Affordable Materials Grants, Round 19:

Transformation Grants

(Spring 2021-Spring 2022)

# Applicant and Team Information

| Requested information | Answer |
| --- | --- |
| Institution(s) | Georgia Gwinnett College |
| Applicant name | Gillian E. A. Rudd |
| Applicant email  | grudd@ggc.edu |
| Applicant position/title | Professor Chemistry |
| Submitter name  | Cathy Hakes |
| Submitter email  | chakes@ggc.edu |
| Submitter position/title | ORSP Executive Director |

Please provide the first/last names and email addresses of all team members within the proposed project. Include the applicant (Project Lead) in this list. Do not include prefixes or suffixes such as Ms., Dr., Ph.D., etc.

| Team member | Name | Email address |
| --- | --- | --- |
| Team member 1 | Gillian E. A. Rudd | grudd@ggc.edu |
| Team member 2 | Charmita Burch | cburch@ggc.edu |
| Team member 3 | Julia E. Paredes | jbarker@ggc.edu |
| Team member 4 | Richard Pennington | rpenning@ggc.edu |
| Team member 5 | Candace Timpte | ctimpte@ggc.edu |

# Project Title

**Low-cost Transformation of ALL Sections of Survey of Chemistry II Labs ALG grant**

# Project Information

| Requested information | Answer |
| --- | --- |
| Priority Category / Categories*Projects in these categories will receive three extra points in the final score for fitting a priority of these particular rounds of Transformation Grants. The type of funding for the project is determined by the funding categories criteria above. As of Round 18, projects can be a part of more than one category. Note that the below categories only indicate priority, not which applications qualify for a grant. Select all that apply.* | *Priority categories:* * *Collaborative Projects with Professional Support*
* *Student Participation in Materials Evaluation and/or Development*
* *Departmental Scaling Projects*
 |
| Requested Total Amount of Funding*$30,000 maximum total award per grant* | *$30,000* |
| Final Semester of Project | *Spring 2022* |
| Using OpenStax Textbook?*This is to indicate to OpenStax that they can provide additional support and resources to your team during the adoption process.* | *No*  |

# Impact Data

## Course 1

| Row # | Requested information | Answer |
| --- | --- | --- |
| N/A | Course title and number | CHEM1152K Survey of Chemistry II with Lab  |
| N/A | Course instructor | Gillian E. A. Rudd |
| 1 | Average number of students enrolled per section | 28  |
| 2 | Average number of affected course sections scheduled in summer 2021 semester | 0 |
| 3 | Average number of affected course sections scheduled in fall 2021 semester | 2 |
| 4 | Average number of affected course sections scheduled in spring 2022 semester | 2 |
| 5 | Total number of course sections scheduled in an academic year *Add up rows 2-4.* | 4 |
| 6 | Total number of student section enrollments per academic year*Multiply row 1 and row 5.* | 112 |
| 7 | Original required commercial materials*Include each title, author, price for a new copy purchased from either your campus bookstore, the publisher, or Amazon, and a URL to the book showing the price.* | Title: Survey of Chem II lab manual CustomISBN: 978132391190Retail Price: $45.35Publisher: PearsonAuthor: TimberlakeThis text was last used in Summer of 2020 as a Pearson custom item and is not available on Amazon, or on the GGC bookstore site. A screenshot of the GGC bookstore is available upon request.<https://ggc.bncollege.com/shop/ggc/page/find-textbooks>If take the price of the unabridged lab manual, retail would be $77.32, with an etext of $49.99<https://www.amazon.com/Laboratory-General-Organic-Biological-Chemistry/dp/0321811852>  |
| 8 | Original cost per student section enrollment*Add up the cost of all materials in row 7.* | $45.35 |
| 9 | Average post-project cost per student section enrollment | $0.00 |
| 10 | Average post-project savings per student section enrollment*Subtract row 9 from row 8.* | $45.35 |
| 11 | Projected total annual student savings per academic year*Multiply row 10 and row 6.* | $5,079.20 |

## Course 1

|  |  |  |
| --- | --- | --- |
| Row # | Requested information | Answer |
| N/A | Course title and number | CHEM1152K Survey of Chemistry II with Lab  |
| N/A | Course instructor | Charmita Burch |
| 1 | Average number of students enrolled per section | 28  |
| 2 | Average number of affected course sections scheduled in summer 2021 semester | 0 |
| 3 | Average number of affected course sections scheduled in fall 2021 semester | 3 |
| 4 | Average number of affected course sections scheduled in spring 2022 semester | 2 |
| 5 | Total number of course sections scheduled in an academic year *Add up rows 2-4.* | 5 |
| 6 | Total number of student section enrollments per academic year*Multiply row 1 and row 5.* | 140 |
| 7 | Original required commercial materials*Include each title, author, price for a new copy purchased from either your campus bookstore, the publisher, or Amazon, and a URL to the book showing the price.* | Title: Survey of Chem II lab manual CustomISBN: 978132391190Retail Price: $45.35Publisher: PearsonAuthor: TimberlakeThis text was last used in Summer of 2020 as a Pearson custom item and is not available on Amazon, or on the GGC bookstore site. A screenshot of the GGC bookstore is available upon request.<https://ggc.bncollege.com/shop/ggc/page/find-textbooks>If take the price of the unabridged lab manual, retail would be $77.32, with an etext of $49.99<https://www.amazon.com/Laboratory-General-Organic-Biological-Chemistry/dp/0321811852> |
| 8 | Original cost per student section enrollment*Add up the cost of all materials in row 7.* | $45.35 |
| 9 | Average post-project cost per student section enrollment | $0.00 |
| 10 | Average post-project savings per student section enrollment*Subtract row 9 from row 8.* | $45.35 |
| 11 | Projected total annual student savings per academic year*Multiply row 10 and row 6.* | $6,349.00 |

## Course 1

|  |  |  |
| --- | --- | --- |
| Row # | Requested information | Answer |
| N/A | Course title and number | CHEM1152K Survey of Chemistry II with Lab  |
| N/A | Course instructor | Julia E. Paredes |
| 1 | Average number of students enrolled per section | 28  |
| 2 | Average number of affected course sections scheduled in summer 2021 semester | 0 |
| 3 | Average number of affected course sections scheduled in fall 2021 semester | 3 |
| 4 | Average number of affected course sections scheduled in spring 2022 semester | 2 |
| 5 | Total number of course sections scheduled in an academic year *Add up rows 2-4.* | 5 |
| 6 | Total number of student section enrollments per academic year*Multiply row 1 and row 5.* | 140 |
| 7 | Original required commercial materials*Include each title, author, price for a new copy purchased from either your campus bookstore, the publisher, or Amazon, and a URL to the book showing the price.* | Title: Survey of Chem II lab manual CustomISBN: 978132391190Retail Price: $45.35Publisher: PearsonAuthor: TimberlakeThis text was last used in Summer of 2020 as a Pearson custom item and is not available on Amazon, or on the GGC bookstore site. A screenshot of the GGC bookstore is available upon request.<https://ggc.bncollege.com/shop/ggc/page/find-textbooks>If take the price of the unabridged lab manual, retail would be $77.32, with an etext of $49.99<https://www.amazon.com/Laboratory-General-Organic-Biological-Chemistry/dp/0321811852> |
| 8 | Original cost per student section enrollment*Add up the cost of all materials in row 7.* | $45.35 |
| 9 | Average post-project cost per student section enrollment | $0.00 |
| 10 | Average post-project savings per student section enrollment*Subtract row 9 from row 8.* | $45.35 |
| 11 | Projected total annual student savings per academic year*Multiply row 10 and row 6.* | $6,349.00 |

## Course 1

|  |  |  |
| --- | --- | --- |
| Row # | Requested information | Answer |
| N/A | Course title and number | CHEM1152K Survey of Chemistry II with Lab  |
| N/A | Course instructor | Richard Pennington |
| 1 | Average number of students enrolled per section | 28  |
| 2 | Average number of affected course sections scheduled in summer 2021 semester | 0 |
| 3 | Average number of affected course sections scheduled in fall 2021 semester | 2 |
| 4 | Average number of affected course sections scheduled in spring 2022 semester | 2 |
| 5 | Total number of course sections scheduled in an academic year *Add up rows 2-4.* | 4 |
| 6 | Total number of student section enrollments per academic year*Multiply row 1 and row 5.* | 112 |
| 7 | Original required commercial materials*Include each title, author, price for a new copy purchased from either your campus bookstore, the publisher, or Amazon, and a URL to the book showing the price.* | Title: Survey of Chem II lab manual CustomISBN: 978132391190Retail Price: $45.35Publisher: PearsonAuthor: TimberlakeThis text was last used in Summer of 2020 as a Pearson custom item and is not available on Amazon, or on the GGC bookstore site. A screenshot of the GGC bookstore is available upon request.<https://ggc.bncollege.com/shop/ggc/page/find-textbooks>If take the price of the unabridged lab manual, retail would be $77.32, with an etext of $49.99<https://www.amazon.com/Laboratory-General-Organic-Biological-Chemistry/dp/0321811852> |
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| 9 | Average post-project cost per student section enrollment | $0.00 |
| 10 | Average post-project savings per student section enrollment*Subtract row 9 from row 8.* | $45.35 |
| 11 | Projected total annual student savings per academic year*Multiply row 10 and row 6.* | $5,079.20 |

## Course 1

|  |  |  |
| --- | --- | --- |
| Row # | Requested information | Answer |
| N/A | Course title and number | CHEM1152K Survey of Chemistry II with Lab  |
| N/A | Course instructor | Candace Timpte |
| 1 | Average number of students enrolled per section | 28  |
| 2 | Average number of affected course sections scheduled in summer 2021 semester | 0 |
| 3 | Average number of affected course sections scheduled in fall 2021 semester | 2 |
| 4 | Average number of affected course sections scheduled in spring 2022 semester | 2 |
| 5 | Total number of course sections scheduled in an academic year *Add up rows 2-4.* | 4 |
| 6 | Total number of student section enrollments per academic year*Multiply row 1 and row 5.* | 112 |
| 7 | Original required commercial materials*Include each title, author, price for a new copy purchased from either your campus bookstore, the publisher, or Amazon, and a URL to the book showing the price.* | Title: Survey of Chem II lab manual CustomISBN: 978132391190Retail Price: $45.35Publisher: PearsonAuthor: TimberlakeThis text was last used in Summer of 2020 as a Pearson custom item and is not available on Amazon, or on the GGC bookstore site. A screenshot of the GGC bookstore is available upon request. <https://ggc.bncollege.com/shop/ggc/page/find-textbooks>If take the price of the unabridged lab manual, retail would be $77.32, with an etext of $49.99<https://www.amazon.com/Laboratory-General-Organic-Biological-Chemistry/dp/0321811852> |
| 8 | Original cost per student section enrollment*Add up the cost of all materials in row 7.* | $45.35 |
| 9 | Average post-project cost per student section enrollment | $0.00 |
| 10 | Average post-project savings per student section enrollment*Subtract row 9 from row 8.* | $45.35 |
| 11 | Projected total annual student savings per academic year*Multiply row 10 and row 6.* | $5,079.20 |

## **Narrative Section**

## **1. Project Goals**

1. **Develop new laboratory supplementary materials in line with course goals, including more biochemistry content in CHEM1152K for both in-person and online laboratory sections.**
2. **Deploy final products across all sections in fall 2021 and revise as needed per student comments. This will effectively reduce cost for GGC students. Final products will also be published to open educational resource sites, including ALG and the GALILEO Open Learning Materials repository**
3. **Increase student performance on a concept inventory (Brown) relevant to GOB course topics that indicate readiness for Allied Health professional school.**

Brown, C., Hyslop, R. and Barbera, J., 2014. Development and analysis of an instrument to assess student understanding of GOB chemistry knowledge relevant to clinical nursing practice. *Biochemistry and Molecular Biology Education*, 43(1), pp.13-19.

***In Support of Goal 1:* Develop new laboratory supplementary materials in line with course goals, including more biochemistry content in CHEM1152K for both in-person and online laboratory sections.**

This proposal supports the development of low-cost, in-house laboratory exercises and supplemental materials for CHEM1152K, Survey of Chemistry II with Lab, to replace the current CHEM1152K Pearson custom laboratory manual. These new labs and supplementary material will include aspects of organic and biochemistry concepts. At Georgia Gwinnett College (GGC), CHEM1152K is the second course in the general, organic and biochemistry (GOB) sequence with corresponding lab. This chemistry course is typically undertaken by allied health and pre-nursing students.

The lecture portion of this course is being reconfigured to better meet the needs of our students as communicated by GGC’s Nursing Program Director, Dr. Sharon Grason. Therefore, the laboratory experiments need to change to parallel the changes in the course. Specifically, the lecture structure of the course will shift to decrease the organic chemistry as an introduction and include a more intensive exploration of biochemical processes, including metabolism. Currently, most faculty instructors focus around 2/3 of the semester teaching organic chemistry concepts and spend only 1/3 of the semester skimming biochemistry content. The proportion of time spent in each of these content categories will be flipped. However, that will not be easily achieved! Organic chemistry concepts are the cornerstone of understanding biochemistry. Labs at the beginning of the semester will focus on organic structures, function, and naming conventions to emphasize these concepts. New biochemically related labs will then be developed to parallel the lecture content of the course for the remainder of the semester. To further inspire students, we will introduce labs related to medicine and health, providing current, real-world examples, and so improve their student satisfaction with the material, and their overall learning and retention. Some of the labs are planned to be inquiry based, to inspire the students, and encourage them to explore how different molecules react and identify unknown molecules through critical analysis of data.

As we prepare for the future, which may include online courses due to the COVID pandemic, we are acutely aware of the need to develop laboratory procedures for both an in-person setting as well as an online setting. Prior to the COVID pandemic, GGC only offered face-to-face laboratory experiences. Starting fall 2021, GGC may offer 1-2 sections as online courses, and the other sections will have traditional face-to-face labs.

The in-house lab manuals, containing our laboratory exercises, will be accompanied with lab-specific introduction, lab content, and presentations containing lab content. Supplementary problems and solutions will be developed for students to apply their knowledge. Lab videos will be created to support the fully online labs.

***In Support of Goal 2:* Deploy final products across all sections in fall 2021 and revise as needed per student comments. This will effectively reduce cost for GGC students. Final products will also be published to open educational resource sites, including ALG and the GALILEO Open Learning Materials repository**

This project represents a full change of ALL labs, both in person and online, for fall of 2021 and onward. To this effect TWO laboratory manuals will be made available, one for in-person labs, and the other for online laboratory sections. ALL student sections in the CHEM1152K course will be impacted. Therefore, use of the laboratory documents exclusively in this course will save students money while increasing their working knowledge of biochemical processes and better prepare them for admission and success in allied health professional schools.

CHEM1152K students will answer our qualitative evaluation questions posed at the end of each lab in fall 2021. In addition, an SST research student (STEC4500) will perform data analysis for lab exercise effectiveness and student satisfaction. Feedback from this analysis will be used to improve the in-house labs and supplemental materials.

Previously, this course employed an unabridged lab manual derived from a Pearson Laboratory Manual that retails at $114.00. The custom laboratory text costs students $45.35 through the GGC bookstore and has been required for both online and in-person courses. The custom lab manual reduced the costs by providing only the laboratory exercises the students engaged in during the course. Other laboratory manuals are similarly inclusive, including a host of experiments for instructors to choose from while boosting the retail price. Since the focus of the lab is to shift toward more biochemical investigation, the Pearson manual will no longer cover the needed content. An in-house lab manual will take advantage of the laboratory resources and equipment already available in GGC’s labs and build on the expertise of GGC faculty. Adopting yet another pre-published lab manual would require purchase of different equipment and reagents.

Spring 2021, due to COVID, we implemented an online lab program obtained through a third party, at a cost of $65.00 per student both online and in person, which was paid by GGC SST. So far, the experience has been quite disappointing for students and instructors alike. Students had internet connection issues and the style of submission for questions has led to a plethora of student problems. The software configuration complicated assessments and grading. Faculty who are currently teaching the course realize that we must have new labs for fall 2021, or else we will need to resort to the expensive ($45.35) printed Pearson Custom laboratory manual available through our bookstore which does not offer sufficient biochemistry content. Transformation of all sections (excluding summer 2021, as the product will not be fully ready by the beginning of May 2021) is a projected total annual student savings per academic year of $27,935.60. If we include summer 2022, then this amount would go up to over $31,745, depending on the number of summer sections offered.

Materials for our open-source laboratory text, in both its in-person and online format, will be 508 compliant and available for other institutions who wish to reference our experiments. Chris Robinson, our support staff, will assist in this process. Notably, our Organic Chemistry I and II laboratory text has already undergone a similar transformation. Two of those listed on this grant were part of this transformation (Richard Pennington and Julia E. Paredes), and we have posted the labs on Research Gate, a site often used by other science professors. This text is frequently downloaded from the site, gaining 18,588 reads in 8 years. This use certainly demonstrates the need to have course-ready labs available through open-source materials. Though many individual GOB II experiments may be available in the literature, they are not specifically connected to, or formatted for our CHEM1152K course with our students. Furthermore, GOB II materials that are currently available in the literature are not connected for both an online setting and in-person setting for an entire course. The time and effort required to link together work proposed in this grant is certainly substantial. Each of us are ready to pursue these efforts, to help our students succeed in learning the material, which best prepares them for future healthcare courses. We hope that these efforts will contribute to increase GGC students’ laboratory skills and eventually increase admission rates to nursing and allied health programs.

***In Support of Goal 3:* Increase student performance on a concept inventory (Brown) relevant to GOB course topics that indicate readiness for Allied Health professional school.**

We will build laboratory skills that will support biology and allied health courses where students typically enroll after completing this course. As a result, labs focusing on biochemical concepts will incorporate equipment and procedures more often seen in a biochemistry lab, which currently are not explored in CHEM1152K at GGC. For example, students will develop a protein standard curve and explore enzyme kinetics. To address these labs and the requirements for biochemistry, students also need to acquire certain laboratory skills. These include working with micropipettes, using microcentrifuges and spectrophotometers. The purchase of essential microcentrifuges has been included in this grant. **Micropipettes and spectrophotometers will be funded through GGC School of Science & Technology to a total cost of $24,373 as a purchase to support this laboratory enhancement.** A concept inventory will be used to assess student learning throughout this course.

**2. Statement of transformation**

## **Current state of the course**

The labs in CHEM1152K have undergone a couple of transformations since the course was first offered in 2010. The first labs were adapted from current organic chemistry labs. The first revision implemented a custom General, Organic, and Biochemistry lab manual purchased from Pearson at a considerable cost to students, $45.35 each. Due to this cost, some students failed to purchase the custom Pearson labs until later in class or never at all, which affected their overall class performance.

When face-to-face labs were discontinued in March 2020, students were provided data that was needed to complete these labs. As a result of the COVID- 19 pandemic, the institution began offering CHEM1152K in different modalities including face-to-face, hybrid, and online. CHEM1152K continued to use the Pearson labs with limited success. To provide all students enrolled in the course with a more enriching lab experience, online labs were purchased from on online vendor for spring 2021 and implemented for all enrolled students independent of modality. Moving forward, these labs are cost prohibitive and do not include enough of the biochemistry content necessary for students planning to apply for admission to nursing schools.

## **Overall description of this project**

Prior to this ALG grant application, the Director of the GGC’s newly accredited B.S. Nursing program met with faculty to identify the concepts in the CHEM1152K curriculum that would best prepare GGC students for admission into the nursing program. As a result, the course will be transformed to include more biochemistry, specifically metabolism, while excluding some of the organic chemistry topics. As faculty adapt to teaching more metabolism in the course, labs must be developed to support these topics. In addition to developing labs to support the added content knowledge, the labs will be targeted to increase student understanding of concepts and their relationship to healthcare. Thinking critically and making connections are critical skills for allied health students to develop in lab.

All the labs developed for CHEM1152K under the ALG grant will have adaptations that can be used for online and hybrid courses to account for the possible evolution of permanent course offerings. Additionally, the labs will be stored on Desire 2 Learn in a course specific folder for all faculty who will be teaching this course and it will provide labs at no cost to students.

1. Brown, C., Hyslop, R. and Barbera, J., 2014. Development and analysis of an instrument to assess student understanding of GOB chemistry knowledge relevant to clinical nursing practice. *Biochemistry and Molecular Biology Education*, 43(1), pp.13-19.
2. El-Farargy, N., 2009. Chemistry for student nurses: applications-based learning. *Chemistry Education Research and Practice*, 10(3), p.250.
3. Schroeder, L., Bierdz, J., Wink, D., King, M., Daubenmire, P. and Clark, G., 2017. Relating Chemistry to Healthcare and MORE: Implementation of MORE in a Survey Organic and Biochemistry Course for Prehealth Students. *Journal of Chemical Education*, 95(1), pp.37-46.

**Project impact**

The development of this laboratory manual and exercises will follow the recommendations of GGC’s Director of the School of Nursing to enhance preparation of students for Allied Health professions. Lowering the cost of this manual will aid GGC students, many of whom are first generation college students, to obtain the laboratory manual, which is essential for success in the lab. Many students choose to attend GGC due to the lower cost and students work to assist in their college finances. Thus, by lowering the cost of the lab manual, students can access the course and hopefully better succeed.

**Impact on course**

All sections of this course, about 25 per academic year, (including all summer sections from summer 2022 onwards) will be impacted. This new laboratory manual will be required across all sections of the course every semester, starting fall 2021. These changes will positively impact students financially while providing better preparation for admission and success in Allied Health professional schools by increasing the biochemistry content of the course.

**Impact on department and institution**

This adjustment supports the needs of GGC’s allied health students and specifically redesigns the course based on recommendation from GGC’s School of Nursing. Naturally, this will benefit our students, potentially increasing admission rates to nursing schools. This realignment will place GGC’s pre-nursing curriculum in the forefront of colleges and potentially increase student enrollment, benefiting our institution.

**3. Action plan**

**Goal 1: Develop new laboratory supplementary materials in line with course goals, including more biochemistry content in CHEM1152K for both in-person and online laboratory sections.**

The laboratory exercises in this section have been split into the organic and biochemistry labs. The number of hours that it will take each faculty member to complete the development of each lab is given in the individual lab description. GGC will purchase pipettors and spectrophotometers to support these new labs. We request funds to purchase microcentrifuges for this laboratory course in order to support the development of labs focused on biochemistry. A common biochemical practice is to separate tissues, cell parts and larger molecules using microcentrifugation.

**Action plan:** Developing new lab exercises will be separated into Organic and Biochemistry focused labs, as seen below.

***CHEM1152K Organic Chemistry focused labs*** will be developed and managed by Julia Paredes and Richard Pennington (with time equally divided on each lab). As needed, videos will be supplied for students that are taking the course online and linked into the online laboratory documents. Labs in this category may include:

* **Introduction to Drawing Organic Compounds**
	+ Students will take an in-depth look at different representations of organic structures. This lab will use model kits to allow students to visualize molecules in 3 dimensions. Model kits are currently available in the lab for those who do not have them. (30 hours)
* **Functional Group Identification**
	+ Students will learn how to identify functional groups in the laboratory through the analysis of known compounds and then prediction of the identity of several unknowns. (30 hours)
* **Ester/Amide Synthesis**
	+ Students will synthesize biochemically relevant functional groups such as esters and amides. Students will also investigate the utility of catalysts in reactions. (30 hours)
* **Thin Layer Chromatography**
	+ Students will analyze the active compounds in over-the-counter medications by thin layer chromatography (TLC). Compounds may include caffeine, acetaminophen, ibuprofen, and aspirin. A similar procedure was presented in our Organic Chemistry lab manual, so this rendition would be adapted for these students. (30 hours)
* **Synthesis of Aspirin**
	+ Students will synthesize the common analgesic, Aspirin. In addition, students will analyze their product purity via thin layer chromatography. (30 hours)
* **Determination of Iron in a Vitamin Tablet**
	+ Students will determine the amount of iron in a vitamin tablet via spectrophotometric analysis. First, they will generate and graph a standard curve using known concentrations of iron samples. They will then use the information from the graph to determine the concentration of iron in their sample. (30 hours)

***CHEM1152K Biochemistry focused labs*** will be developed and managed by the three biochemists, Charmita Burch, Candace Timpte and Gillian Rudd, with time equally divided on each lab. As needed, videos will be supplied for those that are taking the course online and linked into the online laboratory documents. Labs in this category may include, but are not limited to, the following topics, some of which could be split into two week-long labs:

* **Conversion problems/pipetting skills**
	+ Quantitative skills and dilution comprehension are areas where GGC pre-nursing students need more practice. Students will be trained in the proper use of a micropipette, while also performing an inquiry activity. For example, students may use different colored food dyes to create a recognizable pattern in a microtiter plate with 96 wells to practice pipetting and dilutions. (30 hours)
* **Got Protein? Protein assay and use of a protein standard curve (two-week module)**
	+ Students will learn how to use a spectrophotometer to record the absorbance of protein standards. They will continue in the proper use of a micropipette, as they prepare the micro protein quantities for this assay. Students will investigate the actual protein content of various samples, for example several types of milk, protein drinks or meat broth. (50 hours)
* **Aspartame: a biological weapon, or an integral part of our diet?**
	+ Students will perform thin layer chromatography (TLC) on various amino acids and an artificial sweetener. After visualization, they will discover the separation of the two naturally occurring amino acids, aspartic acid, and phenylalanine, and compare them with standards. (30 hours)
* **Fun with PyMOL molecular modeling**
	+ Students will use the freely downloadable PyMOL protein visualization program, in an exercise involving the RSCB protein data base, free to access and use. All three faculty are members of the national Biomolecular Visualization group (BioMolVis at https://biomolviz.org/ accessed 2/10/2021), and we are eager to promote student visual literacy skills. (30 hours)
* **Why use Lactaid, and how much?**
	+ Students will use Benedict’s solution to investigate sugars in distinct types of milk and beverages. Benedict’s solution turns red in the presence of reducing sugars, such as glucose and galactose. Students will investigate the quantity of Lactaid required to convert the milk sugar, lactose, into its monosaccharides. (30 hours)
* **Enzyme Kinetics Exploration (two weeks)**
	+ Students will examine the activity of the enzyme acid phosphatase as an inquiry experiment. Students can determine the optimal conditions regarding pH, salt, and temperature for optimal enzyme activity. Additionally, students will examine enzyme inhibition, which has a direct correlation to medical applications. (40 hours)

**Goal 2: Deploy final products across all sections in fall 2021 and revise as needed per student comments. This will effectively reduce cost for GGC students. Final products will also be published to open educational resource sites, including ALG and the GALILEO Open Learning Materials repository.**

**Action Plan:** The course coordinator for CHEM1152K will disseminate the new lab manual to all course instructors. Lab support personnel will deploy appropriate equipment and reagents to accomplish each lab exercise. Student input during the duration of the labs will be solicited and instructors will note points of difficulty. The lab manual will be revised as a living document during the first couple of semesters of use to refine the instructions as indicated by student satisfaction surveys and discussion. By not requiring a purchased custom lab manual, students will reduce expenses for this course. Lab materials will be available to enrolled students through the course management system.

As a cost comparison, online laboratory kits delivered to a student’s home are incredibly expensive. Esciencelabs.com has an online kit available for a two-semester sequence for $313.00. We are currently utilizing Hands-On Lab and only using their online interactions, which totals $65.00. However, after using it in spring 2021, we choose not to pursue this partnership in the future. Carolina Biological’s distance learning has a wide variety of experiments that look interesting. A set of seven labs, however, costs $207.25. Each of these companies may also send students physical equipment to complete lab in their home. We will consult with GGC’s legal team to determine acceptable materials to send to our students OR ask them to obtain on their own for a virtual lab; instead, we can simply take videos of the results if this is what is needed.

Though several free textbooks exist for the lecture portion of this course, few are open-source texts for the laboratory. For example, LibreTexts has around six texts for the class, and another three workbooks of problems, but does not have an open laboratory text available. Though research papers and individual labs abound, a collection of online labs for our level of students in the GOB second semester course simply do not exist, especially with corresponding online modalities. ALG does have a free text for the course portion of the course, but it only covers the first semester of the GOB sequence, not this course.

The written materials for each laboratory exercise will be edited for 508 compliance, including color blindness, and presented in each of two laboratory manual formats: one for online and another for in-person labs and maintained by Richard Pennington (10 hours) and Candace Timpte (30 hours). Gillian Rudd will work to infuse the biochemistry laboratory documents with nursing clinical practice related connections (30 hours). Julia Paredes will ensure connections to biochemistry/allied health in the organic chemistry labs (10 hours). Charmita Burch will assess and analyze data from the concept inventory (30 hours). The project team will work with Chris Robinson, technical trainer, on the 508 compliance.

We do not have a repository outside of the GGC password protected environment, so we plan to have Affordable Learning Georgia assist in storing our files for others to access, including the GALILEO Open Learning Materials repository. We will also post these laboratory manuals in GGC’s D2L sites. In addition, the final product will be posted on Research Gate, as with the Organic Chemistry Manual from GGC. Further, we plan to publish this work if warranted. To this end, all structures, figures, and tables will be original work. However, we will link to existing simulation software and open-source materials to provide chemical visualizations as appropriate.

**Goal 3:** **Increase student performance on a concept inventory (Brown) relevant to GOB course topics that indicate readiness for Allied Health professional school.**

Brown, C., Hyslop, R. and Barbera, J., 2014. Development and analysis of an instrument to assess student understanding of GOB chemistry knowledge relevant to clinical nursing practice. *Biochemistry and Molecular Biology Education*, 43(1), pp.13-19.

**Action Plan:** Concept inventory will be levied at the beginning and end of each semester. Faculty will assess this data and compare across control sections (current sections using the old lab materials). An example of this concept inventory is given in the appendix.

**4. Quantitative and Qualitative Measures**

**Goal 1: Develop new supplementary materials in line with course goals, including more biochemistry content in CHEM1152K for both in-person and online laboratory sections.**

Quantitative and Qualitative Measure and Tools: Accomplishment of Goal 1 will be measured by simple completion of the laboratory exercises and materials by fall 2021. Faculty will work over summer 2021 to develop the labs and test run the labs on student volunteers or students engaged in STEC2500 research course.

**Goal 2: Deploy final products across all sections in fall 2021 and revise as needed per student comments. This will effectively reduce cost for GGC students. Final products will also be published to open educational resource sites, including ALG and the GALILEO Open Learning Materials repository.**

Qualitative Measure and Tools: Will be measured by completion of the experiments by students enrolled in CHEM1152K. Students will be asked to give feedback at the end of each lab, and faculty will listen to students throughout the lab period. Faculty will note student difficulties or hurdles in understanding and work to clarify those hurdles. In addition, a research student in STEC4500 will collect this feedback and give to the PI/Co-PIs of this grant. Collaborators will consider these comments and adjust labs as needed after the fall 2021 semester is complete. Newly adjusted labs will then be released across all sections for spring of 2022. The attitudinal survey will include a pre and post questionnaire (El-Farargy) classified by some of the following broad categories: previous experiences, college experiences, lab work, course organization, student materials, attitudes, and future intentions. This survey and student feedback will help us analyze student satisfaction.

Quantitative and Measure and Tools: Documents will bemade accessible to the public through OpenALG and the GALILEO Open Learning Materials repository as two laboratory manuals, both for in-person and online, in fall of 2021. Revisions to each manual will be submitted in spring of 2022. The final products will be uploaded to ALG and Research Gate by the end of the spring 2022 semester, after we fully account for all student comments and suggestions.

We will also track the total cost impact for students’ savings for all impacted sections, along with course retention, completion rates and average GPA. At the end of this project, we will present findings at GGC’s CREATE symposium and at a National American Chemical Society (ACS) Meeting.

El-Farargy, N., 2009. Chemistry for student nurses: applications-based learning. *Chemistry Education Research and Practice*, 10(3), p.250.

**Goal 3:** **Increase performance on a concept inventory (Brown) relevant to GOB course topics that indicate readiness for Allied Health professional school.**

CHEM1152K at GGC requires students to register for both class and lab together at the same time, and with the same instructor. We currently collect grade distributions for students using the traditional Pearson product, so we will be able to compare the DFW rates upon adoption of our in-house lab manuals.

Quantitative Measure and Tools: We will submit a required application for these OER surveys to the GGC Institutional Review Board. Students will be given a GOB Concept Knowledge Assessment (Brown) and an attitudinal survey (El-Farargy). Notably, the concept knowledge assessment will help us assess student learning, while the attitudinal survey will assist us with understanding student satisfaction. The validated concept inventory will be used to measure the labs impact on the knowledge of the important concepts in this course. The attitudinal survey will include a pre and post questionnaire classified by some of the following broad categories: previous experiences, college experiences, lab work, course organization, student materials, attitudes, and future intentions.

The student attitudinal survey and a concept inventory will be administered during summer 2021, fall 2021, spring 2022, summer 2022 and fall 2022, to assess student attitudes towards our lab manuals versus the traditional Pearson labs.

IRB approval: we will submit a required application for these OER surveys to the GGC Institutional Review Board.

1. Brown, C., Hyslop, R. and Barbera, J., 2014. Development and analysis of an instrument to assess student understanding of GOB chemistry knowledge relevant to clinical nursing practice. *Biochemistry and Molecular Biology Education*, 43(1), pp.13-19.
2. El-Farargy, N., 2009. Chemistry for student nurses: applications-based learning. *Chemistry Education Research and Practice*, 10(3), p.250.

**5. Timeline**

**Full implementation: Fall 2021**

*Timeline given as follows:*

**Spring and Summer 2021**

* Ongoing participation as needed in ALG-related communication.
* Application submitted by March 1, 2021 deadline.
* Attendance by at least two team members, at a required synchronous Kickoff meeting on March 26, 2021 from 1-4 pm.
* March through July 2021, faculty will develop and test the lab materials. Generating and editing these OER materials will be challenging, but feasible shared with five team members. This will complete **Goal 1:** Develop new laboratory supplementary materials in line with course goals, including more biochemistry content in CHEM1152K for both in-person and online laboratory sections. Summer 2021 semester begins on May 24.
* Attitudinal survey, and a validated concept inventory (GOB chemistry knowledge assessment) will both be administered in the summer 2021 semester to all students in all sections of CHEM1152K, using the traditional Pearson labs.
* IRB materials to be generated and approved for start of summer 2021 implementation
* End of July 2021, in-house lab manuals and supplemental material ready for **implementation at the start of the fall 2021 semester**, for both face-to-face and fully online lab courses.

**Fall 2021**

* The fall 2021 semester begins on Aug 9. This initiation **Goal 2:** Deploy final products across all sections in fall 2021 and revise as needed per student comments. This will effectively reduce cost for GGC students. Final products will also be published to open educational resource sites, including ALG and the GALILEO Open Learning Materials repository.
* Attitudinal survey, and a validated concept inventory (GOB chemistry knowledge assessment) will both be administered in the fall 2021 semester to all students in all sections of CHEM1152K, using our OER labs.
* Student feedback on laboratory materials will be collected during the semester as students work through the new laboratory exercises. A STEC4500 (research course) student researcher will collect and analyze these comments.
* Student researcher in STEC4500 research course will analyze anonymized data.
* End of fall 2021 semester status report submission.

**Spring 2022**

* Ongoing revision and refinement of labs and exercises as needed.
* Attitudinal survey, and a validated concept inventory (GOB chemistry knowledge assessment) will both be administered in the spring 2022 semester to all students in all sections of CHEM1152K, using the OER labs. Spring 2022 semester begins on Jan 18.
* Completion of **Goal 3:** increase performance on a concept inventory (Brown) relevant to GOB course topics that indicate readiness for Allied Health professional school.
* Completion of **Goal 2:** deploy final products across all sections and revise as needed per student comments. This will effectively reduce cost for GGC students. Final products will also be published to open educational resource sites, including ALG and the GALILEO Open Learning Materials repository.
* Submission of final report at end of spring 2022 semester.

**After grant is over**

* Attitudinal survey, and a validated concept inventory (GOB chemistry knowledge assessment) will both be administered in the summer 2022 semester to all students in all sections of CHEM1152K, using our OER labs. Summer 2022 semester begins May 23.
* Ongoing revision and refinement of labs and exercises as needed.
* Attitudinal survey, and a validated concept inventory (GOB chemistry knowledge assessment) will both be administered in the fall 2022 semester to all students in all sections of CHEM1152K, using our OER labs. Start of fall 2022 semester is not yet available in the GGC academic calendar. This will be the final semester of implementation for data collection. The estimated total number of students affected during this project is 1,064.
* Completion of a brief annual survey for three years after the project is completed.

**6. BUDGET**

1. **Individual Awards (Max of $5,000/person): $25,000**

**Gillian E. A. Rudd** will help infuse the biochemistry laboratory documents with nursing clinical practice related connections. Along with Drs. Burch and Timpte, she will develop and manage *CHEM1152K Biochemistry focused labs*. Along with Dr. Burch, she will supply videos for those that are taking the course online and link them into the online laboratory documents.

* Summer Pay: $4,277.53
* Fringe Benefits: $722.47. This will cover employer’s portion at the rates of FICA SS 1.45%, FICA Med 6.2%, and ORP 9.24% at the time of submission.

**Total: $5,000**

**Charmita Burch** will help infuse the biochemistry laboratory documents with nursing clinical practice related connections. She will assist in developing and managing *CHEM1152K Biochemistry focused labs* and in supplying videos for those that are taking the course online and linking them into the online laboratory documents. She will be working with Dr. Rudd on this last task.

* Summer Pay: $4,277.53
* Fringe Benefits: $722.47. This will cover employer’s portion at the rates of FICA SS 1.45%, FICA Med 6.2%, and ORP 9.24% at the time of submission.

**Total: $5,000**

J**ulia E. Paredes** will ensure the connections to biochemistry/allied health in the organic chemistry labs and will develop and manage *CHEM1152K Organic Chemistry focused labs* along with Dr. Pennington.

* Summer Pay: $4,277.53
* Fringe Benefits: $722.47. This will cover employer’s portion at the rates of FICA SS 1.45%, FICA Med 6.2%, and ORP 9.24% at the time of submission.

**Total: $5,000**

**Richard Pennington**will develop and manage the *CHEM1152K Organic Chemistry focused labs* along with Dr. Paredes. He will work with Dr. Timpte to edit the written materials for each laboratory exercise for 508 compliance, including color blindness, and presented in each of two laboratory manual formats: one for online and another for in-person labs. With Dr. Timpte, he will maintain these materials.

* Summer Pay: $4,277.53
* Fringe Benefits: $722.47. This will cover employer’s portion at the rates of FICA SS 1.45%, FICA Med 6.2%, and ORP 9.24% at the time of submission.

**Total: $5,000**

**Candace Timpte** will work with Drs. Rudd and Burch on the *CHEM1152K Biochemistry focused labs*. She will also supply videos for those that are taking the course online and linking them into the online laboratory documents. Along with Dr. Pennington, she will edit the written materials for each laboratory exercise for 508 compliance, including color blindness, and presented in each of two laboratory manual formats: one for online and another for in-person labs. She will work with Dr. Pennington in maintaining these materials.

* Summer Pay: $4,277.53
* Fringe Benefits: $722.47. This will cover employer’s portion at the rates of FICA SS 1.45%, FICA Med 6.2%, and ORP 9.24% at the time of submission.

**Total: $5,000**

1. **Other Project Expenses (Important lab supplies): $5,000**

We would like to request for the following lab supplies that will be used by the entire team in creating and validating Chemistry laboratory experiments. These are essential items that are required to complete this project, and they will remain in the CHEM1152K laboratory. These are NOT part of the **micropipettes and spectrophotometers that will be funded through GGC School of Science & Technology to a total cost of $24,373 as a purchase to support this laboratory enhancement.**

* Three Microcentrifuges. Microcentrifuges are used to separate cells or tissues or large molecules from solutions as a common biochemical technique. To properly train students for allied health professions, use of centrifugation as a technique is essential. Without these supplies, the team will be unable to fully realize the suggestions by the D of GGC Nursing School to emphasize biochemistry in the open source laboratory manual transformation. The microcentrifuges are Fisher brand AccuSpin Micro 17 with 24-place rotor, and a capacity of 24 x 1.5/2mL. Unit price is $1,330.89 per each. 3 X $1,330.89 = $3,992.67
* Microcentrifuge tubes, pipette tips, cuvettes and microtiter plates = $1,007.33. The microcentrifuge tubes are Eppendorf safe-lock tubes that provide reliable and safe sample preparation, and they can also be used for storage. Pipette tips are used with pipettes for liquid handling needs. Cuvettes hold liquid samples for spectroscopic analysis. The microtiter plates contain 96 micro wells for holding solution.

**Total: $5,000**

1. **Other personnel: no cost**

The Library Specialist team member, Barb Mann, will be assisting the project as a service to the institution, as per institutional guidelines.

The design specialist team member, Chris Robinson, will be assisting the project as a service to the institution, as per institutional guidelines.

STEC 4500 students working on this project will receive STEC 4500 course credit for their work, so they will not be paid project members.

**7. SUSTAINABILITY PLAN**

These open resource laboratory manuals will be scaled across the chemistry discipline **for ALL CHEM1152K sections.** After development of these lab experiments, we will troubleshoot and refine the labs as the students perform them. Frequently, there are unanticipated issues that arise when newly developed experiments are performed by students for the first several times. As a result, each of these experiments will be evaluated during and after the first semester of use in CHEM1152K; this evaluation will allow us to fix problems that occur during each lab, and to improve labs where necessary. The CHEM1152K course coordinator will be responsible for disseminating the revisions to all involved faculty and updating in the D2L course site. These improvements will help maximize the effectiveness of the experiments for future years of their administration.

***Maintenance and updating of course materials:*** *t*he materials for each of these experiments including procedure documents, lab report grading rubrics, chemical reagents and equipment supply lists will initially be under the purview of the PI and co-PI grant team. This team will be responsible for updating procedure documents at the end of each semester to reflect improvements to procedures as needed, and for coordinating the disbursal of updated documents with the CHEM1152K course coordinator.

***Commitment of SST Dean to continue the use of affordable materials:*** The School of Science and Technology Dean supports our endeavors, including institutionalizing the department-wide adoption of our lab manuals, and will provide the necessary resources to develop the proposed low-cost learning materials to enhance these CHEM1152K labs. See attached letter of support from the Interim Dean. **Further, the SST Dean approved the purchase of required equipment, which comes to a total of $24,373, including micropipettes and spectrophotometers as support for this critical course revision.**

***Future plans for sharing this work:*** the data acquired from student surveys will be presented at (I) GGC CREATE symposium, fall 2022 and (II) American Chemical Society (ACS) National Meeting, either fall 2022 or spring 2023. In addition, we intend to submit these original works, and their statistical findings, for peer-reviewed publication(s).

**References**

Brown, C., Henry, M., Barbera, J. and Hyslop, R., 2012. A Bridge between Two Cultures: Uncovering the Chemistry Concepts Relevant to the Nursing Clinical Practice. *Journal of Chemical Education*, 89(9), pp.1114-1121.

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Mahaffey, A., 2019. A Complementary Laboratory Exercise: Introducing Molecular Structure–Function Topics to Undergraduate Nursing Health Professions Students. *Journal of Chemical Education*, 96(10), pp.2188-2193.

Schroeder, L., Bierdz, J., Wink, D., King, M., Daubenmire, P. and Clark, G., 2017. Relating Chemistry to Healthcare and MORE: Implementation of MORE in a Survey Organic and Biochemistry Course for Prehealth Students. *Journal of Chemical Education*, 95(1), pp.37-46.

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# Letter of Support

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| --- |
| Sonal Dekhane, Ph.D.Interim Dean, School of Science and TechnologyGeorgia Gwinnett College |

# Grants or Business Office Letter of Acknowledgment

*Institutional Grants/Business Offices will be responsible for fund disbursement, often in correspondence with the Department Chair, including expense and travel reimbursement. Applicants will need to provide a short Letter of Acknowledgment stating that the Grants/Business Office knows about the applicant’s intent to apply for an Affordable Materials Grant. Either the Department Chair or the Project Lead can work with the Grants/Business Office to get this signed letter.*

*In the case of multi-institutional affiliations, all participants’ institutions must provide a letter of acknowledgment.*

*Please provide the name and title of the grants or business office representative who provided you with the Letter of Acknowledgment.*

|  |
| --- |
| Cathy HakesExecutive DirectorOffice of Research & Sponsored Programs, Certification and Accreditation Activities |

**Appendix: Example of Concept Inventory**

**General, Organic, and Biological Chemistry Knowledge Assessment (GOB-CKA)**

Corina E. Brown, Richard M. Hyslop, and Jack Barbera

Department of Chemistry and Biochemistry, University of Northern Colorado,

 Greeley, CO 80639

The General, Organic, and Biological Chemistry Knowledge Assessment (GOB-CKA) is developed to assess the topics deemed most important for the clinical practice of nurses. The items were developed with input from practicing nurses, nurse educators, and chemists who regulalry teach this material. The details of this development are outlined in our 2012 publication. An evaluation of the items and the overall instrument can be found in our 2014 publication. This manuscript outlines several psychometric properties of the data derived from the GOB-CKA.

The GOB-CKA can be used for classroom or research purposes provided that the developing authors are given appropriate credit. **Please refer to each publication below when presenting or publishing results based on use of the GOB-CKA.**

# GOB-CKA Development and Analysis Publications

Corina E. Brown, Richard M. Hyslop, and Jack Barbera, “Development and Analysis of an Instrument to Assess Student Understanding of GOB Chemistry Knowledge Relevant to Clinical Nursing Practice,” *Biochemistry and Molecular Biology Education*, **2014**, DOI:

10.1002/bmb.20834

Corina E. Brown, Melissa L. M. Henry, Jack Barbera, and Richard M. Hyslop, ”A Bridge Between Two Cultures: Uncovering the Chemistry Concepts Relevant to the Nursing Clinical Practice,” *Journal of Chemical Education*, 89, **2012**, 1114-1121.

1. Under physiological conditions, Mg2+ is a good electrolyte. Which of the following is the correct electronic configuration of this ion?

 A. 1s22s22p63s2 B. 1s22s22p6

 C. 1s22s22p43s2  D. 1s22s22p63s23p2

1. Iron-59 is used in studies of iron metabolism in the spleen. What is the nuclear composition of this isotope?

 A. 26 protons, 59 neutrons B. 33 protons, 26 neutrons

 C. 59 protons, 26 neutrons D. 26 protons, 33 neutrons

1. From the following, choose the one that matches the correct name of the compound with the correct chemical formula:

 A. sodium phosphate (Na3PO4) B. disodium bicarbonate (Na2HCO3) C. magnesium chloride (MgCl) D. ammonia chloride (NH3Cl)

1. From the following options, choose the one that contains only mixtures:

 A. urine, carbon dioxide, air B. glucose, blood, sodium chloride

 C. air, blood, urine D. carbon dioxide, sodium chloride, glucose

1. From the following options, choose the one that contains only ionic compounds:

 A. NaCl, CaO, CaCO3 B. CO2, NaCl, CaO

 C. CO2, CaO, NaCl D. CO, NaCl, NH3

1. Hepatic metabolism of drugs often makes them more polar and thus more water soluble. The resulting metabolites are then more readily excreted in the urine. From the following options, choose the one that contains only polar compounds.

 A. CO2, CO, HCl B. CO2, O2, N2

 C. CO2, N2, NH3 D. CO, HCl, NH3

1. When red blood cells are placed in a hypotonic solution, water will be transported \_\_\_\_\_ the cell because the solute concentration is \_\_\_\_\_\_ in the cell.

 A. into; higher B. into; lower

C. out of; lower D. out of; higher

1. An I.V. solution is at a drip rate of 135 mL per hour. If the I.V. bag contains 1000.0 mL, how long will it last?

 A. 1.35 h B. 7.41 h

C. 8.10 h D. 12.5 h

1. The metabolic pathway occurring when there is an intake of glucose and inadequate ATP in the cell is:

 A. glycogenolysis B. gluconeogenesis

C. glycogenesis D. glycolysis

1. The pathway which ultimately leads to the storage of excess carbon as triglycerides is:

 A. glycogenesis B. lipogenesis C. β-oxidation

1. A patient’s HDL has a value of 15 mg/dL and he is told the value is low. The normal value is 40-135 mg/dL. The nurse explains that HDL is the “good” cholesterol, and it should be higher because HDL transports cholesterol
2. for storage in muscle for energy.
3. to the tissues to be used for the synthesis of membranes.
4. from the tissues to the liver for elimination.
5. for binding to fiber to be excreted from the body.
6. A thyroid cancer patient is treated with radioactive iodine-131 which has a half-life of 8.08 days. If the patient is given 2.00 grams of iodine-131, how many days will it take for the amount of iodine-131 to reach 0.250 grams?

 A. 12.1 days B. 16.2 days C. 24.2 days D. 32.3 days

1. How would one prepare a 1L solution of 0.9% (m/v) NaCl from a solution of 20% (m/v) solution of NaCl?
2. Add 45 mL of the 20% solution and dilute to make 1L
3. Add 45 mL of the 20% solution to 1L of H2O
4. Add 4.5 mL of the 20% solution to 1000 mL of H2O
5. Add 4.5 mL of the 20% solution and dilute to make 1000 mL
6. In which set are the following compounds arranged in order of increasing (low to high) water solubility: CH3CH2CHO (propanal), CH3CH2COOH (propionic acid), CH3CH2CH3 (propane), CH3OH (propanol)?
7. propionic acid < propanal < propane < propanol
8. propane < propanal < propanol < propionic acid
9. propane < propanol = propanal < propionic acid
10. propionic acid < propanol < propanal < propane
11. When divers return too quickly to the surface, a painful condition known as the bends caused by N2(g) dissolved into the blood and tissues, can cause paralysis or death. What is the explanation of this condition?
12. The dissolved N2(g) inhibits the binding of oxygen to hemoglobin.
13. The dissolved N2(g) is less soluble in the blood and tissues at lower pressures causing bubbles of gas to form.
14. The dissolved N2(g) is more soluble into the blood and tissues at lower pressures and prevents oxygen from dissolving in blood.
15. As a result of uncontrolled diabetes, a serious decrease in blood pH can occur. The normal blood pH, which is 7.4, may decrease to as low as 6.8. Explain how the blood bicarbonate system (H2CO3/HCO3-) attempts to compensate for this change in pH. A. H2CO3 is a base that can react with the excess H+.
16. HCO3- is an acid that can react with the excess OH-.
17. H2CO3 is an acid that can react with the excess OH-.
18. HCO3- is a base that can react with the excess H+.
19. As a result of diarrhea, large quantities of bicarbonate ion (HCO3-) are eliminated. Consider the following equation (the bicarbonate buffer system):

 H2O(l) + CO2(aq) <--> H2CO3(aq) <---> H+(aq) + HCO3-(aq)

 In which direction does the bicarbonate buffer system shift under this circumstance and for what reason?

1. to the left so the amount of CO2 will increase.
2. to the right so the amount of H+ will increase.
3. to the right so the amount of HCO3- will increase.
4. to the left so the amount of H2O will increase.
5. Which of the following molecules are able to form intermolecular hydrogen bonds with molecules identical to themselves?

 I. propionic acid, CH3CH2COOH

II. Acetone, CH3COCH3

 III. Ethyl chloride, CH3CH2Cl

 IV. Ethylamine, CH3CH2NH2

 A.I and IV only B.I, II, IV only C.II and III only D.II, III, IV only

1. A low carbohydrate intake, such as with starvation or uncontrolled diabetes, results in the formation of which product?

 A. glycogen B. a ketone body C. glucose D. urea

1. What is the function of the urea cycle?

 A. To detoxify urea. B. To transaminate amino acids.

 C. To detoxify lactic acid. D. To convert ammonium ion to urea.

1. During diaphragm contraction (moving downward), what is the relationship between air pressure in the lungs and the volume of the thoracic cavity (chest cavity)?

 A. pressure decreases, volume decreases

 B. pressure decreases, volume increases

 C. pressure increases, volume increases

 D. pressure increases, volume decreases

1. If blood pH increases from 7.4 to 7.8, then the
2. hydronium ion concentration increases.
3. hydronium ion concentration decreases.
4. hydroxide ion concentration decreases.
5. hydroxide ion concentration is not affected.
6. NAD+ is

 A. an enzyme of the electron transport chain.

 B. an important coenzyme in the cell.

 C. the oxidized form of coenzyme Q.

 D. the reduced form of niacin.

1. A person with a blood alcohol concentration of 0.03 % (v/v) is considered over the legal limit. If the blood plasma volume is 3.0 L, how many mL of alcohol does this concentration represent?

 A. 0.09 mL B. 0.9 mL C. 9.0 mL D. 90 mL

1. Which of the following twelve-carbon compounds has the potential for generating the most ATP?
2. maltose (a disaccharide of glucose)
3. lauric acid (a saturated fatty acid)
4. lysyl lysine (a dipeptide of the amino acid lysine)
5. sucrose (a disaccharide of glucose and fructose)

1. Epinephrine and glucagon are two hormones involved in the release of glucose from glycogen. Which of the following statements is true regarding these hormones?
2. The two have the same effect and use the same receptor.
3. The two have the same effect but use different receptors.
4. The two have the same effect as insulin but use different receptors.
5. Lauren (three years old) has osteogenesis imperfecta which makes her bones very fragile. It is due to a mutation in the gene for collagen. Which of the following is not true for a genetic mutation?
6. It is a change in one base of a gene.
7. One or more bases are inserted or deleted in a gene.
8. A simple change in one base will affect more than one gene.
9. It is a permanent change in the DNA sequence of a gene.

1. Which of the following compounds will form ions when dissolved in water: potassium chloride, glucose, a triglyceride?

 A. only glucose B. only potassium chloride

 C. only a triglyceride D. all will form ions

1. Digestion of triglycerides, catalyzed by lipases, produces monoglycerides and fatty acids through a process called:

 A. dehydration B. hydrogenation C. oxidation D. hydrolysis

1. What are the functional groups in the following molecule:

H2NCH2COOH

 A. aldehyde, alcohol, amine B. carboxylic acid, amine

 C. alcohol, amide, ketone D. ketone, alcohol, amine

1. In metabolic acidosis, the pH of blood decreases. Based on the Bohr effect, how is the binding of O2 to hemoglobin (Hb) affected?
2. when the pH increases, the O2 binding decreases.
3. when the pH decreases, the O2 binding increases.
4. when the pH decreases, the O2 binding decreases.
5. the increase in H+ reacts with O2 to form water.

1. Which of the following is not a correct reason for limiting the exposure of a patient to radiation?
2. Radiation can cause free radical formation, regardless of dose.
3. X-ray radiation can damage the DNA of the cell.
4. Exposure to radiation can increase the risk of cancer.
5. Radiation can affect the immune system, regardless of dose.

1. B-vitamins affect metabolism due to which of the following reasons?
2. They form coenzymes important for many enzyme-catalyzed reactions.
3. They serve as enzymes in important reactions necessary for metabolism.
4. They are involved in the absorption of minerals.
5. They form hormones necessary for metabolism.

1. Glucose is metabolized to several different products, two of which are lactate and acetyl-

CoA. Under what physiological conditions would each of these be products of glucose? A. Lactate is produced aerobically; acetyl CoA is produced anaerobically.

B. Lactate is produced anaerobically; acetyl CoA is produced aerobically.

 C. Both are produced aerobically.

1. Both are produced anaerobically.

1. In which of the following pathways is lactate recycled and converted into glucose in the liver and the glucose is returned to tissue to form lactate?

 A. Krebs’cycle

 B. Alanine cycle

 C. Urea cycle

 D. Cori cycle

1. During recovery from intense muscular exertion, lactate in the liver is converted to glucose through the process of:

 A. gluconeogenesis B. glycolysis C. glycogenolysis

1. The main role of oxygen in cellular respiration is to:

 A. combine with CO to form CO2. B. combine with NADH to form ATP.

 C. combine with glucose to form water. D. accept electrons to produce water.

1. During certain disorders, the metabolism of fatty acids will produce ketone bodies which can

 A. result in a neutral pH in the blood. B. provide support for the digestive system.

 C. be a source of energy for the brain. D. produce pyruvate for the Krebs’ cycle.

1. The equilibrium reaction for the binding of oxygen by hemoglobin (HbH+) can be represented as:

 Hb(nH+)(aq) + 4 O2(aq) <--> Hb(O2)4(aq) + nH+(aq)

 When Hb(nH+) is in the lungs, where oxygen has a high concentration, how will the reaction be affected?

1. The reaction shifts to the right.
2. The reaction shifts to the left.
3. The reaction will not be affected.
4. The increase of H+ reacts with O2 to form water.

1. The trace element that serves as a cofactor for the action of insulin is Cr3+. This ion is formed by the element Cr:

 A. accepting 3 protons.

 B. losing 3 electrons.

 C. accepting 3 electrons.

 D. losing 3 protons.

1. The liver enzyme alcohol dehydrogenase catalyzes the conversion of ethanol to acetaldehyde. The enzyme acetaldehyde dehydrogenase then catalyzes the conversion of acetaldehyde to the relatively harmless acetic acid:

 Ethanol → Acetaldehyde → Acetic acid

 Which of the following represents structures of the compounds in each step of the reaction?

 A. CH3COOH → CH3CHO → CH3CH2OH

 B. CH3CH2OH → CH3CHO → CH3COOH

 C. CH3COOH → CH3CH2OH → CH3CHO

 D. CH3CH2CH2OH → CH3CH2OH → CH3CH2COOH

1. One of the antidotes used in the traditional treatment of ethylene glycol poisoning is ethanol. Which statement best explains the use of ethanol?
2. Ethanol will prevent the reduction of ethylene glycol since they compete for the same enzyme.
3. Ethanol will prevent the oxidation of ethylene glycol since they compete for the same enzyme.
4. Ethanol neutralizes the basicity of the ethylene glycol metabolites.
5. Ethanol will compete with ethylene glycol for binding to calcium ions.

1. How will ATP production be affected by a high protein/high fat (triglyceride)/low carbohydrate diet?
2. Proteins will be converted to fatty acids for ATP production.
3. The ATP production will decrease.
4. The ATP production will remain the same.
5. Fatty acids (from triglycerides) will be converted into glucose for ATP production.

1. Cyanide inhibits a cytochrome involved in the reduction of oxygen in the mitochondrial electron transport system. How does this explain the death of a person due to cyanide poisoning?
2. The cyanide is reduced to a toxic product.
3. The electrons cannot flow through the system.
4. The cyanide is oxidized to a toxic product.
5. Oxygen cannot be transported by hemoglobin.
6. The following conversion is an example of what type of reaction:

 H3C CH (OH) CH3 --> H3C CO CH3

 A. Hydrolysis B. Hydration C. Oxidation D. Reduction