New Hampshire
Department of Education
Learn Everywhere Program Initial Application and Related Documentation

Sponsoring Organization Name	**The New Hampshire Academy of Science**
Purpose, mission statement, or both	The ***New Hampshire Academy of Science, Inc.*** (NHAS) has a mission to support the scientific research of New Hampshire high school and middle school students and to sponsor their attendance at the annual symposium of the largest scientific organization in the world, the American Association for the Advancement of Science (AAAS). The NHAS is a not-for-profit 501(c)(3) organization, Federal Tax ID #46-5758781 and an affiliated organization of the AAAS. Our Broader Mission is to: • further the work of scientists and future scientists in New Hampshire; • provide a forum for scientific discussion, interaction, and collaboration with the general public; • increase public understanding and appreciation of the importance and promise of science in human welfare and progress; • encourage authentic scientific research by having scientists mentor students in middle and high school.
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1. A description of demonstrated qualifications and a statement assuring that the instructor satisfies those qualifications:

New Hampshire Academy of Science (NHAS) requires all teaching personnel to have undergraduate degrees in science from accredited colleges or universities as well as a demonstrated background in scientific research.

All supervisors have advanced degrees in science as well as teaching experience. The Executive Director of the NHAS, Dr. Peter Faletra, serves as oversight director of all courses. Dr. Faletra was a NH certified teacher of middle school science and high school Biology for 10 years. He is an accomplished research scientist with numerous peer-reviewed publications.

The two other NHAS instructors are Dr. Kelly Salmon and Alyson Michael. Dr. Salmon is a senior scientist with a PhD in molecular biology. She has 3 years' experience administering our programs with middle school and high school students and has experience teaching ethics at the graduate school level. Alyson Michael has an MS in Chemistry from Dartmouth College. She has an undergraduate degree in biochemistry from Ohio Wesleyan University and has taught chemistry labs to undergraduates at Dartmouth College.

More information about our staff and their qualifications may be found here.

2. **A criminal history records check policy that includes a statement affirming that the sponsoring entity shall not allow instruction or student contact by a person who has been charged pending disposition for, or convicted of any violation or attempted violation of any of the offenses as outlined in RSA 189:13-a, V pursuant to a criminal history records check conducted by the department of safety as outlined in Saf-C 5703.06 through Saf-C 5703.11.**

NHAS Criminal History Records Check Policy.

In accordance with NH RSA189-13a, the NHAS requires all staff, substitutes, volunteers and contracted service providers to complete a criminal history records check through the NH Criminal Records Unit, with results received at the NHAS office, BEFORE they will be approved for hire and/or allowed in the lab or programs, whether in-person or virtually.

Instructional Programs

1. Identification of the education, program, or opportunity from Ed 306.27(t) for which students completing the learn everywhere program shall receive high school credit(s);

We are applying for the following 4 instructional courses for which one high school credit each will be given in recognition of student's achievement:

1) Biology Research (Life Science) 1 credit

2) Chemistry Research (Physical Science) 1 credit
3) Physics Research (Physical Science) 1 credit
4) AP Biology (Life Science) 2 credits

2. An outline of each program for which approval is sought, which includes goals, competencies, and a description of expected student outcomes;

Research in Biology, Chemistry, and Physics
Our research experiences in biology, chemistry, and physics all will share the following general outline and structure.

The **goals** of each NHAS research program include providing the following in accordance with Ed 306.45(e):

(1) Opportunities for student researchers to learn first-hand the impact, limitations, fundamental principles, and methods of scientific research;
(2) Opportunities for students to form their own hypotheses, design their own experiments, record their observations, analyze their data, and draw their own conclusions for their own scientific research project;
(3) Opportunities for students to gain an understanding of the attitudes, ethics, and problem-solving techniques needed for life in a complex technological society;
(4) Mentoring, fieldwork, and experimentation designed to enable students to:
    a. Gain experience with the methods of studying natural phenomena;
    b. Develop an understanding of the interrelationship and interdependence of living organisms and the role of a biological organism in the physical world;
    c. Advance scientific knowledge through engagement of the scientific method of investigation with an emphasis on the role of observation and experimentation;
    d. Gather scientific data through laboratory work, field work, and computational research;
    e. Present their data graphically and interpret graphically-presented data from the scientific literature;
    f. Use their experimental data to draw conclusions and make inferences;
    g. Develop scientific problem-solving skills that can be employed to solve problems in everyday situations;
    h. Communicate quantitative and qualitative data clearly and concisely through the written word, mathematical relationship, and oral presentations.
    i. Understand and apply the unifying concepts and principles within the natural sciences;
    j. Develop an awareness of the philosophical, ethical, legal, political, and economic impacts of science and technology;
    k. Appreciate that science is a human endeavor that builds upon the work of generations of scientists;

l. Become aware of the concerns around the current and future impacts of science and technology on society and the environment.

Authentic scientific research includes, but is not limited to:

- In-person and online lessons that provide the knowledge base and background concepts required for full engagement with authentic research experiences. See example listing of lessons here.
- Creation of a written research proposal that includes:
  - Background literature search
  - Hypothesis
  - Material
  - Methods
  - Research plan with timeline
- Completion of a research project that includes:
  - Training by the instructors in the experimental techniques needed to conduct the research
  - A research plan
  - Adjustments to the research plan based on preliminary findings
  - Collection of quantitative and qualitative data
  - Statistical analysis of the gathered data, when appropriate
  - Drawing of conclusions based on gathered data
- Writing and revising a summary paper, which shall include:
  - Abstract
  - Introduction
  - Materials
  - Methods
  - Results
  - Discussion
  - Conclusion
  - Bibliography
- Presentation of research to the scientific community, which shall include at least one of the following:
  - Preparation of a scientific conference style poster for presentation to experts in the field, NHAS mentors, and student-peers
  - Oral presentation of results/conclusions to experts in the field, NHAS mentors and student-peers
  - Compilation of a summary video describing the investigation and major results/conclusions
- After completing a revision process, the research may be:
  - Submitted for peer-review by NHAS mentors

- Published in the proceedings of the AAAS meeting or an appropriate peer-reviewed academic journal

The **shared competencies** of the research programs in biology, chemistry, and physics include, but are not limited to:

(1) Proficiencies in experimental design including:
   a. Positive and negative controls
   b. Experimental planning

(2) Proficiencies in experimental data analysis employing:
   a. Spreadsheets for data compilation and analysis
   b. Presenting data in multiple graphical and tabular formats

(2) Proficiencies in technical writing including:
   a. Development of an experimental proposal
   b. Compilation of a summary paper outlining the key findings of the long-term investigation

(3) Proficiencies in scientific presentation demonstrated by completion of one of the following:
   a. Preparation of a professional scientific poster for presentation at a scientific conference
   b. Verbal presentation of the findings of the investigation
   c. Compilation of a video describing the investigation and its key findings

The **shared outcomes** of the research programs in biology, chemistry, and physics include, but are not limited to:

- Submission of research proposal that includes, but is not limited to:
  - Background of research to be conducted
  - Hypothesis to be investigated
  - Proposed methods to be used
  - List of required materials and instrumentation
  - Research plan with timeline for the long-term multi-experiment investigation
- Maintenance of a detailed laboratory notebook that will contain:
  - Records of observations, data collection, and results of experiments/investigations
  - Summary records of weekly correspondence or meetings between student and respective instructor
  - Records of experimental data
- Submission of a summary paper after several rounds of edits made by the student and instructor. It will, in form and substance, resemble an article

from a peer reviewed scientific journal through the inclusion of the following sections:

- Abstract
- Introduction
- Materials
- Methods
- Results
- Discussion
- Conclusion
- Bibliography

- Communication of the results of the long-term research investigation via one, or more, of the following:
  - Preparation of a professional scientific conference style poster for presentation to experts in the field, NHAS mentors, and student-peers
  - Oral presentation of results/conclusions to experts in the field, NHAS mentors and student-peers
  - Compilation of a summary video describing the investigation and major results/conclusions
  - Submission for peer-review by NHAS mentors, if appropriate
  - Publication in the proceedings of the AAAS or an appropriate academic journal, if accepted.
- A total of at least 140 hours is expected to be required for completion any of the three research courses.
  - A minimum of 20 hours of preparation for experimentation is expected to be done outside of the scheduled time in the lab.
  - The research project is expected to be complex enough to require at least 75 hours of experimentation.
  - It is expected that students will participate in at least 15 hours of team meetings and supplemental lectures.
  - It is anticipated that at least 30 hours will be spent by the student in the preparation of the summary paper and presentation(s).
- In some cases, the research may lead to:
  - Abstract publication
  - Presentation to regional and or national science communities
  - Full paper publication as a pre-print or peer-reviewed paper in appropriate journals
  - Attendance as a NH student delegate to the American Association for the Advancement of Science annual meeting
  - Induction into the American Junior Academy of Science

Goals, competencies, and outcomes specific to each field of research offered are listed below.

1) Biology Research (Life Science)

- The specific **goals** of the **Biology Research course** will include, but are not limited to:
    - Empowering students to comfortably work in a biological research laboratory environment
    - Introducing of students to the variety of careers available in biological research
    - Developing students' skills in biology-specific laboratory techniques
- The **competencies** specific to the **Biology Research course** will include, but are not limited to:
    - Proper application of all safety procedures of a BSL-1 laboratory including the safe use of all instruments that will be used in the students' investigations
    - Ethics training, guided by the National Institutes of Health standards, to enable the ethical design and execution of a scientific investigation
        - With special emphasis on the ethics of model organism use
    - Proficiency in basic instruments including:
        - Scales and balances
        - Pipettes of a variety of sizes
            - Both manual and semi-automated
        - Scientific glassware for:
            - Volume measurements
            - Compound preparation and dispensation
            - Chemical and specimen storage
        - Microscopes appropriate for the investigation, which may include:
            - Stereo zoom microscopes
            - Compound microscopes
            - Fluorescent microscopes
        - Autoclave for sterilization
        - Clean/sterile hood for sterile sample preparation
    - An understanding of differences in precision, accuracy, and resolution in measurements
    - Proficiency in aseptic techniques, depending on area of investigation
    - The ability to design and apply single- and double-blind experiments when appropriate
    - Statistical analysis of large populations of data, when appropriate, including:
        - Discernment of significant differences in data sets via parametric or non-parametric analyses about a mean
            - The most common techniques used are anticipated to be the Student's t-test and ANOVA.

- The **outcomes** specific to the **Biology Research course** will include, but are not limited to:
    - Proficiency in biology specific laboratory techniques
    - An understanding of the ethical requirements of biological research
    - The ability to use statistical methods to analyze large datasets

2) Chemistry Research (Physical Science)

- The specific **goals** of the **Chemistry Research** course will include, but are not limited to:
    - Empowering students to work in a chemical research laboratory environment
    - Introducing students to the variety of careers available in chemical research related fields
    - Developing student's skills in chemistry-specific laboratory techniques
- The specific **competencies** of the **Chemistry Research** course will include, but are not limited to:
    - An understanding and appreciation of the chemical and physical hazards presented in a laboratory environment and the measures needed to mitigate those hazards including:
        - Proper use of personal protective equipment
        - Proper use of a chemical fume hood
        - Use of the Global Harmonized System for labeling hazardous materials
        - Ability to read and understand materials and safety data sheets
        - Proper storage and disposal procedures for hazardous materials
    - Ethics training, guided by the standards of the National Institutes of Health, to enable ethical design and execution of a long-term scientific investigation
        - With emphasis on ethical recording and presentation of data
    - Proficiency in basic scientific instruments including:
        - Analytical balances
        - Micropipettes
        - Volumetric pipettes
        - Transfer pipettes
        - Choosing appropriate laboratory glassware for each experiment
            - With emphasis on green chemistry techniques
    - Proficiency in the use and maintenance advanced scientific instruments appropriate to the investigation which may include:
        - Scanning ultra violet/visible spectrophotometer
        - High performance liquid chromatograph
    - Ability to make a standard curve and use the calculated curve to find the concentration of an unknown

    - Understanding of significant digits and the difference between random and systematic error including the propagation of error throughout an experiment
- The specific **outcomes** of the **Chemistry Research** course will include, but are not limited to:
    - Proficiency in chemistry-specific laboratory techniques
    - An understanding of chemical laboratory safety
    - Proficiency in reporting data with appropriate statements of error

3) Physics Research (Physical Science)

- The specific **goals** of the **Physics Research** course will include, but are not limited to:
    - Empowering students to feel comfortable working in a physics/engineering laboratory environment
    - Introducing students to the variety of physics/engineering research related careers available
    - Developing students' skills in physics/engineering-related laboratory techniques
- The specific **competencies** of the **Physics Research** course will include, but are not limited to:
    - Proper assessment and mitigation of research related physical hazards
        - Proper use of personal protective equipment
        - Rigorous safety instruction on the use of low-powered lasers
    - Ethics training, guided by the standards of the National Institutes of Health, to enable ethical design and execution of a long-term scientific investigation
        - With emphasis on the ethical repercussions of eventual research application
    - Proficiency in basic scientific equipment including:
        - Scales and balances
        - Digital Vernier calipers
        - 3D printers
        - CAD software
    - Basic computer coding
    - Understanding of the iterative process of design
    - When applicable, the proper use of error propagation and statistical analysis
- The specific **outcomes** of the **Physics Research** course will include, but are not limited to:
    - Proficiency in physics-specific laboratory techniques
    - An understanding of the safety procedures needed in a physics laboratory
    - An understanding of the design process from model to prototype to final product

AP Biology

- The **goals** of the **AP Biology** course will include:
    - A level of mastery of the topics of advanced biology sufficient to earn a minimum of a "2" according to the AP Bio Rubric (see attached AP Bio Rubric and Lab Rubric) in the evaluatory metrics of short papers, section tests, research paper, lab reports, and poster.
- The **competencies** of the **AP Biology** course, which coincide with our submitted syllabus and rubrics, will include:
    - Safe laboratory procedures including the proper and safe use of standard laboratory equipment and instruments and BSL-1 laboratory issues
    - Proper use of personal protective equipment
    - Ethics training according to NIH standards
    - An understanding of introductory molecular and cell biology
    - A working knowledge of genetics, both molecular and hereditary
    - Understanding of population biology
    - Comprehension of the systematics of nature and classification systems
    - Proficient understanding of evolution including:
        - The history of the development of the evolutionary principle
        - The mechanisms of evolution
            - Genetic change
            - Natural selection
            - Genetic drift
        - Adaptation, fitness, and specialization
        - Convergent vs. parallel evolution
        - Speciation
    - Introductory ecology including:
        - Ecosystem structure
        - Energy flow through an ecosystem
        - Four major kinds of ecosystems
        - Effect of environmental factors on all living systems
    - Thermodynamics of biological systems including maintenance of dynamic equilibrium
- The **outcomes** of the **AP Biology** course will include:
    - Short papers or poster on readings
    - Section tests composed of:
        - Short answer questions
        - Essay questions requiring drawings, tables and graphs to convey command of the subject matter
    - Laboratory reports and observational evaluation of laboratory techniques
    - Major Research Paper
    - Poster

- AP Biology Exam (optional)

Please see our AP Biology Syllabus in the Appendix section and the related Rubrics

3. Plan for recording student progress in meeting expected student outcomes:

Research in Biology, Chemistry, and Physics
All students will be assigned a mentor scientist who works alongside them, tracks progress, and provides feedback and advice on a weekly basis. The recording/tracking of students' progress will be based on:

- The student exhibiting expertise in their experimental methods as viewed by the instructor
- Entrance and exit evaluations, prepared by an outside expert STEM educational evaluator.
- Weekly review of observations and recorded data
- Monthly review of students' assigned readings or online instructional lessons, found here, to ensure an understanding of concepts that underpin research
- Students' effective use of graphical/visual representation of data and proper application of statistical analysis
- Meeting of timeline for preparation of research paper, poster, and presentation

AP Biology
Over the course of one academic year, students will meet online every week for at least 1.75 hours with the instructor to review assigned lessons, readings, essays, lab experiments/papers. That will require at least 140 hours of work, not including time in the lab conducting experiments. These laboratory experiments will have at least 56 hours of in-the-lab experimental time over the academic year. Section tests will be given over the span of the course. Laboratory experiments will be conducted at our STEM Lab in Lyme NH and be evaluated based on direct instructor observation of safe and proper instrument use as well as written lab experimental papers that adhere to standard format of: Introduction, Methods, Results, and Discussion/Conclusions. During weekly meetings, students' participation in discussions will be evaluated both on demonstration of understanding and effective communication. A final research paper that is a report of at least 8 hours of lab experimentation investigating a specific hypothesis will be submitted and evaluated at the end of the course. This research paper will be evaluated based on the students' proper execution of background literature research, execution of design, safe/ethical bench research, and submission of paper with standard sections of Introduction, Methods, Results and Discussion/Conclusions. Students may take the AP Biology Exam, if desired.

4. A description of assessments of student learning outcomes, including, but not limited to:

- **Instructor observation of problem-based learning, including off-site learning projects;**

- **Competency-based or performance-based assessments;**
- **Instructor observations of student performance;**
- **Evaluation rubrics used to evaluate program proficiencies where a minimum average of a score of "2" is required for credit as shown in the attached rubric; and**
- **Other assessment approaches as determined by the learn everywhere program;**

Research in Biology, Chemistry, and Physics

All students are assessed on a weekly basis, with feedback given in real time verbally at each work session. Students take an entrance evaluation and exit evaluation that was prepared by an outside expert STEM educational evaluator.

Since this course is a problem-based investigation over 140 hours of learning, the timeline of when particular assessments occur will depend, to some extent, on any one student's individual projects and abilities. In the first third of the course, all students will be assessed, at the appropriate time, through direct observation by their respective instructor(s) as to their progress towards the applicable competencies outlined above.

In the latter two thirds of the course, instructors provide more intense feedback, not only on basic subject material but also as to progress towards the final outcomes of the course including the summary paper and chosen presentation.

Since our problem-based course is centered on the overarching objective that each student will have an authentic experience of the scientific process, the rubric for evaluation is directly based on tracking the students' progress through this process so that each student will be:

1. Able to use the appropriate published scientific information to come up with their own research idea;
2. Knowledgeable of the background concepts underpinning their field of research;
3. Responsible for the creation of a research proposal that includes the request for materials and instruments that match their research protocol's/method's needs;
4. Able to safely and logically execute experiments
5. Capable of recording data and presenting it in a graphic or tabular formats that include statistical analyses
6. Able to effectively communicate their findings in formats and venues typical of scientists such as abstracts, full manuscripts, verbal presentations and posters.

AP Biology

Section tests, similar in style and content to the AP exam but covering only the most recent course material, will be administered throughout the course. Laboratory experiments will be evaluated both by instructor observation and written laboratory reports that follow the standard format of that most commonly seen in research manuscripts. Class involvement in weekly online meetings will be evaluated on comprehension of course material and efficacy of communication. The class will culminate in the execution of an original research experiment

and submission of a respective research paper. We will provide practice and the opportunity to take the AP Biology Exam, when desired.

Admissions

1. A description of methods for admission which shall not be designed, intended, or used to discriminate or violate individual civil rights in any manner prohibited by law;

NHAS Course Admissions Policy

Admission is non-competitive and students of all backgrounds are selected. The Summer Program for research in life and physical sciences welcomes a diverse cross-section of learners including racial and ethnic minorities, and people from all socioeconomic backgrounds. All students are required to attend the entire program including training in safety and ethics. Students with minor date conflicts are encouraged to apply despite the minor conflicts; our staff will assist participants to facilitate dealing with minor schedule conflicts to ensure they get the most from the program. Students with significant date conflicts, such as missing key days (first two days of safety and experimental planning), are encouraged to delay their application for another year. Please check with our staff to find if your conflicts are only minor.

Eligibility and Selection for the NHAS Programs giving credit for research in Biology, Chemistry of Physics:

By the fall (start) of any academic year the student must be in grades 8-12. Preference will be given to applicants who:

- show sound academic achievement with no minimum grade achievement
- exhibit personal and academic responsibility
- exhibit curiosity of the natural world
- work well either as an individual or in a team

Non-Discrimination Statement

NHAS is open to all students, on a space-available basis, and shall not discriminate on the basis of race, color, national origin, creed, sex, gender identity, ethnicity, sexual orientation, mental or physical disability, age, ancestry, athletic performance, special need, proficiency in the English language or a foreign language, or academic achievement. NHAS adheres to all applicable provisions of federal and state law relating to students with disabilities including, but not limited to, the Individuals with Disabilities Education Act, section 504 of the Rehabilitation Act of 1974, and Title II of the Americans with Disabilities Act of 1990 and New Hampshire state laws.

Our admission policy is guided by our purpose, which is to provide an outstanding STEM educational program.

Any rising or current 8th to twelfth grader can apply for admission to NHAS Learn Everywhere program. We seek a diverse student population with students who bring a range of interests, backgrounds, and strengths to our program. We hope to enroll students who have the desire to participate fully in our program.

Admissions decisions are not based on rigid lines of academic performance but on a thoughtful reflection of our available human resources, our ability to provide high quality learning opportunities for all of our students, and the students' and the respective families' support of our program's vision, policies, and standards.

Admission is on a rolling and first-come-first-served basis. Decisions are made without regard to ability to pay. Our policy is to not turn students away for their inability to pay, offering financial aid on a sliding scale.

We actively target rural students from economically depressed regions who have little access to stimulating science research opportunities. One of our missions is to attract and retain students who would otherwise have limited access to the world of inspiring scientific experiences.

Our admissions policy takes in to account:
1) Age appropriateness - These Learn Everywhere courses are intended for high-school-aged students with exceptions for advanced 8th graders.
2) Grade level/course pre-requisites - These courses require that students have completed some basic science courses or can show evidence of some command of the basic science background to be able to succeed in the curriculum. Admission is not dependent on grades received in any course.

2. A description of how the program will liaison with the local education agency (LEA) for students with an education plan pursuant to section 504 of the Rehabilitation Act;

When a parent chooses to enroll a student at NHAS, the school district of residency remains responsible for provision of necessary related services to all children with disabilities residing within the district, required under the Individuals with Disabilities Education Act (IDEA), the Americans With Disabilities Act, and New Hampshire Law.

We are committed to ensuring that our programs, services, and activities are accessible to staff, members of the school community, students, and family members. As such, NHAS welcomes collaboration with the student's sending district in the development and implementation of an appropriate 504 plan or any accommodations needed to allow students of all abilities to participate fully in our programs.

3. A description of how the program will liaison with the LEA for a student with disabilities, consistent with the student's IEP to include, but not be limited to coordinating:

- Required special education programs
- Support services

- Least restrictive environment
- A statement that the program understands that it has certain responsibilities, pursuant to Section 504 of the Rehabilitation Act, if it receives Federal funds, or the Americans with Disabilities Act, as amended, to provide students with disabilities with equal access and equal opportunities to participate in the Learn Everywhere program, including by providing the student with reasonable accommodations

We recognize that students have unique and distinctive learning styles. We are committed to working with parents, students and school personnel to develop a curricular program to meet the instructional needs of students with different talents, interests, and development.

The nature of our program allows us to personalize the education of each student. Our one-on-one mentorship model is especially effective at personalizing both teaching and assessment of students. The flexibility of our format allows us to provide students with all reasonable accommodations.

Consistent with *child find* and parent consent obligations, the NHAS will contact the student's school district of residency when a specific learning disability is suspected, and when appropriate, file a special education referral.

Minimum Standards

1. A description of how the program meets the minimum standards for graduation credit for the program as referenced in Ed 306.31 through Ed 306.48;

As an advanced STEM program, all classes taught at NHAS exceed the relevant portions of Ed 306.45(e)(4)f "General or advanced science which shall include subject matter appropriate to the disciplines listed in e. above", and the entirety of Ed 306.45(e)(5).

2. Number of credits the program will fulfill;

Each of the Research courses that we offer will grant a single high school credit either in life science or physical science. For the AP Biology we will grant 2 life science credits.

We are applying for 4 instructional programs for which one credit each is sought including the match to Ed 306.27(t)

1) Biology Research (Life Science) 1 credit
2) Chemistry Research (Physical Science) 1 credit
3) Physics Research (Physical Science) 1 credit
4) AP Biology (Life Science) 2 credits

3. A competency-based grading description;

All completed courses are assigned a final credit that is generated from both academic performance and laboratory work. As indicated in the Research-Based courses and the credit granting Rubric, the credit to be given is based on achieving a minimum standard in a number of goals and competencies that lead to measurable tangible outcomes. An example outcome is a research paper that is based on a long-term set of experiments that in turn answer an overarching hypothesis tested by modern science empirical standards. These courses are all guided by safe and proper laboratory procedures and the ethical standard set out by the US National Institute of Health

Academic Credit: Each course at NHAS has competencies. All competencies are listed in the respective sections above. NHAS offers both formative and summative assessments throughout each course that are linked to specific course competencies. Students must earn a passing grade in each competency in order to receive credit for a course. (See appendix with rubric for research courses and separate rubrics related to AP Biology)

Facilities

1. A description of facilities to be used for educational instruction and a description of how the facilities will meet the priorities of the program;

The New Hampshire Academy of Science (NHAS) operates its own STEM Lab. The NHAS Stem Lab is housed in a leased Building at 95 Dartmouth College Highway in Lyme NH. The building has a handicap accessible bathroom and eating area. The STEM Lab has all of the required safety equipment including an eye wash station, acid cabinet, flammable cabinet, biological safety cabinets, and fume hood. The NHAS has a non-terminating lease with the Crossroads Academy. The NHAS has a very positive and close relationship with Crossroad Academy (CA). Having successfully raised over $1,800,000 in donations from regional STEM companies, the NHAS is partnering with CA to add a ~2500 square ft. “Michael Fanger STEM Center” laboratory by 2021.

The current NHAS 1,200 square foot lab is a Biosafety Level 1 laboratory (BSL-1) outfitted to perform sterile plant and animal tissue culture and bacteriology, and especially to fully take advantage of standard biological model systems without the use of biologically hazardous organism and infectious agents. We also have a 1400 ft^2 storage space.

We have an extensive array of equipment including but not limited to:

- Microscopic and digital imaging
- Fluorescent compound and fluorescent stereo-microscopes
- Stereo zoom microscopes
- Advanced digital imaging
- 2 biosafety cabinet clean benches for sterile work
- Various advanced spectrophotometric instruments
- HPLC

- Advanced optical engineering pneumatic table
- Advanced 3D printers
- An extensive array of molecular biology instrumentation including, 12 thermocyclers, 12 gel electrophoresis units, an RT-PCR machine, and a Nanodrop machine.
- > 45 micropipettes
- Over 2,000 pieces of specialized scientific glassware
- Autoclave
- 6 incubators
- 3 standard freezers and 1 ultra-cold freezer.

We have a regional community of biotech, industrial, and academic professionals that provide extensive support such as Dr. Erik Griffin at Dartmouth College and Dr. Chery Whipple from Colby Sawyer College for *C. elegans*; Dr. Zi Chen, Ann Lavanway, and Dr. Markus Testorf at Dartmouth for microscopy and imaging support; Dr. Zheng Duan and Ms. Lin Chu from Hypertherm Inc. for engineering and computational guidance. The regional Veterans Administration Hospital has donated extensive amounts of instruments in excess of $100,000.

2. A statement affirming that the facilities shall comply with all applicable federal and state health and safety laws, rules, and regulations, including, but not limited to the following:

The NHAS facilities comply with all state and local fire safety; Barrier-free access under Abfd 300, code for barrier-free design, and the Americans with Disabilities Act of 1990(ADA), as amended by the ADA Amendments Act of 2008; and Participation in the Learn Everywhere program shall not require facility requirements not otherwise required by state or federal law.

Insurance

1. Proof of insurance for protection of children in care and in amounts as recommended by the program's insurance provider, which provider shall be licensed to do business in the state of New Hampshire and which the department shall be an additional named insured so as to receive notice of policy changes or cancellations;

Please see attached Proof of Insurance in submittal package:

2. A policy for signature of parents or legal guardians of students, or emancipated minors, referred by an LEA to an approved Learn Everywhere program.

The following is a policy that parents or legal guardians of students, or emancipated minors must sign prior to participating in the Learn Everywhere courses we administer.

"I (the parent/legal guardian of, or the emancipated student, _____/_____) covenant and agree at all times to indemnify and hold harmless the (school district), their school boards,

officers, directors, agents, employees, all funding districts and sources, and their successors and assigns, (the “indemnified parties”) from any and all claims, demands, actions and causes of action, whether in law or in equity, and all damages, costs, losses, and expenses, including but not limited to reasonable attorneys’ fees and legal costs, for any action or inaction of the state approved Learn Everywhere program, its board, officers, employees, agents, representatives, contractors, guests and invitees, or pupils.”

Appendix

AP Biology Syllabus
&
Relevant Rubrics

THE NEW HAMPSHIRE ACADEMY OF SCIENCE
www.NHAcadSci.org

NHAS AP BIOLOGY SYLLABUS

Duration: At least 140 hours of study and experimental work during an academic year

Students are expected to participate in weekly ~ 2-hour meetings, usually held virtually.

Some short experiments will be conducted remotely.

An all-day of laboratory experiments held at our lab will be scheduled about once every month.

Study Materials: Although most standard biology texts will work well, as most of our learning is not text-based, we recommend the following:

Hard copy text: *Campbell Biology* (the most recent edition is the 10th edition with an ISBN-13: 978-0321775658). The used edition costs about $30.00.

On-line free text: https://openstax.org/details/books/biology-2e

In addition to the content of whatever text you use to cover the following subjects, we include links to enrich the subject matter and place the information in a broader context than the text or online venue you are using provides. Many of the links are found at our NHAS website instructional lessons.

Pacing and Evaluation: This course content is detailed in the AP Syllabus (see appendix). The syllabus content sequence will take at least 140 hours to cover. During the first week of class, students should set up a pace chart, which is especially important for those wishing to take the AP exam. There are suggested due dates for some readings.

Students will be evaluated in the following ways:

1. Essays and poster on readings 20%
2. Section-tests composed of short answer and long answers requiring drawings, tables and graphs to convey command of the subject matter 20%
3. Labs and lab reports (all labs are to be followed by a lab report due within 7 days after lab). Labs will include observational evaluation of technique by instructor 40%
4. Research paper on problem-based experiment that entails at least 8 hours of experimentation/observation/data gathering 20%

Enrichment Readings:

Lucretius, *De Rerum Natura*, books 1, 2, and 3. (two page summary due October 30th)

Aldous Huxley; *Brave New World.* (two-page summary due November 30th)

Your choice of any biography of Madam Curie (a short video you create as a summary of her life; due January 30th)

I. Introduction

A. Characteristics of Living Things (like energy, life is difficult to define)

B. Science Compared to Non-Science (Karl Popper) https://fs.blog/2016/01/karl-popper-on-science-pseudoscience/

C. Scientific Method (if there is "one") https://www.youtube.com/watch?v=EYPapE-3FRw

D. Homework exercise:

Experiments define modern science (the empirical world) Lab: Consider an investigation on a psychotropic drug that is being tested to treat depression. The drug will be evaluated in its effectiveness through a personal evaluation by a physician. To avoid bias you need to design an experiment that would avoid both physician and patient biases. In your design be clear about all the names of the groups of patients you will use and any other groups or variables you should consider. **Oral presentation required**

II. Chemistry

A. Atomic Structure: Subatomic Particles, Electron Shells
B. Chemical Bonding: Covalent, Ionic, Hydrogen Bonds
C. Biologically Important Compounds and Molecules

Lab on Milk chemistry

1. Properties of Water

https://static1.squarespace.com/static/580d5051cd0f68322963dc55/t/5ec56a60be4c4531fd48ffa1/1589996130821/Milk+Experiment+Background+and+Procedure.pdf

This home lab activity will require you to record your results by video and explain why the motions of the fluids behave as they do.

2. Acids, Bases, Buffers
3. Macromolecules: Carbohydrates, Lipids, Proteins & Nucleic Acids (lab, analyzing the nutritional content of one week of your diet)

Lab on measurements

This lab will introduce you to the safe and appropriate use of a variety of liquid and solid measurement instruments in our lab. These include

- Serological pipets
- Micropipettes
- TD and TC glassware
- Digital and non-digital scales
- Calipers
- Digital and non-digital thermometers

You will use a wide variety of the above instruments to make a variety of liquid and solid measurements.

At the end of this lab you should be able to:

- Know what instruments to use when and how to safely measure a variety of substances in different states of matter.

- Understand accuracy, precision, and resolution
- Where these instruments are located in our lab for future use.

III. Cell Biology

A. Comparison of Prokaryotic and Eukaryotic Cell Structures
B. Eukaryotic Cell Structure

1. Functions of Organelles (you will use the histology website http://histologyguide.org/EM-atlas/01-introduction.html)

https://blogs.scientificamerican.com/lab-rat/bacteria-with-bodies-multicellular-prokaryotes/

Nucleus
Ribosome
Endoplasmic Reticulum (ER), RER, SER
Mitochondrion
Chloroplast
Lysosome
Golgi Complex
Peroxisome (Microbody)
Centriole
Cilium/Flagellum
Cytoskeleton (Homework/lab on recognizing ultrastructure with TEM and SEM and drawing a plant and animal cell)

Lab on Histology of Plant and animal cells
At the end of this lab you will be:

- Able to safely and correctly use both a compound and stereo zoom microscope
- Be able to recognize basic animal tissues including
    1. Connective
    2. Epithelial
    3. Muscle
    4. Nervous
- Be able to recognize plant tissues. Plants tissues are sometimes categorized as:

    1. dermal
    2. ground
    3. vascular

- They are also sometimes categorized as:

    1. Meristematic (undifferentiated)
    2. Parenchyma (differentiated)
    3. Collenchyma (differentiated)
    4. Sclerenchyma (differentiated)

2. Membrane Structure and Function
https://www.youtube.com/watch?v=y31DlJ6uGgE

Scientific drawing of an animal and plant cell and flow chart of intracellular mechanism of protein production and exocytosis

3. Movement Across Membranes and activation of receptors

Diffusion/Osmosis (Lab on osmosis)

Your lab on osmosis is to first review your information regarding osmosis. Before you begin designing, be sure to have a thorough understanding of the following Terms:

- Osmosis
- Plasma membrane
- Semipermeable
- Tonicity
- Hypotonic
- Isotonic
- Hypertonic
- Equilibrium
- Diffusion
- Dialysis tubing
- Starch
- Glucose
- Starch indicator

Using this information, design and perform an experiment on osmosis using potato cores immersed in various solutions. Make sure to have a means to determine what concentration of solutions would be considered isotonic.

Watch this video only AFTER the lab has been performed and you have written your experimental report including its discussion section.
https://www.youtube.com/watch?v=LeS2-6zHn6M

Facilitated Diffusion
Active Transport
Endocytosis and Exocytosis
Insulin receptor binding

TEST on previous all previous Sections to this point

C. Energy Conversion in Eukaryotic Cells

1. Laws of Thermodynamics
https://static1.squarespace.com/static/580d5051cd0f68322963dc55/t/5cf0848f10e8be000127770f/1559266451505/Overview-of-Energy-and-Thermodynamics.pdf

2. Energy Flow: Photosynthesis, Cell Respiration
http://www.bozemanscience.com/013-photosynthesis-and-respiration

http://www.bozemanscience.com/photosynthesis

2a. Photosynthesis- Overall Equation of photosynthesis

1. Structure of the Chloroplast
2. Light Reaction of Photosynthesis
    - Location
    - Photosystems and Their Pigments
    - The Role of H2O
    - The Role of NADP
    - The Role of Electron Transport
    - Chemiosmotic Phosphorylation
3. Light Independent Reaction - Calvin Cycle
    - The Role of RuBP
    - The Role of CO_2
    - The Role of NADPH2
    - The Role of Rubisco Enzyme
    - The Role of ATP
4. How light and dark reactions work together
5. C3 and C4 Photosynthesis CAM plants

2b. Cellular Oxidation of Glucose

1. Mitochondrion Structure
2. Glycolysis
    - Where is ATP Required (why?)
    - Where is ATP Produced (how?)
    - Why is there a split in the pathway and how does nature deal with the uneven split in the 6-carbon structure?
    - What is Net Gain in ATP and how is this determined?
    - Compare Aerobic and Anaerobic Glycolysis
    - What is the Role of NAD and how do NAD+ and NADH act in REDOX reactions?
    - What are the roles of Anaerobic Glycolysis in various life forms and cells?

3. Conversion of Pyruvate to AcCoA and why is this a central way point in metabolism?

4. Krebs Cycle and the Role of AcCoA
    - Role of NAD
    - Role of FAD

- Net Gain of ATP
- Where is CO_2 released and how does the human body deal with this?

5. Electron Transport System
    - What are the roles of FADH2 and NADH
    - What is the Role of diatomic oxygen
    - How Much ATP is Produced per NADH, FADH2 and why is there a difference
    - Do plants utilize this system as well as animals?
    -

Test on all sections since the last test Section III parts 1 and 2

IV. Genetics: Molecular

- Chromosome Structure and Replication of DNA https://learngendev.azurewebsites.net/content/basics/readchromosomes/
- DNA as the genetic material
- https://www.youtube.com/watch?v=vQOdDGM5vSg

  https://www.youtube.com/watch?v=OcPKbdiuUi0

- Mitosis and cell division https://static1.squarespace.com/static/580d5051cd0f68322963dc55/t/5e29d9967dcf0907bd998a71/1579800986824/Mitosis+and+cell+division.pdf

  https://www.youtube.com/watch?v=C6hn3sA0ip0

- Meiosis https://www.youtube.com/watch?v=16enC385R0w

Lab on Mitosis

(lab on make a karyotype https://learngendev.azurewebsites.net/content/basics/karyotype/

- Structure of RNA
- Transcription and Translation
- Control of Expression
- Techniques of Molecular Genetics
- PCR
- Genetic Engineering

Lab on PCR (see instructional lessons on NHAS website)

V. Genetics: Heredity

A. Mendel's Laws and Modern Genetic Terminology (Homework give a short essay on the life of Mendel and what impact his work had on Darwin.)

B. Monohybrid Crosses and Dihybrid Crosses

Home work: explain Mendel's laws of inheritance. In what phase of meiosis would independent assortment occur? What impact does this have on genetic diversity? What might cause an "exception" to this "second law"?

https://en.wikipedia.org/wiki/Mendelian_inheritance#Mendel's_laws

C. Patterns of Inheritance

1. Dominant/Recessive
2. Sex-linked
3. Incomplete Dominance
4. Co-dominance
5. Polygenic Inheritance
6. Multiple Alleles.

Lab on dominant vs recessive traits and how difficult it is for a population to eliminate a recessive lethal gene from its gene pool.

D. The Genetics of ABO and Rh Blood Groups

Test on Section IV. And V: Genetics: Molecular and Genetics: Heredity

VI. Origin of Life

- Spontaneous Generation and early investigators: Reti, Spallanzani, Pasteur

VII. Evolution (Origin of Species)

A. History of Development of Evolutionary Principle

- Lamarck
- Malthus
- Darwin

B. Mechanisms of Evolution

- Genetic change (mutations, Genetic Load
- Natural selection

- Genetic drift

C. Other Evolutionary Topics
- Adaptation
- Fitness
- Co-evolution/Co-adaptation
- Convergent vs. Parallel Evolution

D. Speciation (what is a species and how do new species arise?)

F. Human Evolution

Lab on local endangered species (*Cypripedium reginae*)
(see instructional lesson on Axenic seed culture on NHAS website)

VIII. Systematics of Nature, Classification Systems

A. Kingdom Survey of Monera, Protista, Fungi, Plantae

https://www.youtube.com/watch?v=0UEpq1W9C_E

B. Kingdom Survey Animalia

IX. Population Dynamics

A. General Population Characteristics

- Linear Growth and Exponential Growth (lag, log, stationary, decline phases of bacterial growth in. attest tube with limited food) https://www.thoughtco.com/bacterial-growth-curve-phases-4172692
- Populations from cells to planets: Erythropoiesis as a starting example
- Carrying Capacity and Limiting Factors

B. Population Dynamics of humans
- Birth Rate, Death Rate, & Annual Percentage Growth Rate
- Ethics of Human Population Control

Ethics Lab guest speaker on NIH ethics guidelines

X. Ecology

Reading due April 15thth Silent Spring by Rachael Carson with Poster Presentation

A. Ecosystem Structure

1. Abiotic (non-living) Factors
2. Biotic (living) Factors

B. The Flow of Energy in Ecosystems

1. Food Chains
2. Food Webs
3. Energy Pyramids
4. Symbiotic Relationships
    - Communalism
    - Mutualism
    - Parasitism

C. Major Ecosystems

1. Marine
2. Aquatic
3. Estuarine
4. Terrestrial

D. Biogeochemical Cycles

1. Nitrogen
2. Phosphorus
3. Carbon/Oxygen
4. Soil
5. Water

E. Succession

1. Primary
2. Secondary

F. Others Topic in Ecology

The tragedy of the Commons with **Short essay paper due April 30th**

G. Current issues Ecology (are humans destined to repeat the Tragedy of the Commons?)

- Global Climate Change **Short Essay Paper**

Water Quality Lab

Final Exam and optional AP biology Standardized Test

RUBRICS

FOR AP BIOLOGY

Name: _____
Title of Lab or Project: _____

Lab Report Rubric

	Excellent (4 pts)	Good (3 pts)	Adequate (2 pts)	Needs Work (1 pt)	Not attempted (0)
Introduction	1. Includes the question to be answered by the lab 2. states hypothesis that is based on research and/or sound reasoning 3. title is relevant.	One of the "excellent" conditions is not met, two conditions met	Two of the "excellent" conditions is not met , one is met	Introduction present, no exemplary conditions met	
Methods	Description or step-by-step process is included, could be repeated by another scientist	Description included, some steps are vague or unclear	The description gives generalities, enough for reader to understand how the experiment was conducted	Would be difficult to repeat, reader must guess at how the data was gathered or experiment conducted	
Data and Analysis	Results and data are clearly recorded, organized so it is easy for the reader to see trends. All appropriate labels are included	Results are clear and labeled, trends are not obvious or there are minor errors in organization	Results are unclear, missing labels, trends are not obvious, disorganized, there is enough data to show the experiment was conducted	Results are disorganized or poorly recorded, do not make sense ; not enough data was taken to justify results	
Conclusions	1. Summarizes data used to draw conclusions 2. Conclusions follow data (not wild guesses or leaps of logic), 3. Discusses applications or real world connections 4. Hypothesis is rejected or accepted based on the data.	3 of 4 of the "excellent" Text Text conditions is met	2 of the 4 excellent conditions met	1 of the 4 excellent conditions met	
Format and Lab Protocols	Lab report submitted as directed, and on time. Directions were followed, stations were cleaned. All safety protocols followed.	Most of the excellent conditions were met; possible minor errors in format or procedures	Some of the excellent conditions met, directions were not explicitly followed, lab stations may have been left unclean or group not practicing good safety (such as not wearing goggles)	Student did not follow directions, practiced unsafe procedures, goofed around in the lab, left a mess or equipment lost	
	Total (out of 20)				

AP Biology Rubrics for Short papers, Section Tests, Final Research Paper, and Poster

	3	2	1	Student Score
Short papers	Paper is well written with a clear story line connecting past research to the student's arguments/perspectives. Includes appropriate analysis of subject matter, social, and ethical implications when applicable. :	The proposal contains a thorough analysis but misinterprets or misses some of the key points or not fully explained. Does not fully address or execute an appropriate analysis of subject matter, social, and ethical implications when applicable. .	The story line is unclear and major implications in the analysis are missing or incorrect. Minimally addresses or executes an appropriate analysis of subject matter, social, and ethical implications when applicable.	
Section Tests	Correctly answering over 90% of the test material that illustrates a thorough understanding of the subject matter.	Correctly answering at least 80% of the test material that illustrates a thorough understanding of subject matter.	Correctly answering at least 70% of the test material that illustrates a thorough understanding of the subject matter.	
Final Research Paper	Paper is well written with a command of the supporting science concepts. Paper includes the following sections: • Abstract • Introduction • Materials • Methods • Results • Discussion • Conclusion • Bibliography	There are some spelling and grammar errors, but they do not hinder communication. The paper contains all of the required sections, but some information may be missing or miscategorized. The data is presented in figures and tables,	Spelling and grammar errors make the paper difficult to understand. Sections are missing from the paper. The data is not reported graphically, or not reported at all. There are no legends or captions.	

	The data is organized well into figures and tables with legends and captions. Appropriate statistical analysis has been conducted and is correctly displayed. The paper effectively communicates the research conducted and demonstrates an understanding of the project and how it fits into the body of scientific knowledge.	but some legends or captions are missing. There are some errors in the statistical analysis or it is incorrectly displayed. The paper adequately communicates the research conducted. There are some gaps in the understanding of the project and how it fits into the body of scientific knowledge.	No attempt at statistical analysis has been made. The paper does not communicate the research conducted. The experimenter clearly did not understand the project. There is no context given for how the project fits into the body of scientific knowledge.	
Poster Presentation	All information was conveyed clearly and logically. There were no factual errors in the presentation. The research was presented within a narrative that had a clear beginning, middle, and end. The key findings from were communicated, and the general structure of standard format was followed The student showed a comfort with and confidence in the scientific concepts of research presented.	There were some deficiencies in the clear and logical organization of the presentation. The presentation included a few factual errors. The narrative of the research was at times difficult to follow. Some key findings from the summary paper were omitted. The presentation did not consistently follow the standard format. Some discomfort was evident in lack of confidence in the scientific concepts of research.	The information presented did not at all follow a clear or logical path. The presentation included many factual errors. There was minimal clear narrative to the research presented. The presentation did not follow the standard format. Many key findings were not presented. The student demonstrated modest understanding of or comfort with the scientific concepts in the research.	

RUBRIC FOR RESEARCH COURSES

Assessment	3	2	1	Student Score
Experimental Proposal	Proposal is well written with proper spelling and grammar. Proposal contains the following sections: • Rationale • Hypothesis/Engineering Objective • Materials and Methods • Risks and Safety • Data Analysis Plan • Research Plan and Timeline • Bibliography It is clear that extensive background research has been done and expert level familiarity has been gained with existing scientific knowledge and the concepts underlying the investigation.	There are some grammatical and spelling errors. The proposal contains all sections required for a 3, but some information is missing, miscategorized, or not fully explained. Some background research has been done, but is not at the expert level demonstrated by a 3.	There are spelling and grammatical errors throughout the proposal to the extent that the readability of the proposal is impacted. One or more of the required sections are missing. It is clear that minimal to no background research has been done, and there is only limited understanding of the scientific concepts underlying the investigation	
Experimental Technique	A mastery of the experimental techniques required for the research investigation is shown when conducting work in the lab. The instructor can be confident that research is being done accurately and safely without constant correction.	An adequate proficiency in the experimental techniques required for the research investigation is exhibited in the laboratory. There are occasional lapses in accuracy or	Poor laboratory technique is demonstrated. Regularly violates lab safety procedures. Technique is so poor that experimental results cannot be trusted.	

		correct risk mitigation.		
Summary Paper	Paper is well written with correct spelling and grammar. Paper includes the following sections: • Abstract • Introduction • Materials • Methods • Results • Discussion • Conclusion • Bibliography The data is organized well into figures and tables with legends and captions. Appropriate statistical analysis has been conducted and is correctly displayed. The paper effectively communicates the research conducted and demonstrates an understanding of the project and how it fits into the body of scientific knowledge.	There are some spelling and grammatical errors, but they do not hinder communication. The paper contains all of the required sections, but some information may be missing or miscategorized. The data is presented in figures and tables, but some legends or captions are missing. There are some errors in the statistical analysis or it is incorrectly displayed. The paper adequately communicates the research conducted. There are some gaps in the understanding of the project and how it fits into the body of scientific knowledge.	Spelling and grammatical errors make the paper difficult to understand. Sections are missing from the paper. The data is not reported graphically, or not reported at all. There are no legends or captions. No attempt at statistical analysis has been made. The paper does not communicate the research conducted. The experimenter clearly did not understand the project. There is no context given for how the project fits into the body of scientific knowledge.	
Final Research Presentation	The student chose among the following options for final research presentation: • Professional conference style poster • Oral presentation to expert audience	The student chose from among the options given for a final research presentation. There were some deficiencies in the	An appropriate medium for the presentation was not chosen. The information presented did not	

	• Summary video All information was conveyed clearly and logically. There were no factual errors in the presentation. The research was presented within a narrative that had a clear beginning, middle, and end. The key findings from the summary paper were communicated, and the general structure of the summary paper was followed. The student showed a comfort with and confidence in the research presented.	clear and logical organization of the presentation. The presentation included a few factual errors. The narrative of the research was, at times, difficult to follow. Some key findings from the summary paper were omitted. The presentation did not always follow the general structure of the summary paper. Some discomfort with or lack of confidence in the research was evident.	at all follow a clear or logical path. The presentation included many factual errors. There was no narrative to the research presented. The presentation did not follow the general format of the summary paper. Many key findings were not presented. The student demonstrated no clear understanding of or comfort with the research.	