C Work Ethic and Professionalism

4.C.01 Demonstrate attendance and punctuality.

- 4.C.01.01 Identify and practice professional time-management and attendance behaviors including punctuality, reliability, planning and flexibility.

4.C.02 Demonstrate proper workplace appearance.

- 4.C.02.01 Identify and practice professional appearance specific to the workplace.
- 4.C.02.02 Identify and practice personal hygiene appropriate for duties specific to the workplace.
- 4.C.02.03 Identify and wear required safety gear specific to the workplace.

4.C.03 Accepts direction and constructive criticism.

- 4.C.03.01 Demonstrate ability (both verbally and non-verbally) to accept direction and constructive criticism and to implement solutions to change behaviors.
- 4.C.03.02 Ask appropriate questions to clarify understanding of feedback.
- 4.C.03.03 Analyze own learning style and seek instructions in a preferred format that works best for their understanding (such as oral, written or visual instruction).

4.C.04 Demonstrate motivation and initiative.

- 4.C.04.01 Evaluate assigned tasks for time to completion and prioritization.
- 4.C.04.02 Demonstrate motivation through enthusiasm, engagement, accurate completion of tasks and activities.
- 4.C.04.03 Demonstrate initiative by requesting new assignments and challenges.
- 4.C.04.04 Explain proposed solutions to challenges observed in the workplace.
- 4.C.04.05 Demonstrate the ability to evaluate multiple solutions to problems and challenges using critical reasoning and workplace/industry knowledge and select the best solution to the problem.
- 4.C.04.06 Implement solution(s) to challenges and/or problem(s) observed in the workplace.
- 4.C.04.07 See projects through completion and check work for quality and accuracy.

4.C.05 Demonstrate awareness of workplace culture and policy.

4.C.05.01 Display ethical behavior in use of time, resources, computers and information.
4.C.05.02 Identify the mission of the organization and/or department.
4.C.05.03 Explain the benefits of a diverse workplace.
4.C.05.04 Demonstrate a respect for diversity and its benefit to the workplace.

4.C.06 Interact appropriately with coworkers.
4.C.06.01 Work productively with individuals and in teams.
4.C.06.02 Develop positive mentoring and collaborative relationships within work environment.
4.C.06.03 Show respect and collegiality, both formally and informally.
4.C.06.04 Explain and follow workplace policy on the use of cell phones and other forms of social media.
4.C.06.05 Maintain focus on tasks and avoid negative topics or excessive personal conversations in the workplace.
4.C.06.06 Negotiate solutions to interpersonal and workplace conflicts.

4. C Performance Examples:
- Complete a learning style analysis tool.
- Develop a rubric to assess work ethic and professionalism as detailed in the standards above.

Student Organizations

Business Professionals of America www.bpa.org

Selected Websites

- 5 Ways to Ace a Job Interview: http://kidshealth.org/teen/school_jobs/jobs/tips_interview.html
- America's Career Resource Network: http://acrn.ovae.org/teachers/careerexpclassrm.htm
- Career Cruiser – Florida Department of Education: http://www.fldoe.org/workforce/pdf/cruiser.pdf
- Career Development Guide and Glossary: http://www.doe.mass.edu/connect/cde.html
- Career One Stop: http://www.careeronestop.org/
- Career Plan: http://www.doe.mass.edu/cd/plan/intro.html
- Career Plan Model: http://www.doe.mass.edu/ccr/epp/samples/cpmodel_11x17.pdf
- Checklist: http://www.doe.mass.edu/cd/plan/checklist.pdf
- Career Tech: http://www.okcareertech.org/cac/Pages/resources_products/ethics_web_sites.htm
- Ethics Resource Center: http://www.ethics.org/
- Interaction in the Workplace: http://hrweb.berkeley.edu/guides/managing-hr/interaction/communication
- Individual Learning Plans: How-to Guide: "Promoting Quality Individualized Learning Plans: A How to Guide on the High School Years" http://www.ncwd-youth.info/ilp/how-to-guide

- ILP Fact Sheet: http://www.ncwd-youth.info/fact-sheet/individualized-learning-plan
- ILP Policy Brief: http://www.ncwd-youth.info/ilp/produce-college-and-career-ready-high-school-graduates
- ILP Resources Home Page: http://www.ncwd-youth.info/ilp
- Interview Skills Lesson Plans: http://www.amphi.com/media/1220281/interview%20skills%20lesson%20plan.doc
- Labor and Workforce Development: http://www.mass.gov/lwd/employment-services/preparing-for-your-job-search/
- Maine Community College System – Center for Career Development: http://www.ccd.me.edu/careerprep/CareerPrepCurriculum_LP-6.pdf
- Massachusetts Work-Based Learning: http://skillspages.com/masswbl
- North Dakota Association of Agriculture Educators: http://www.ndaae.org/attachments/File/Preparing_students_for_a_Job_Interview.pptx
- NY CTE Learning Standards—Career Development and Occupational Studies (CDOS) Resource Guide with Core Curriculum : http://www.p12.nysed.gov/cte/cdlearn/cdosresourceguide.html
- Occupational Outlook Handbook: http://www.bls.gov/ooh/
- Purdue OWL Job Search Resources (for writing resumes, applications, and letters): https://owl.english.purdue.edu/engagement/34/
- Soft Skills to Pay the Bills — Mastering Soft Skills for Workplace Success: http://www.dol.gov/odep/topics/youth/softskills/
- US Department of Labor: http://www.dol.gov/dol/audience/aud-unemployed.htm
- Workplace Communication: http://www.regionalskillstraining.com/sites/default/files/content/WC%20Book%201.pdf
- Your Plan For the Future: http://www.yourplanforthefuture.org

Strand 5: Management and Entrepreneurship Knowledge and Skills

5.A Starting a Business

5.A.01 Demonstrate an understanding of the practices required to start a business.

- 5.A.01.01 Define entrepreneurship and be able to recognize and describe the characteristics of an entrepreneur.
- 5.A.01.02 Compare and contrast types of business ownership (i.e., sole proprietorships, franchises, partnerships, corporations).
- 5.A.01.03 Identify and explain the purpose and contents of a business plan.
- 5.A.01.04 Demonstrate an understanding of the principles and concepts of a business's supply chain (i.e., suppliers, producers and consumers.

5. A Performance Examples:

- Develop a presentation pertaining to an entrepreneur and their business.
- Communicate with a business owner and discuss the pros and cons of starting and owning a business. Summarize the main points of the discussion.
- Choose a product or service and describe the process leading to distribution.
- Write a business plan for a business in your community.

5.B Managing a Business

5.B.01 Demonstrate an understanding of managing a business.

- 5.B.01.01 Formulate short- and long-term business goals.
- 5.B.01.02 Demonstrate effective verbal, written and visual communication skills.
- 5.B.01.03 Utilize a decision-making process to make effective business decisions.
- 5.B.01.04 Identify a business's chain of command and define its organizational structure.
- 5.B.01.05 Identify and apply effective customer service skills and practices.
- 5.B.01.06 Identify, interpret and develop written operating procedures and policies.
- 5.B.01.07 Track inventory, productivity and labor cost.
- 5.B.01.08 Demonstrate business meeting skills.
- 5.B.01.09 Identify professional organizations and explore their benefits.

5. B Performance Examples:

- Working as a team, role-play situations that an entrepreneur might face in dealing with customers or employees.
- Contact a relevant professional organization and request information about its benefits, membership requirements and costs.
- Plan and conduct a business meeting.
- Identify companies that are known for customer service and list the practices that help differentiate themselves from all others in their industry.

5.C Marketing a Business

5.C.01 Demonstrate an understanding of marketing and promoting a business.

- 5.C.01.01 Explain the role of business in the economy.
- 5.C.01.02 Describe the relationship between business and community.
- 5.C.01.03 Describe methods of market research and identifying target markets.

5.C.01.04 Describe and apply the concepts of a marketing mix (the 4Ps of marketing: product, price, place and promotion).
5.C.01.05 Compare and contrast the promotional tools and techniques used to sell products, services, images and ideas.
5.C.01.06 Describe the impact of supply and demand on a product or business.
5.C.01.07 Identify direct and indirect competition on a business.
5.C.01.08 Identify and use sales techniques to meet client needs and wants.
5.C.01.09 Discuss strategies to acquire and retain a customer base.

5. C Performance Examples:
- Research reliable sources to identify marketing and industry data related to a business.
- Conduct market research by developing a survey and presenting the results.
- Create a promotional campaign using a variety of media.
- Write a marketing plan for a product.

5.D Financial Concepts and Applications in Business

5.D.01 Demonstrate an understanding of financial concepts and applications.

5.D.01.01 Identify essential financial reports and understand their purpose (i.e., budget, balance sheet and income statement).
5.D.01.02 Describe payroll practices (i.e., deductions – federal, FICA and state taxes and insurances).
5.D.01.03 Identify the importance of maintaining accurate records.
5.D.01.04 Apply practices related to pricing, purchasing and billing.
5.D.01.05 Maintain and reconcile a checking account.
5.D.01.06 Identify the options for funding a business.

5. D Performance Examples:
- Given an employee time card and rate of pay, calculate gross pay, taxes, deductions and net pay.
- Develop a budget for a simulated business or project.
- Analyze and discuss financial documents from a company.
- Research various methods of funding a business.

5.E Legal/Ethical/Social Responsibilities

5.E.01 Demonstrate an understanding of legal, ethical and social responsibility for businesses.

5.E.01.01 Identify state and federal laws and regulations related to managing a business.
5.E.01.02 Describe and identify ethical business practices.
5.E.01.03 Demonstrate an understanding of business contracts.
5.E.01.04 Explain the role of diversity in the workplace.
5.E.01.05 Explain the role of labor organizations.
5.E.01.06 Identify practices that support clean energy technologies and encourage environmental sustainability.
5.E.01.07 Demonstrate an understanding of how technology advancements impact business practices.

5.E Performance Example:
- Read and interpret a contract.
- Complete an application for a license, permit or certificate.
- Research federal, state and local regulations and laws required for a business.
- Participate in and summarize a discussion with a member of a labor or civil rights organization.

Selected Websites

- CVTE Strand 1, 4, and 5 Resources: https://sites.google.com/a/mccanntech.org/cvte-strands-1-4-and-5-resources/
- Entrepreneur: http://www.entrepreneur.com
- Inc. Magazine: http://www.inc.com/
- Junior Achievement "Be Entrepreneurial Program": https://www.juniorachievement.org/web/ja-usa/home
- Kahn Academy Interviews with Entrepreneurs: https://www.khanacademy.org/economics-finance-domain/entrepreneurship2/interviews-entrepreneurs
- Kauffman Founders School: http://www.entrepreneurship.org/en/founders-school.aspx
- National Federation of Independent Business: www.nfib.com
- National Foundation for Teaching Entrepreneurship (NFTE): www.nfte.com
- SBA Loans: http://www.sba.gov
- SkillsUSA Professional Development Program Competency List: http://www.skillsusa.org/downloads/PDF/lessons/professional/PDPPreview.pdf
- Small Business Administration: www.sba.gov

Glossary

Term	**Definition**
Balance sheet	A statement of the assets, liabilities and capital of a business at a particular point in time.
Budget	An estimate of income and expenditure for a set period of time.
Business Ownership	Types of business ownership refer to the legal structure of an organization. Legal structures include: Sole Proprietorship, Partnerships, Corporations and Limited Liability Companies.
Business Plan	A written document that describes in detail your business goals and how you are going to achieve them from a marketing, operational and financial point of view.

Term	Definition
Chain of Command and Organizational Structure 	Refers to the management structure of an organization. It identifies lines of authority, lines of communication, and reporting relationships. Organizational structure determines how the roles, power and responsibilities are assigned and coordinated and how information flows between the different levels of management. (A visual representation of this structure is called an org chart).
FICA	Federal Insurance Contributions Act requires taxes deducted from pay for supporting Social Security.
Income Statement	A financial statement providing operating results for a specific time period showing a business's revenues, expenses and profit or loss.
Market Research	• Primary: Surveys, Focus Groups, Observation • Secondary: Websites, Internet
Marketing Mix	A set of controlled variables that formulate the strategic position of a product or service in the marketplace. These variables are known as the 4 P's of marketing and include product, place, price and promotion.
Methods to Track Inventory, Productivity and Labor Cost	Refers to the processes a business uses to account for: 1) the inflows and outflows of inventory and materials related to inventory; 2) the efficiency of operations and 3) the cost of labor including salary and benefits.
Promotional Tools and Techniques	The six elements of a promotional mix are: advertising, visual merchandising, public relations, publicity, personal selling and sales promotion.
Supply Chain	The supply chain, or channel of distribution, describes how the product is handled and/or distributed from suppliers with materials, to the manufacturer, wholesaler or retailer and finally to the consumer.
Target Market	Those who are most likely to buy your product or service.

Strand 6: Technology Literacy Knowledge and Skills

6.A Technology Literacy Knowledge and Skills (Grades 9 through 12)

6.A.01 Demonstrate proficiency in the use of computers and applications, as well as an understanding of the concepts underlying hardware, software, and connectivity.

- 6.A.01.01 Use online help and other support to learn about features of hardware and software, as well as to assess and resolve problems.
- 6.A.01.02 Install and uninstall software; compress and expand files (if the district allows it).
- 6.A.01.03 Explain effective backup and recovery strategies.
- 6.A.01.04 Apply advanced formatting and page layout features when appropriate (e.g., columns, templates, and styles) to improve the appearance of documents and materials.
- 6.A.01.05 Use editing features appropriately (e.g., track changes, insert comments).
- 6.A.01.06 Identify the use of word processing and desktop publishing skills in various careers.
- 6.A.01.07 Identify the use of database skills in various careers.
- 6.A.01.08 Define and use functions of a spreadsheet application (e.g., sort, filter, find).
- 6.A.01.09 Explain how various formatting options are used to convey information in charts or graphs.
- 6.A.01.10 Identify the use of spreadsheet skills in various careers.
- 6.A.01.11 Use search engines and online directories.
- 6.A.01.12 Explain the differences among various search engines and how they rank results.
- 6.A.01.13 Explain and demonstrate effective search strategies for locating and retrieving electronic information (e.g., using syntax and Boolean logic operators).
- 6.A.01.14 Describe good practices for password protection and authentication.

6.A.02 Demonstrate the responsible use of technology and an understanding of ethics and safety issues in using electronic media at home, in school, and in society.

- 6.A.02.01 Demonstrate compliance with the school's Acceptable Use Policy.
- 6.A.02.02 Explain issues related to the responsible use of technology (e.g., privacy, security).
- 6.A.02.03 Explain laws restricting the use of copyrighted materials.
- 6.A.02.04 Identify examples of plagiarism, and discuss the possible consequences of plagiarizing the work of others.

6.A.03 Design and implement a personal learning plan that includes the use of technology to support lifelong learning goals.

- 6.A.03.01 Evaluate the authenticity, accuracy, appropriateness, and bias of electronic resources, including Web sites.
- 6.A.03.02 Analyze the values and points of view that are presented in media messages.
- 6.A.03.03 Describe devices, applications, and operating system features that offer accessibility for people with disabilities.

6.A.03.04 Evaluate school and work environments in terms of ergonomic practices.

6.A.03.05 Describe and use safe and appropriate practices when participating in online communities (e.g., discussion groups, blogs, social networking sites).

6.A.03.06 Explain and use practices to protect one's personal safety online (e.g., not sharing personal information with strangers, being alert for online predators, reporting suspicious activities).

6.A.03.07 Explain ways individuals can protect their technology systems and information from unethical users.

6.A.04 Demonstrate the ability to use technology for research, critical thinking, problem solving, decision making, communication, collaboration, creativity, and innovation.

6.A.04.01 Devise and demonstrate strategies for efficiently collecting and organizing information from electronic sources.

6.A.04.02 Compare, evaluate, and select appropriate electronic resources to locate specific information.

6.A.04.03 Select the most appropriate search engines and directories for specific research tasks.

6.A.04.04 Use a variety of media to present information for specific purposes (e.g., reports, research papers, presentations, newsletters, Web sites, podcasts, blogs), citing sources.

6.A.04.05 Demonstrate how the use of various techniques and effects (e.g., editing, music, color, rhetorical devices) can be used to convey meaning in media.

6.A.04.06 Use online communication tools to collaborate with peers, community members, and field experts as appropriate (e.g., bulletin boards, discussion forums, listservs, Web conferencing).

6.A.04.07 Plan and implement a collaborative project with students in other classrooms and schools using telecommunications tools (e.g., e-mail, discussion forums, groupware, interactive Web sites, video conferencing).

Appendices

The framework teams created an "Appendix" listing potential industry recognized credentials attainable by secondary students; lists of professional, student, and relevant government organizations; and useful resources and websites. **** It is important to note that although most Framework Teams provided information for the "Appendix", not all teams did. <u>Therefore, sub-headings within the "Appendix" without information have been deleted</u>.***

Disclaimer: Reference in the Appendices Section to any specific commercial products, processes, or services, or the use of any trade, firm or corporation name is for the information and convenience of the public, and does not constitute endorsement or recommendation by the Massachusetts Department of Elementary and Secondary Education.

Embedded Academic Crosswalks

Embedded English Language Arts and Literacy

CVTE Learning Standard Number	Strand Coding Designation Grades ELAs Learning Standard Number	Text of English Language Arts Learning Standard
2.C.01.02	W.2	Writing—Text Types and Purposes
Performance Example: Open response/Quiz grade: Explain how process control data is used to monitor processes.		
2.C.01.04	SL.4, SL.5	Speaking and Listening-- Presentation of Knowledge and Ideas (findings), Speaking and Listening-- Presentation of Knowledge and Ideas (digital media)
Performance Example: PowerPoint presentation or project		
2.C.01.05	SL.5	Speaking and Listening-- Presentation of Knowledge and Ideas (digital media).
Performance Example: In a small group, create a video which demonstrates applying the concepts of total quality management appropriate to the field.		
2.C.01.06	SL.5	Speaking and Listening-- Presentation of Knowledge and Ideas (digital media).
Performance Example: Choose a product and develop a comprehensive development plan for it. Present it to class, using visual aids (PowerPoint presentation, posters, etc.)		
2.B.02.01	SL.1	Speaking and Listening—Comprehension and Collaboration
Performance Example: Class discussion		
2.B.02.02	W.7, SL.4	Writing—Research to Build and Present Knowledge, Speaking and Listening-- Presentation of Knowledge and Ideas (findings),
Performance Example: Research the history of pharmaceutical regulations and the FDA and share out findings.		
2.B.02.03	W.7, SL.4	Writing—Research to Build and Present Knowledge, Speaking and Listening-- Presentation of Knowledge and Ideas (findings),
Performance Example: Students will research the FDA and its specific roles. Students will then role play as the different parts (ex: CDER and CBER) demonstrating how the FDA functions.		
2.B.02.04	W.2, W.4	Writing—Text Types and Purposes, Writing—Production and Distribution of Writing
Performance Example: Write an essay, which explains the life cycle of medical products		
2.B.02.05	SL.4	Speaking and Listening-- Presentation of Knowledge and Ideas (findings)
Performance Example: Work with a partner and present cGMP and GLP regulations to each other. Compare and contrast with your partner and share results in class discussion.		
2.B.02.06	W.2	Writing—Text Types and Purposes
Performance Example: Write a five paragraph essay explaining the regulatory agencies at the local, state and federal levels.		
2.B.02.09	W.4, SL.5	Writing—Production and Distribution of Writing, Speaking and Listening-- Presentation of Knowledge and Ideas (digital media).

Performance Example: Via PowerPoint presentation, students demonstrate accuracy in reporting results in written technical reports and orally.		
2.E.02.03	W.2, W.4, SL.4	Writing—Text Types and Purposes, Writing—Production and Distribution of Writing, Speaking and Listening-- Presentation of Knowledge and Ideas (findings).
Performance Example: Short answer quiz; hands-on presentation of microscopes.		
2.E.02.09	W.2, W4	Writing—Text Types and Purposes, Writing—Production and Distribution of Writing
Performance Example: Open response writing assignment.		
2.F.08	W.7, SL4	Writing— Research to Build and Present Knowledge , Speaking and Listening-- Presentation of Knowledge and Ideas (findings),
Performance Example: Research use of cells in biotechnology and create a PowerPoint presentation to share with class.		

Embedded Mathematics

CVTE Learning Standard Number	Math Content Conceptual Category and Domain Code Learning Standard Number	Text of Mathematics Learning Standard
2.E.02.08	7.RP.3	7.RP.3 Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error
Performance Example: Count the number of tissue culture cells in the four large corner squares and the middle squares combined of a hemocytometer. Take the total number of cells counted in the 5 squares and multiply by 2 to determine the total number of cells per mm^3. Multiply by 10^3 to determine the cell count/ml. Example, count 100 cells in the 5 squares. 2 X 100 = 200 cells per mm^3 = 2 x 10^5 cells/ml. Remember to take into account any dilution performed prior to loading the hemocytometer.		
2.E.03.02	7.RP.3	7.RP.3 Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error
Performance Example: Determine the concentration of DNA using the following relationship: 1 OD 260 = 50 ug/ml double stranded DNA. Read the absorbance 280 nm to determine the amount of protein present in the sample. A ratio of OD 260/OD 280 of 1.8 to 2.0 indicates the preparation is pure. If the ratio is less than 1.8 the DNA is contaminated and may require further purification.		
2.E.03.08, 2.E.03.09	8.SP.3, 5.G.2, 6.NS.8, 7.RP.2.a	8.SP.3 Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height. 5.G.2 Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

		6.NS.8 Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate. 7.RP.2.a Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.
Performance Example: Set up a BSA standard curve and read at proper absorbance . Determine the linear relationship for y = mx + b (Excel). Use the equation to solve for the unknown sample. Make sure the unknown sample falls in the linear range of the standard curve. If not, correct for amount of sample assayed. Set up serial dilutions of horseradish peroxidase and assay for activity using a TMB substrate.		
2.E.04.02	4.MD.1	4.MD.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two column table. For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), .
Performance Example: Students will be able to understand the relationship between pore size and molecule size. Example, a bacteria will not pass through 0.2 micrometer filter. Mycoplasma can vary in size from 0.15 to 0.3 micrometers and could pass through a 0.2 micrometer filter, as will viruses.		
2.D.02.02	4.MD.1, 8.EE.4	4.MD.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two column table. For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ... 8.EE.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.
Performance Example: Dilute 1 M sodium chloride 1/1,000,000 and report as a 1/10^6 dilution and as a final concentration of 1.0 uM		
2.D.02.03	4.MD.1, 7.RP.3, 8.EE.4	4.MD.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two column table. For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3,

		36), ... 7.RP.3 Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error 8.EE.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.
Performance Example: Dilute 10 mg/ml BSA, using a 1/10 set of serial dilutions down to a final concentration of 0.0001 mg/ml. Report using scientific notation as 10^-4 mg/ml		
2.E.01.02	5.NBT.4	5.NBT.4 Use place value understanding to round decimals to any place.
Performance Example: Round weight measurement to significant digit. Example, 1.0039 grams = 1.00 g rounded to 100ths		
2.E.01.03	5.NBT.4	5.NBT.4 Use place value understanding to round decimals to any place.
Performance Example: Round volume measurement to significant digit. Example, 1.52 ml = 1.5 ml rounded to nearest 10th		
2.E.01.04	5.NBT.4, F-BF.5	5.NBT.4 Use place value understanding to round decimals to any place. F-BF.5 (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.
Performance Example: Round PH measurement to the nearest 10th. Students will show knowledge of PH scale versus concentration of hydrogen ions in a solution.		
2.E.01.05	5.NBT.4	5.NBT.4 Use place value understanding to round decimals to any place.
Performance Example: Measure temperature in Celsius plus or minus 1 degree		
2.E.01.06	5.NBT.4	5.NBT.4 Use place value understanding to round decimals to any place.
Performance Example: Measure absorbance to the 10th position		
2.F.02.02	F-BF.5 , F-IF.7.b	F-BF.5 (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents. F-IF.7.b Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
Performance Example: Inoculate 5.0 ml of a bacterial overnight culture into 500 ml of nutrient media. Incubate on a shaker at the appropriate temperature. Record absorbance at OD 600 at 30 minute intervals (include 0 minute time point). Graph the result. Identify lag, log, stationary and death phases. Determine cell doubling time using the graph.		
2.D.01.01	6.RP.3.c, 7.RP.3, F-LE.1.c, 4.MD.1	6.RP.3.c Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent.

		7.RP.3 Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error F-LE-1.c Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. 4.MD.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two column table. For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...
Performance Example: Determine the population doubling time of an animal cell in tissue culture.		
2.D.01.02	6.RP.3.c, 7.RP.3, 4.MD.1	6.RP.3.c Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent. 7.RP.3 Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error 4.MD.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two column table. For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...
Performance Example: Change a solution concentration reported as mass per volume to a percentage.		
2.D.01.03	8.EE.5, 8.SP.3, S-ID.7	8.EE.5 Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed. 8.SP.3 Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height. S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

		4.MD.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two column table. For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...
Performance Example: Perform a bacterial growth curve and report the equation for the linear relationship of log phase growth. Determine rate of change.		
2.D.01.04	4.MD.1	4.MD.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two column table. For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...
Performance Example: Express product concentration in ug/ul, mg/ml, kg/l and choose the appropriate units for your product.		
2.D.01.05	8.EE.4	8.EE.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.
Performance Example: Report seeding of animal cells and absolute numbers of cells at various times using scientific notation.		
2.D.01.06	4.MD.1	4.MD.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two column table. For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...
Performance Example: Perform a protein assay and report concentration using appropriate units.		
2.D.02.01	6.RP.3.c, 7.RP.3, 4.MD.1	6.RP.3.c Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent. 7.RP.3 Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error 4.MD.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger

		unit in terms of a smaller unit. Record measurement equivalents in a two column table. For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...
Performance Example: Prepare 100 ml of 0.5 M sodium chloride.		

Embedded Science and Technology/Engineering

Life Science (Biology)

CVTE Learning Standard Number	Subject Area, Topic Heading and Learning Standard Number	Text of Biology Learning Standard
2.A.03.01 2.B.03.04 2.E.01.01	SIS2: Conduct and Design Scientific Investigations	Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage. Follow safety guidelines.
Performance Example: Students will be able to follow lab safety guidelines and maintain safety in the laboratory area.		
2.E.03.09	1.3 The Chemistry of Life	Explain the role of enzymes as catalysts that lower the activation energy of biochemical reactions. Identify factors, such as pH and temperature, that have an effect on enzymes
Performance Example: Students will be able to determine the role of enzymes using pH and temperature as variables.		
2.E.02.08	2.8 Cell Biology	Compare and contrast a virus and a cell in terms of genetic material and reproduction
Performance Example: Students will be able to compare and contrast viruses and cells in relation to their use in Biotechnology.		
2.E.03.02	3.1 Genetics	Describe the basic structure (double helix, sugar/phosphate backbone, linked by complementary nucleotide pairs) of DNA, and describe its function in genetic inheritance.
Performance Example: Students will be able to determine the various components of DNA.		

Physical Science (Chemistry)

CVTE Learning Standard Number	Subject Area, Topic Heading and Learning Standard Number	Text of Chemistry Learning Standard
2.D.01.06 2.D.02.02	7.2 Solutions, Rates of Reaction and Equilibrium	Calculate concentration in terms of molarity. Use molarity to perform solution dilution and solution stoichiometry
Performance Example: Students will be able to perform calculations using solution concentration, molarity and molality.		
2.A.03.02	SIS2	Properly use instruments, equipment, and materials (e.g., scales,

2.B.03.04 2.E.01.01		probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage. Follow safety guidelines
Performance Example: Students will be able to follow lab safety guidelines and maintain safety in the laboratory area		

DESE Statewide Articulation Agreements

No Statewide Articulation Agreements at this time.

Industry Recognized Credentials (Licenses and Certifications/Specialty Programs)

OSHA 10hr www.osha10hourtraining.com
CPR AED certification www.redcross.org

Other

Reference Materials

- Daugherty, E. (2012). *Biotechnology – Science for the New Millennium*. St. Paul, MN: Paradigm Publishing, Inc.
- Daugherty, E. (2012). Biotechnology Lab Manual. St. Paul, MN: Paradigm Publishing , Inc.
- Theiman, W.J. and Palladino, M.A. (2012). Introduction to Biotechnology. San Francisco, CA. Pearson Benjamin Cummings.
- Seidman, L.A. and Moore, C.J. (2009). Basic Laboratory Methods for Biotechnology. San Francisco, CA. Pearson Benjamin Cummings.
- Brown, J. (2011). *Biotechnology: A Laboratory Skills Course.* Hercules, California. Bio-Rad Laboratories
- Seidman, L. (2008). *Basic Laboratory Calculations for Biotechnology.* San Francisco, CA. Pearson Benjamin Cummings.
- Wallman, S. (2010). *Introduction to Biomanufacturing.* Portsmouth, NH. Northeast Biomanufacturing Center & Collaborative NBC^2

Related National, Regional, and State Professional Organizations

- Biotechnology Industry Organization
- Northeast Regional Biomanufacturing Collaborative (NBC^2)
- MassBio - Massachusetts Biotechnology Council
- New England Biotech Association
- Massachusetts Biotechnology Education Foundation
- Bio-Link

Student Organizations

- Skills USA www.maskillsusa.org
- HOSA - Health Occupations Students of America

Selected Websites

- http://www.ncbi.nlm.nih.gov/sites/entrez
- http://www.freetrademagazines.com/?cid=1677&gclid=CNO4pZnduawCFUbf4AodUnTxoA
- www.bio.org
- http://www.biomanufacturing.org/
- http://www.massbio.org/
- www.newenglandbiotech.org/

- http://www.massbioed.org/
- http://www.bio-link.org/home/
- www.hosa.org
- www.web.expasy.org/translate/
- www.sigma-genosys.com/calc/DNACalc.asp
- www.neb.com