Software Engineering

Group Number Five

The Rutgers Virtual Biology Laboratory

Website: http://sjlu.github.com/Virtual-Biology-Lab

February 17, 2012

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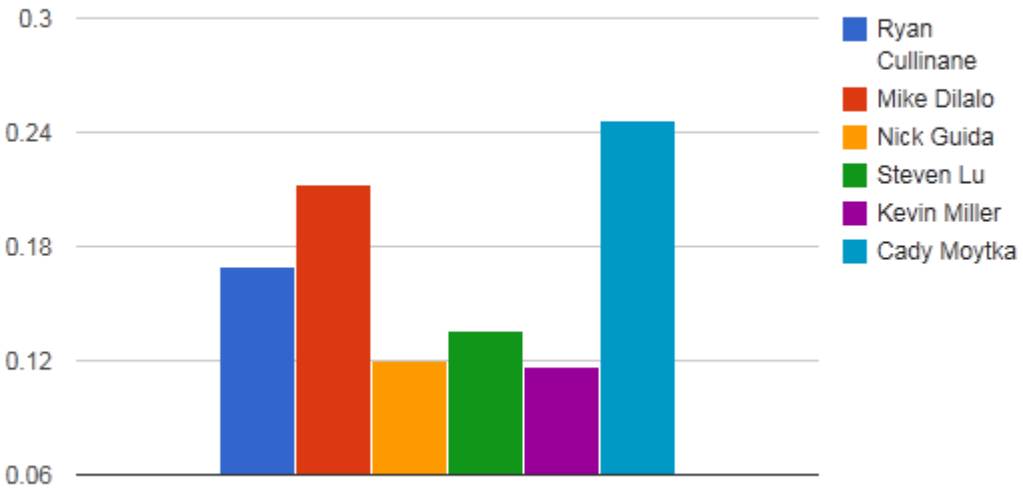
Breakdown of Individual Contributions



Responsibilities	Ryan Cullinane	Mike Dilalo	Nick Guida	Steven Lu	Kevin Miller	Cady Moytka	Totals
Totals:	0.17	0.2125	0.1195	0.1355	0.1165	0.246	100%
Project Managment	20%	25%	10%	20%	0%	25%	**100%**
1.1 Customer Statement of Requirements	15%	25%	10%	20%	0%	30%	**100%**
1.3 Glossary of Terms	0%	0%	0%	0%	0%	100%	**100%**
2.1 Functional Requirements	0%	0%	0%	0%	0%	100%	**100%**
2.2 Nonfunctional Requirements	0%	0%	0%	100%	0%	0%	**100%**
2.3 On-Screen Appearence requirments	100%	0%	0%	0%	0%	0%	**100%**
3.1 Stakeholders	0%	0%	0%	0%	0%	100%	**100%**
3.2 Actors and Goals	0%	0%	0%	100%	0%	0%	**100%**
3.3 Use Cases & Lab Sub-Modules	0%	30%	0%	10%	20%	40%	**100%**
3.4 System Sequence Diagrams	0%	15%	0%	0%	85%	0%	**100%**
4.1 Preliminary User Interface Design	100%	0%	0%	0%	0%	0%	**100%**
4.2 User Effort Estimation	100%	0%	0%	0%	0%	0%	**100%**
5.1 Domain Model	0%	15%	50%	0%	0%	35%	**100%**
5.2 Association Definitions	0%	50%	50%	0%	0%	0%	**100%**
5.3 Mathematical Model	0%	0%	0%	100%	0%	0%	**100%**
7 Plan of Work	0%	100%	0%	0%	0%	0%	**100%**
8 References	5%	5%	5%	5%	5%	75%	**100%**
Totals:	**17**	**21.25**	**9.75**	**17.55**	**11.65**	**22.8**	**100%**

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1. Customer Statement of Requirements

The goal of the Virtual Biology Laboratory is to reinforce the concepts taught in an introductory biology course by allowing each student to complete an informative and uniform laboratory. Each student will have to prepare slides and use machines to complete the laboratory as if they were completing all of the tasks in a real laboratory setting. The laboratories will focus on the subjects of mitosis, urinalysis, enzyme activity, chromosome structures, meiosis and genetics. While doing research on what the customer would be potentially interested in, it was discovered that the clearest way of presenting this information is to first show a diagram that represents the cell activity and then present a picture of a real cell and how that looks during the activity; this was the students will have an idea of what processes are going on and know how this is visible in a real cell.

1.1 Goal of Each Laboratory

Laboratory One Cell Division

The goal of the first Laboratory is to demonstrate all of the stages of the type of nuclear division known as Mitosis. This lab will start with a demonstration of all of the steps of Mitosis, this starts with the Interphase stage where the cell is preparing for division, the cell increases in size and duplicates its chromosomes. The next stage is Prophase; this is when the chromosomes begin to bind together at their centromeres. During this stage the nuclear membrane disintegrates too. Next is the Metaphase where the chromosomes line up on the equatorial plane of the cell. Next is the Anaphase where the chromosomes are pulled apart and to opposite sides of the cell. This is where the cell has separated into two identical copies of genetic material. The last stage is the Telophase, this stage is the reversal of prophase and the two newly created cells settle down and a new nuclear membrane forms.

The second part of this lab is going to involve the student preparing a slide to view the stages of mitosis like how they would in a real laboratory. The last part of this lab is going to show the student what the differences are between an animal cell and a plant cell. An animal cell is irregular shaped and has only a cell membrane while a plant cell is a fixed shape and has both a cell wall and a membrane.

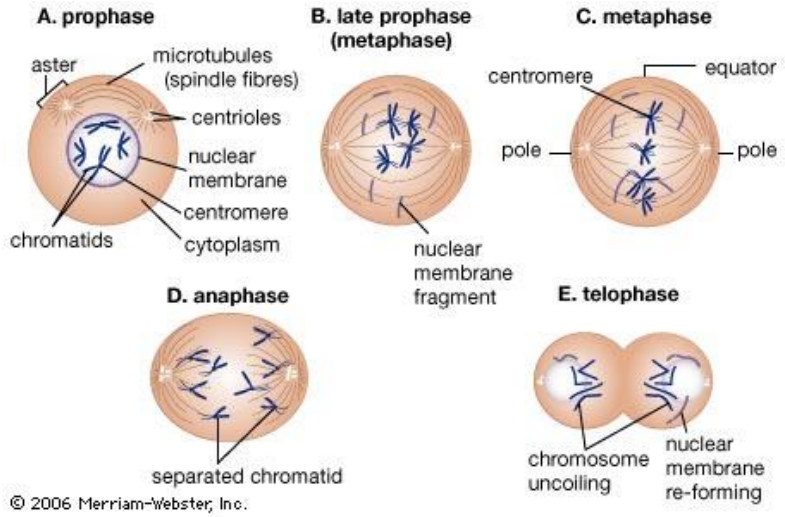


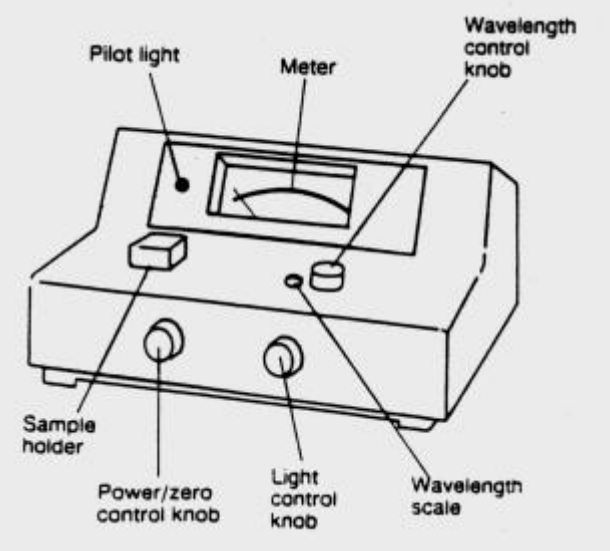
Fig.1 This image shows the staged of mitosis that will need to be animated in order to explain in detail how each step occurs.

Laboratory Two Biological Molecules

The goal of the second laboratory is to learn how to use and calibrate the spectronic 20 spectrophotometer to figure out the absorbance of a substance. The absorbance is a measure of what size wavelength of light will pass through the test tube full of liquid without being absorbed. This machine uses a light and dark knob to set the zero and infinity ends of the absorbance scale. Once the machine has been set correctly using a 'blank' test tube, usually filled with distilled water, any test tube can be placed in the sample slot and the machine will immediately show the absorbance.

Once the basics of this machine are taught, the student will begin running urinalysis. First they will check for the pH of the urine, making sure it is between a 5 and an 8. Secondly they will check for Glycosuria, making sure the amount of glucose per milliliter is about 0.6. Next, they will ensure the patient doesn't have proteinuria, or an excess of 0.3 mg of albumin per milliliter. Lastly they will check for the color of the urine, making sure the patient doesn't have hemoglobinuria. The last part of this laboratory will involve the students experimenting with carbohydrate and protein chemistry. In this part the student will be given a prepared test tube of some mixture and have to use the Spec 20 to figure out what the concentration is based on some example readings.

The image to the right (**Fig.2**) shows what the spectronic 20 spectrophotometer looks like and how the buttons and screen are positioned on the machine. Most importantly is the sample holder on the top left side where the student will place the prepared test tubes to find their absorbance.



Laboratory Three Enzyme Activity

The third laboratory is similar to the second laboratory. This lab also uses the Specronic 20 to quantify enzyme activity under different conditions. Students in this lab will have to prepare 6 test tubes each with a different combination of buffer and enzymes. Once all of these mixtures have been prepared, the test tubes absorbance is found using the spec 20. Depending on which test tube the student is testing, there will be a very different reading of absorbance and this will illustrate how different types of reagents and substrates will react.

The second part of this lab involves the students preparing six test tubes again, each with a different amount of undiluted enzyme from 100 percent to six percent. Once this has been completed, the substrate is added to begin the reaction. The spec 20 will be used to find the absorbance initially and then again after five minutes. This will allow the student to see how the concentration of the enzyme affects how quickly the reaction begins and how long it takes to complete.

Laboratory Four Chromosome Structure, Meiosis and Genetics

The fourth laboratory is like and extension of the first lab. The focus is more on genetics and how genetic material is passed from parent cells to the daughter cells. A human has 48 chromosomes per somatic cell. Without meiosis, when a sperm and egg fuse to form a single zygote, there would be 4 copies of each chromosome.

Meiosis ensures that when the gamete contains one representative of each homologous pair so that when they fuse, the resulting cell has the correct number of chromosomes. In meiosis, the DNA is synthesized only once, but divides twice. It has the same steps at mitosis, prophase, metaphase, anaphase and telophase. Each of these stages occurs twice so there is, for example, metaphase I and metaphase II. In meiosis, prophase does not only include the chromosomes bounding together but also: Leptotene, Zygotene, Pachytene, Diplotene and Diakinesis. During lepotene the chromosomes become more visible and condense. Then in zygotene the homologous chromosomes pair up. In pachytene the chromosomes form a tetrad and are fully lined up along their length. In diplotene the chromosomes begin to repel and finally in diakineses, the chromosomes become even shorter and the nuclear envelope breaks. This laboratory is going to show all of these steps to meiosis and how important it is to the development of living things.

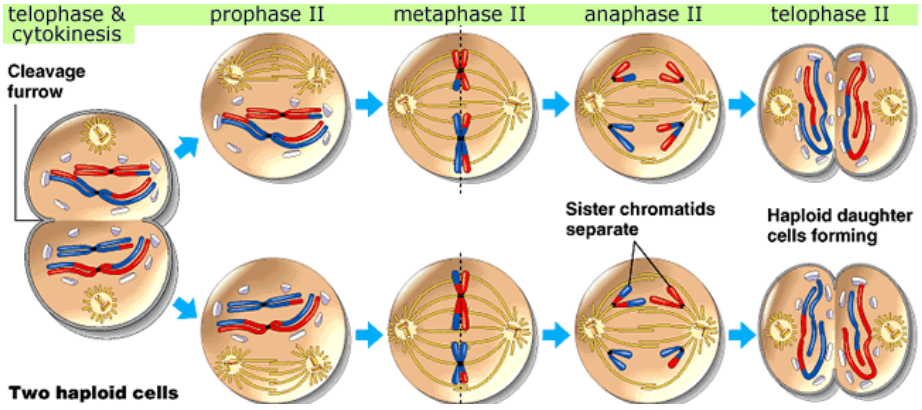


Fig.3 This image above shows the different stages of meiosis. Just like with the staged of mitosis, this laboratory will have to animate exactly what happens during each of these phases.

In the second part of this laboratory, the students will be given a hypothetical chromosome spread. They are going to have to identify and number each of these chromosomes checking for any abnormalities. If there is an issue with the sex chromosomes there are four possible syndromes, either Turner syndrome, for an XO pair, Triple X, Klinefelter syndrome for XXY or and XYY karyotype. Then the student would look for abnormalities in other chromosomes to indicate either Patau, Edwards or Down syndrome.

Fig.4 The image to the left is that of a hypothetical karyotyping sheet similar to the one the students will have to check for chromosome abnormalities.

1.2 Unique Features

The most important goal of the virtual biology laboratory is to reinforce what the students are learning in their lecture. Second to that, this program is going to provide another opportunity for the students to show the instructor what sort of effort they are putting into learning this information. Since everyone will have to register to use this, the professor will have a list of who has worked on the laboratories. If he or she chooses, the program will also compile grades for each of the students. They will have the option to either make the laboratory grade participation based, where if the student completes the lab they will get credit, or based on the percent of questions answered correctly. Each laboratory will have a short quiz on the information taught, and the professor can decide if the student grade should be based on a single score or the best grade out of three. This will allow for a student to prepare for an upcoming real laboratory, and show their instructor that they are taking the time to learn the material better.

This program will also have useful tools for organizing a class. The professors will be able to sort all of the registered students into their correct section and instantly see how a student did on a quiz after it is taken. There will also be a section for addition information. In this area the instructors will be able to add more information for the class. They will be able to share links to other articles they'd like the students to read or provide information on due dates or class announcements or even provide study guides.

1.3 Glossary of Terms

Laboratory 1

Term	Comments
Anaphase	Chromosome move from the equator to the poles. Fig.1
Centromeres	The region of the chromosome found in the center where sister chromosomes almost touch during mitosis. Fig.1
Chromosomes	Organized structure of DNA protein found in a cell's nucleus Fig.1
Cover Slip	Thin piece of plastic that covers the material that you place on a slide before viewing it with a microscope. Fig.6
Cytokinesis	When a single cell splits itself into two cells through cytoplasm division.
Diploid	A type of nuclei that has two sets of genes on two sets of chromosomes. 2n
Dye Solution/Stain	Biological stain that increases one's ability to see small structures within the cell. Fig.6
Equator	Invisible line splitting the cell in half Fig.1
Haploid	A type of nuclei that has one set of genes on one set of chromosomes. 1n
Homologous	Identical strands of chromosomes.
Hot Plate	The machine used to heat material.
Interphase	The time before mitosis. Fig.1
Metaphase	Chromosomes appear aligned on the equatorial plane of the cell Fig.1
Microscope	The machine used to view material on a molecular level.
Mitosis	A kind of nuclear division. A sequence of events by which the nuclear material of one cell is distributed into two equal parts. Fig.1
Nucleus	The control center of the cell that contains the cell's DNA. Fig.1
Nuclear membrane	Envelope around the nucleus that encloses all of the genetic material. Fig.1
Nucleolus	The part of the nucleus made of proteins and nucleic acid that does not have a

	membrane around it. Fig.5
Onion Root Tip	Has a root cap on the very bottom, immediately over this is the meristematic region, where cell division occurs, and the region of elongation. Fig.6
Plant Cell	Usually rectangular or at least a fixed shape cell, has a cell membrane and a rigid cell wall. Fig.5
Pole	Two exist on either side of the cell, divided by the equator. Fig.1
Prophase	Stage of mitosis, chromosomes first appear as darkly stained areas and later as distinct entities spread throughout the nucleus. Nuclear membrane disappears and the nucleolus is gone. Fig.1
Sample Cell	The prepared demonstration slide that shows exactly what a newly prepared slide should look like. Fig.5
Slide	Thin piece of glass that is used to hold material that will be observed with a microscope. Fig.6
Telophase	The darkly stained chromosomes are visible in both daughter nuclei. Fig.1

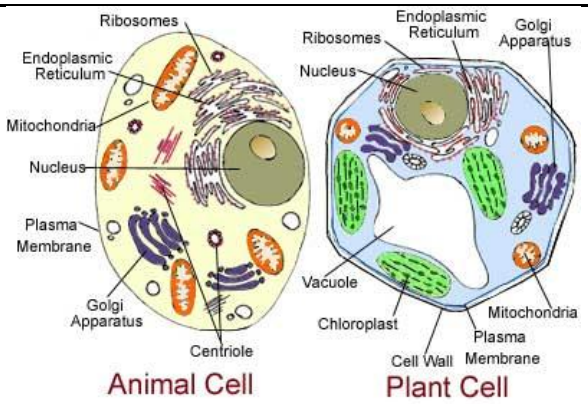


FIG.5 A depiction of the difference between animal and plant cells.

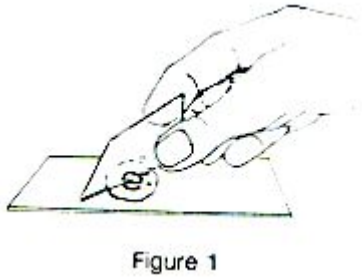


FIG.6 A representation of what preparing a slide would look like.

Laboratory 2

Term	Comments
Absorbance	Or optical density is the intensity of light at a specific wavelength that passes through a sample.
Blank	The sample used to calibrate the zero end of the absorbance scale.
Dark Control	Located on the left front side of the Spec 20, used to set the meter reading to an infinite absorbance on the left side, used for very dark sample where no light passes through. Fig.2
Glycosuria	When urine has a high level of glucose, anything over 0.6 mg glucose/milliliter.
Hemoglobinuria	When there are high levels of free hemoglobin in the blood, usually a very low number.
Light Control	Located on the right side of the Spec 20, used to set the meter reading to zero

	absorbance on the right side of the meter, used for when 100% of light is transmitted. Fig.2
Light Production	Light of whichever wavelength that is set shone from the spec 20 through the sample. Fig.2
pH	Measure of the acidity or basicity of a solution.
pHYDRION paper	Brand of compound pH indicators. Indicates the pH of a liquid dripped on it by changing color.
Proteinuria	An excess of serum proteins in the urine. Normal urine contains about 0.3 mg of albumin per millimeter.
Sample Holder	The slot on the top left side of the spec 20 that is where you place the test tube with the liquid that you want to find the absorbance of. Fig.2
Spectronic 20	B&L Spectronic 20 Spectrophotometer, tool used to find the absorbance of a sample by shining a light through it of a specific wavelength. Fig.2
Test Tube	Glass or plastic tube used to contain liquid is open at the top and u shaped on the bottom.
Urinalysis	An array of tests performed on urine, for medical diagnosis.
Wavelength Control	The top screen on the Spec 20 that indicates at which wavelength, in nanometers, that the light it produces is. Fig.2

Laboratory 3

Term	Comments
Buffer	Liquid with a pH of 8.0, added to the test tubes in the enzyme experiment.
Catalyze	Reagent that change the rate of the chemical reaction but are not used up in that reaction themselves.
Enzyme	A protein that increases the speed of rate of chemical reactions.
Inhibitor	A substance that binds to an enzyme and decreases the enzyme's activity
Inorganic Phosphate	H3PO4, one of the resulting chemicals when pNPP reacts with water, the other is pNP. Used as an inhibitor in the enzyme experiment.
Phenyl Phosphate	Used as an inhibitor in the enzyme experiment.
Phosphate	A group of enzyme that catalyzes the removal of phosphate groups from other molecules. Alkaline phosphate is used as the enzyme in this experiment.
pNP	p-Nitrophenol, one of the resulting chemicals when pNPP reacts with water. The other is inorganic phosphate. Yellow in color
pNPP	p-Nitro-Phenyl Phosphate, the substrate used in the enzyme reaction experiment. Colorless
Rate	Change in some quantity per time.
Sodium	Inhibitor added to some test tubes in the enzyme experiment
Substrate	A substance that is acted on by an enzyme

Laboratory 4

Term	Comments
Diakinesis	Part five of Prophase I, chromosomes become shorter, still repel and the nuclear envelope breaks. Fig.3
Diplotene	Part four of Prophase I, chromosomes repel. Fig.3
Karyotyping	Tool used for counting and viewing chromosomes. Fig.4
Klinefelter Syndrome	A abnormality in the number of sex chromosomes, XXY. Fig.4
Leptotene	Part one Prophase I, chromosomes start to become visible and condense. Fig.3
Meiosis	Type of cell division necessary for sexual reproduction, unlike mitosis, these chromosomes recombine. Fig.3
Pachytene	Part three of Prophase I, Chromosomes are fully synapse along length, forming a tetrad. Fig.3
Tetraploid	Having four copies of chromosomes Fig.3
Tripple-X	A abnormality in the number of sex chromosomes, XXX. Fig.4
Turner Syndrome	A abnormality in the number of sex chromosomes, XO. Fig.4
XYY Karyotype	A abnormality in the number of sex chromosomes, XYY. Fig.4
Zygote	A single cell that develops into a new organism Fig.3
Zygotene	Part two of Prophase I, Homologous chromosomes begins to pair. Fig.3

2. System Requirements

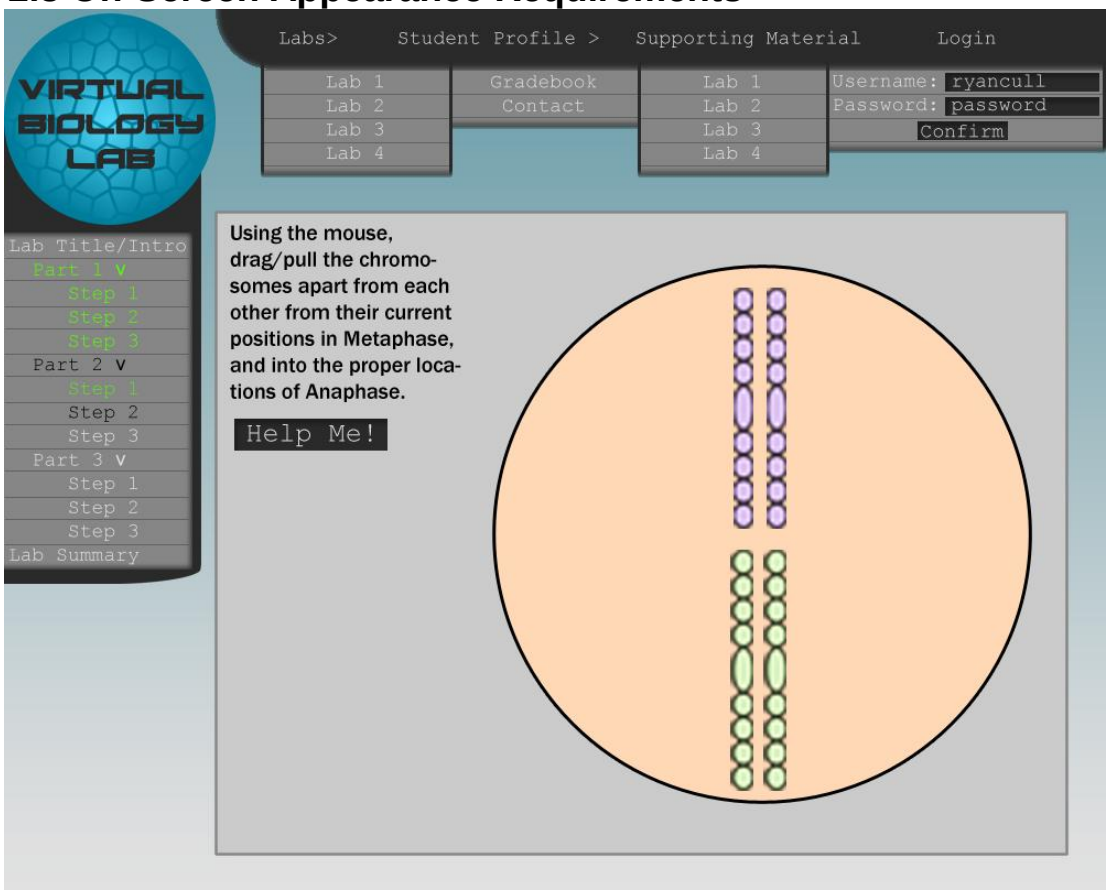
2.1 Enumerated Functional Requirements

Number	PW	Requirement
1	3	The system shall allow the students to register, log in, view their grade, change account settings, and complete five virtual biology laboratory experiments.
2	3	The system shall allow the professors to register, log in, create and edit sections, add information to be shared over the addition information section and view the grades of all students associated with their sections.
3	5	The system shall simulate the four main steps of mitosis and meiosis. Each step will be illustrated with a cell and a picture showing exactly what the chromosomes would be placed and look like within that cell. These images will be similar to the diagrams shown in the customer statement of requirements and will be accompanied by an explanation of each step in great detail. The transition from each stage will be animated.
4	5	The system shall allow for a student to prepare a slide by cutting the tip off of an onion root, adding drops of dye solution and then covering this with the cover slip. The system shall then allow the student to view this under a microscope. All of these steps will be animations prompted by the student.
5	4	The system shall allow for a student to prepare six test tubes for Laboratories two and three. Within these test tubes must be placed distilled water, Enzyme, Substrate, Urine, Glucose, Reagent, Buffer, Phenylphosphate, Inorganic phosphate or Sodium. Once the test tube is full, the system shall all for a student to take a drop from that test tube to be placed on a piece of pH paper, therefore testing the pH of the solution. All of these additions to the test tube or testing for its pH will be animations prompted by the student.
6	4	The system shall simulate the calibration and use of the Spectronic 20 spectrophotometer. This includes inserting a blank or sample test tube, adjusting setting and then reading the wavelength shone through the sample test tube.
7	4	The system shall provide a hypothetical chromosome karyotype and allow for the students to review this karyotpye and click on the irregular chromosomes, this will draw a circle around the abnormalities and show a description of what genetic disorder this abnormality would cause.
8	1	The system shall give a quiz after the student’s completion of each laboratory, asking the student to correctly answer 5 to 10 questions.
9	1	The system shall instantly record the grade the student received, based on the requested way of scoring the professor has chosen, and updating both the student’s grade book and the statistics the professor sees on the class.

2.2 Nonfunctional Requirements

Identifier	PW	Requirement
10	1	System should prohibit students from viewing other student grades, with clear differentiation between student and instructor. (Permissions)
11	3	System should randomize question order and answer order to prevent cheating from occurring.
12	5	System should store student grades into a secure database. Preferably MySQL.

2.3 On-Screen Appearance Requirements



This image shows an example of what one of the steps of the lab may look like. The only difference between this and the final product is that the drop down menus will not always be in their expanded state. These drop downs are shown to make it easier to grasp the descriptions below in the following paragraph and Section 4.2.

For a general overview of the layout, we will have a central navigation bar located on the top which will be used to access to the main subsections of the application. Under Labs, the student will be able to find a drop down listing all the labs that are currently available on the site. Under student profile we will allow the student to view a grade book of the assignments that they have completed and how they did on them. In Supporting materials, the professor of the lab can choose to link to other content which can assist the students in their completion of the labs. Finally the Login/Logout will link to a simple page (or dropdown item) allowing the student/ professor to access their personal account. Further, professors will have an option when logged in to view different content than a student would. For example, “Student Profile” would be changed to give the teacher access to information about all the students who are registered for the course.

3. Functional Requirement Specifications

3.1 Stakeholders

There are two main stakeholders in the Virtual Biology Laboratory. The first is the professor for the course and second are the students currently enrolled in that course. The professor's main purpose for this program is to provide more learning opportunities for his or who students and receive a current report on the time and effort each student has put into using the program. The students' purpose for this program is to reinforce what they have learned in lecture and laboratory.

3.2 Actors and Goals

There are two primary actors (human) and one secondary actor (virtual) in the Virtual Biology Lab. The two primary actors are the student and the professor.

The goal of the student is to learn about various biology topics through interactive lab demos (modeled in Flash) and use this knowledge to complete graded quizzes based on these demos. The student can also check his grades immediately after taking a quiz using a Grade book applet. The professor can use the system to monitor student activity and view/adjust their grades.

The secondary actor in the lab is the MySQL database that holds all the information including student data and grades. It's primary goal is to interface with the main website and provide information to the primary application and its users when needed.

3.3 Use Cases

3.3.1 Casual Description

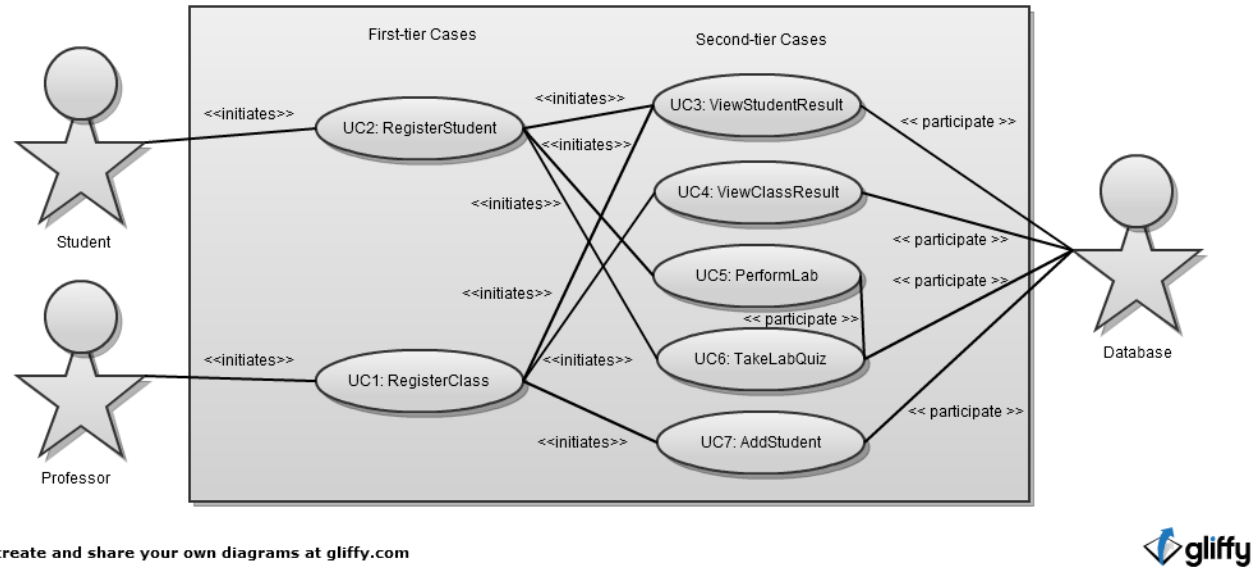
The general use case of the Virtual Biology Lab entails the instructor being able to create course sections and associate any number of students to each. The student is then responsible for registering and completing all virtual laboratory experiments. Upon completion of the lab, students will gain access to a quiz on the material they have covered. These quizzes are automatically graded and both the instructor and student will be able to view the results.

Students will be able to register and log in to their accounts to change their settings, view their grades, view lab information and select labs (REQ 1). After registering, instructors can log in to update and create classes and view student grades (REQ 2). As a lab, the program will simulate the main steps in mitosis and meiosis with graphics, interaction and descriptions (REQ 3). Another lab will simulate a student slicing the tip of an onion and performing the necessary steps to view it under a microscope (REQ 4). The third lab will show different biological elements and allow the student to demonstrate the skills required to measure the pH level for each (REQ 5). The fourth lab will demonstrate to students how to use a spectrophotometer (REQ 6). The last lab will provide hands-on analysis to a hypothetical chromosome karyotype and show irregularities (REQ 7). The labs mentioned above must be taken in order but do not need to be taken all at once. They will be presented in such a way that the student will view and perform the lab, and subsequently take a quiz on the material covered (REQ 8). If the student decides to drop out (or closes the window) prior to the completion of a lab, their progress will be saved so they can continue at a later time. However, if a student drops out (or closes the window) after beginning a quiz, they will not be able to return to it later and will not get any credit for the quiz. When a student's solution is submitted, the system will automatically grade their quiz and then place it in the system for their overall grade calculation (REQ 9).

In terms of flow and use cases, the first use case is involves an instructor creating a new section where students will be able to register to (UC 1, RegisterClass). They will also have the ability to add additional students to a preexisting section after its creation (UC 7, AddStudent). Student can register for these lab sections only after an instructor has created them (UC 2,

RegisterStudent). Students and instructors will also be able to view grades and their overall grade (UC4, ViewClassResult). Students must perform each lab accordingly (UC 5, PerformLab inc. [Sub-modules 1-4]). After every lab, they must perform and answer a quiz to get graded on (UC 6, TakeLabQuiz).

3.3.2 Use Case Diagram



3.3.3 Fully-Dressed Description

Below show the actual instructions and abilities each actor can perform, mostly in order. These are referred to as “Use Cases”. However, these “Use Cases” depend on many other abilities that tend to be repeated and have different associations of each other. We refer to these as “Sub-modules”. Note that these “Sub-modules” can be called upon in no specific order and are shown depending on the permitted functions listed in the “Use Cases” and can also be called at any given time.

Use Case #1 RegisterClass
Related Requirements: REQ1 REQ2 **Initiating Actor:** Instructor **Actor’s Goal:** Associate the instructor and specified students to a new section **Participating Actors:** **Preconditions:** - **Postconditions:** The database contains information about the new section **Flow of Events for Main Success Scenario:** -> 1. Instructor inputs the section number and student NetID’s to associate with it <- 2. The system database is updated to contain all of this information <- 3 The system notifies the students that they can now register **Flow of Events for Extension (Alternate Scenario):** -> 1. Instructor inputs the section number and student NetID’s to associate with it <- 2. System detects errors in input, prompts instructor to re-enter data

Test-case Identifier: TC-1 **Use Case Tested:** UC-1, main success scenario **Pass/fail Criteria:** The test passes if the instructor enters an acceptable number of students [1-1000] to an acceptable section (not previously created) Input Data: **Student NetID(s), section number**	
Test Proceedure	**Expected Result**
Step 1: Enter an invalid number of students to add. (less than 1 or greater than 1000)	System pops up with an error; informs the Instructor that the number of students entered is invalid
Step 2: Enter in a valid number of students to add with an invalid section number.	System pops up with an error; informs the Instructor that they have entered an invalid section number
Step 3: Enter in a valid number of students to add and a valid section number.	System adds students and their associated section number to the database; sends the instructor to a page confirming that the students have been added

Use Case #2 RegisterStudent

Related Requirements: REQ1 REQ2
Initiating Actor: Student
Actor's Goal: Register their information in the correct section number
Preconditions: The instructor has provided the information on who should be in each section
Postconditions: The system database contains the information about this student and shows that they have successfully registered.The student can view their grades and complete labs/quizzes

Flow of Events for Main Success Scenario:
-> 1. The student inputs their netID, username and password
2. The system checks that this netID corresponds with a section that the instructor has registered
<- 3. The system notifies the student that he/she registered successfully and that they can begin completing labs
<- 4. The system makes a change to the professors gradebook indicating that the student has successfully registered
Flow of Events for Extension (Alternate Scenario):
-> 1. The student inputs their netID, username and password
2. The system checks that this netID corresponds with a section that the instructor has registered.
<- 3. The system notifies the student that he/she is not enrolled in any section and informs the student that registration has failed.

Test-case Identifier: TC-2
Use Case Tested: UC-2, main success scenario
Pass/fail Criteria: The test passes if the student enters in a valid NetID, username, and password
Input Data: **Student NetID, student username, student password**

Test Proceedure	**Expected Result**
Step 1: Fail to enter data in all every field	System pops up with an error; informs the student that all three fields are required
Step 2: Enter data in to each field with an invalid username or password (not alphanumeric between 7-12 characters)	System pops up with an error; informs the student that they have entered an invalid username or password
Step 3: Enter data in to each field with a NetID which does not match with any in the database	System pops up with an error; informs the student that their NetID is not in the database
Step 4: Enter data in to each field with a NetID which has already been registered	System pops up with an error; informs the student that their NetID has already been registered; gives the student the e-mail address of the instructor associated with their section
Step 5: Enter data in to each field with a valid NetID which has not yet been registered	System associates username and password with specified NetID; denotes student as registered; sends the student to a page confirming that the registration process has been completed successfully; logs student in

Use Case #3 ViewStudentResult

Related Requirements: REQ1 and REQ2 REQ9
Initiating Actor: Instructor and Student
Actor's Goal: View the grade on every lab that a particular student has completed
Preconditions: The class and individual student has registered. The student has completed the lab. The instructor has selected to assign grades.
Postconditions: -

Flow of Events for Main Success Scenario:
-> 1. The student or instructor requests to see the students grades
<- 2. The system shows the gradebook for that particular student
Flow of Events for Extension (Alternate Scenario):
-> 1. The student or instructor requests to see the students grades
<- 2. The system shows the gradebook for that particular student, but no grades are in the database. System notifies user that there are no grades in the database.

Test-case Identifier: TC-3
Use Case Tested: UC-3, main success scenario (Instructor)
Pass/fail Criteria: Snters in a valid NetID for a student within one of their sections.

Input Data: **Student NetID**

Test Proceedure	**Expected Result**
Step 1: Fail to select a NetID	System pops up with an error; informs the instructor that a NetID was not selected
Step 2: Selects a valid NetID of a student in another instructor's section	System pops up with an error; informs the instructor that the specified student is not in their section
Step 3: Enters a valid NetID of a student in one of the instructor's sections	System associates sends instructor to the specified student's gradebook page

Use Case #4 ViewClassResult

Related Requirements: REQ1 REQ2 REQ9
Initiating Actor: Instructor
Actor's Goal: View the grades of every student in a particular section
Preconditions: The class and every student in it had registered. Students have completed the labs. The instructor has chosen to assign grades.
Postconditions: -

Flow of Events for Main Success Scenario:
-> 1. The instructor requests to see the class grades
<- 2. The system shows the gradebook and statistics on each section
Flow of Events for Extension (Alternate Scenario):
-> 1. The instructor requests to see the class grades
<- 2. The system shows the gradebook, but no grades are in the database. System notifies user that there are no grades in the database.

Test-case Identifier: TC-4
Use Case Tested: UC-4, main success scenario
Pass/fail Criteria: Selects a valid section that is associated with the instructor
Input Data: Section number

Test Proceedure	**Expected Result**
Step 1: Fail to enter a valid section number	System pops up with an error; informs the instructor that the section number is not valid
Step 2: Enters a valid section number associated with another instructor	System pops up with an error; informs the instructor that the specified section number is associated with another instructor
Step 3: Enters a valid section number associated with the instructor	System associates sends instructor to the specified section's gradebook page

Use Case #5 PerformLab

Related Requirements: REQ3, REQ4 REQ5 REQ6 and REQ7
Related Modules: Sub-module[1-4]
Initiating Actor: Student
Actor's Goal: The actor will enter the sub-modules stated above and complete them as according into the sub-module.
Postconditions: Sub-module is complete and student is now eligible to take quiz.

Flow of Events for Main Success Scenario:
-> 1. Student requests to perform one of the lab sub-modules
<- 2. System redirects student to webpage with interactive Flash demo for the lab
Flow of Events for Extension (Alternate Scenario):
-> 1. Student requests to perform one the lab sub-modules
<- 2. System redirects student to webpage with interactive Flash demo for the lab
-> 3. Student decides to leave sub-module before completion
4. System redirects user back to main page and saves the progress the student has made

Test-case Identifier: TC-5 **Use Case Tested:** UC-5, main success scenario (partially completed lab) **Pass/fail Criteria:** selects a Lab (submodule) which is not yet complete **Input Data:** Lab Selection	
Test Proceedure	**Expected Result**
Step 1: Selects a lab that the student has already completed	System pops up with an error; informs the student that they have already completed the selected lab
Step 2: Selects a lab that is not yet complete	System checks to see if student had previously begun the selected lab; sends student to the specified lab page wherever they had stopped previously
Step 3: Leaves lab before completion	System records the point at which the student left the lab

Test-case Identifier: TC-6 **Use Case Tested:** UC-5, main success scenario (new lab) **Pass/fail Criteria:** selects a Lab (submodule) which is not yet complete **Input Data:** Lab Selection	
Test Proceedure	**Expected Result**
Step 1: Selects a lab that the student has already completed	System pops up with an error; informs the student that they have already completed the selected lab
Step 2: Selects a lab that is not yet complete	System checks to see if student had previously begun the selected lab; sends student to the specified lab page at the beginning of the lab; upon completion, records the lab as complete in the database

Use Case #6 TakeLabQuiz

Related Requirements: REQ8
Related Modules: Sub-module[1-4]
Initiating Actor: Student
Actor's Goal: The actor will receive a randomized quiz on the material presented in a sub-module for grading.
Preconditions: The student has completed the associated lab but not yet completed the quiz
Postconditions: The system database contains the grade this student received for this quiz

Flow of Events for Main Success Scenario:
-> 1. Student performs sub-module and has completed it
<- 2. System redirects student to webpage with randomized quiz questions pertaining to the particular sub-module they have just completed
-> 3. Student fills out quiz and submits for grading
<- 4. System records grade in gradebook database
Flow of Events for Extension (Alternate Scenario):
-> 1. Student performs sub-module and has completed it
<- 2. System redirects student to webpage with randomized quiz questions pertaining to the particular sub-module they have just completed
-> 3. Student fills out quiz and decides to leave page before submitting or submits without all answers filled in
<- 4. System prompts user that any unfinished questions will be graded, asks if they want to submit/leave page or resume answering quiz
-> 5. Student makes choice

Test-case Identifier: TC-7
Use Case Tested: UC-6, main success scenario
Pass/fail Criteria: selects a Quiz (submodule) which has not been completed yet but whose Lab has been
Input Data: Quiz Selection

Test Proceedure	**Expected Result**
Step 1: Selects a quiz that the student has already completed	System pops up with an error; informs the student that they have already taken the selected quiz
Step 2: Selects a quiz associated with a lab which the student has not yet completed	System pops up with an error; informs the student that they have not yet completed the associated lab
Step 2: Selects a quiz which the student has not yet taken that is associated with a lab which the student has successfully completed	System sends student to the appropriate quiz page; presents the student with a randomized quiz; upon completion, grades the quiz; stores quiz results in the database; records that the student has taken the quiz

Use Case #7 AddStudent

Related Requirements: REQ1 REQ2
Initiating Actor: Instructor
Actor's Goal: Associate a new student with a preexisting section
Participating Actors:
Preconditions: The database contains information about the supplied section
Postconditions: The database includes information about the new student associated with the specified section

Flow of Events for Main Success Scenario:
-> 1. Instructor inputs the section number and student NetID's to associate with it
<- 2. The system database is updated to contain all of this information
<- 3 The system notifies the students that they can now register

Flow of Events for Extension (Alternate Scenario):
-> 1. Instructor inputs the section number and student NetID's to associate with it
<- 2. System detects errors in input, prompts instructor to re-enter data

Test-case Identifier: TC-8
Use Case Tested: UC-7, main success scenario
Pass/fail Criteria: adds a student to a section the instructor is associated with
Input Data: Student NetID(s), section number

Test Proceedure	**Expected Result**
Step 1: Enter an invalid number of students to add.	System pops up with an error; informs the Instructor that the number of students entered is invalid
Step 2: Enter in a valid number of students to add with an invalid section number.	System pops up with an error; informs the Instructor that they have entered an invalid section number
Step 3: Enter in a valid number of students to add and a valid section number.	System adds students to the specified section in to the database; sends the instructor to a page confirming that the students have been added to the section

Use Case #8 Lab1CellDivision

Related Requirements: REQ3 REQ4
Initiating Actor: Student
Actor's Goal: To Complete laboratory one
Participating Actors:
Preconditions: The student is registered and has selected to do this lab
Postconditions: The database has kept track that the student completed this laboratory and can now take the quiz

Flow of Events for Main Success Scenario:

1. Animate Interphase
2. Transition to Prophasee
3. Transition to Metaphase
4. Transition to Anaphase
5. Transition to Telophase
6. Show Plant Cells
7. Show Animal cells
8. Remove bottom 2 to 3 mm of the the onion root.
9. Place 2-3 drops of dye solution over the tip.
10. Heat gently on warm hotplate for one minute.
11. Press down on the cover slip, squashing the sample.
12. Look at slide and compare to sample to figure out which stage of Mitosis it is in.

Flow of Events for Extension (Alternate Scenario):

1. Incorrect user interaction (ie. wrong answer) will result in a pop up saying "Sorry, try again"
2. If user is repeatedly wrong a hint may be offered pending on the step.

Use Case #9 Lab2BioMolecules

Related Requirements: REQ5 REQ6
Initiating Actor: Student
Actor's Goal: To Complete laboratory two
Participating Actors:
Preconditions: The student is registered and has selected to do this laboratory and finished lab 1
Postconditions: The database has kept track that the student completed this laboratory and can now take the quiz

Flow of Events for Main Success Scenario:

1. Testing for ph balance Place 9 squares of pHYDRION paper in a row
2. One drop of pH 7.0 on one square, pH 4.0 on four squares and pH 10.0 on four squares. Compare all of these colors to the guide.
3. One drop of each persons urine on each of the 6 square left. Record results.
4. Assay for Glycosuria Make BLANK test tube with 1 mL of water and 1 mL of DNS
5. Make STANDARD test tube with 1 mL of glucose and 1 mL of DNS
6. Make 6 test tubes each with 1mL of a patients urine and 1 mL of DNS
7. boiling bath for five minutes
8. Add 8 mL of distilled water and seal each tube.
9. Set Spec20, set at 540 nm, and find the absorbance of each tube. Record Results
10. Assay for Proteinuria Add 1 mL of each patients to 6 different test tubes.
11. Add 4 mL of biuret reagent to each.
12. Set Spec20, set at 540 nm, and find the absorbance of each tube.

13. Compare these results to the graph of the absorbance of different amounts of protein
14. Assay for Hemoglobinuria observe each sample for brownish-red presence, or hemoglobin

Flow of Events for Extension (Alternate Scenario):

1. Incorrect user interaction (ie. wrong answer) will result in a pop up saying “Sorry, try again”
2. If user is repeatedly wrong a hint may be offered pending on the step.

Use Case #10 Lab3EnzymeActivity

Related Requirements: REQ5 REQ6
Initiating Actor: Student
Actor’s Goal: To Complete laboratory three
Participating Actors:
Preconditions: The student is registered and has selected to do this laboratory and finished lab 1 and lab 2
Postconditions: The database has kept track that the student completed this laboratory and can now take the quiz

Flow of Events for Main Success Scenario:

1. Prepare BLANK test tube
2. Add 4 mL of buffer and 1 mL of pNPP solution to test tube 1
3. Add 4 mL of buffer to test tube 2
4. Add 3 mL of buffer and 1 mL of pNPP solution to test tube 3
5. Add 2 mL of buffer and 1 mL of pNPP solution and sodium to test tube 4
6. Add 2 mL of buffer and 1 mL of pNPP solution and inorganic phosphate to test tube 5
7. Add 2 mL of buffer and 1 mL of pNPP solution and phenyl phosphate to test tube 6
8. Start reaction by adding 1.0 mL of enzyme to tubes 2 trough 6. Cover and mix.
9. Place tube 3 in the Spec 20, at 415 nm, and wait till the absorbance equals between 3.0 and 4.0, record the time that has elapsed.
10. then quickly read all the other tubes from 6 to 1, rereading tube 3
11. Prepare BLANK test tube
12. Add 2.0 mL of undiluted enzyme into test tube 1.
13. Add 1 mL of distilled water and 1 mL from test tube 1 into test tube 2.
14. Add 1 mL of distilled water and 1 mL from test tube 2 into test tube 3
15. Add 1 mL of distilled water and 1 mL from test tube 3 into test tube 4
16. Add 1 mL of distilled water and 1 mL from test tube 4 into test tube 5
17. Add 1 mL of distillled water to test tube 6
18. Add 3.0 mL of buffer, pH 8 to each test tube (except blank), mix thoroughly
19. To start the reaction: add 1.0 mL of substrate to each test tube and mix thoroughly
20. Immediately determine absorbance A using the spec 20 at 415 nm
21. redetermine the absorbances for each tube after 5 minutes

Flow of Events for Extension (Alternate Scenario):

1. If user attempts to continue in the lab with an incorrect solution in a test tube, the user will be notified “Please remake the solution in test tube X and begin again”. Solution will be manually dumped.
2. If user acknowledged solution is incorrect before attempting to continue they will be able to manually dump and remake the solution.

Use Case #11 Lab4Meiosis

Related Requirements: REQ3 REQ7
Initiating Actor: Student
Actor's Goal: To Complete laboratory four
Participating Actors:
Preconditions: The student is registered and has selected to do this laboratory and finished lab 1, lab 2 and lab 3
Postconditions: The database has kept track that the student completed this laboratory and can now take the quiz

Flow of Events for Main Success Scenario:

1. Animate Prophase I: Leptotene, Zygotene, Pachytene, Diplotene, Diakinesis
2. Transition to Metaphase I
3. Transition to Anaphase I
4. Transition to Telophase I
5. Transition to Prophase II
6. Transition to Metaphase II
7. Transition to Anaphase II
8. Transition to Telophase II
9. VBL will provide you with a hypothetical chromosome spread
10. Student clicks to circle every chromosome
11. Identify the chromosomes from the guide, and write the number under it
12. Identify if there are any abnormalities listed below
    - XO = Turner Syndrome
    - XXX = Tripple-X
    - XXY = Klinefelter Syndrome
    - XYY = XYY Karyotype
    - Trisomy 13 - Patau Syndrome
    - Trisomy 18 - Edwards Syndrome
    - Trisomy 21 - Down Syndrome
    - 14/21 translocation - normal carrier for down syndrome/inherited down syndrome
    -

Flow of Events for Extension (Alternate Scenario):

1. Incorrect user interaction (ie. wrong answer) will result in a pop up saying "Sorry, try again"
2. If user is repeatedly wrong a hint may be offered pending on the step.

3.3.4 System Requirements - Use Case Traceability Matrix

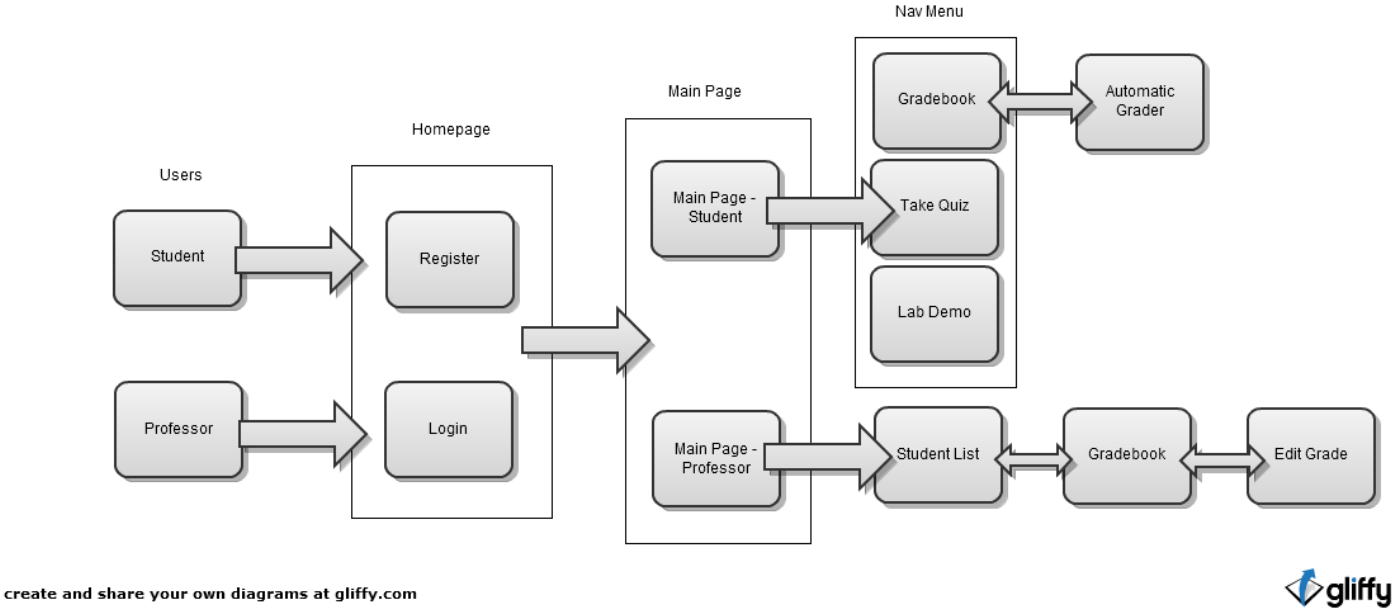
All users including students and professors will require a standard web browser, preferrably Firefox or Google Chrome. This allows all and any operating systems to use our application. Each browser must support the Flash Plugin in order to view any of the virtual labs. Please see the Adobe Flash website for more information.

The application server must have a standard HTTP server (preferable Apache or Lighttpd), PHP 5.1 or greater, and MySQL. The standard requirements for these products should run under Linux with sufficient hardware resources to handle these light weight applications.

Req't	**PW**	UC1 - RegisterClass	UC2 - RegisterStudent	UC3 - View StudentResult	UC4 - ViewClassResult	UC5 - PerformLab	UC6 - TakeLabQuiz	UC7 - AddStudent	UC8- Lab1CellDivision	UC9- Lab2BioMolecules	UC10- Lab3EnzymeActivity	UC11- Lab4Meiosis
REQ1	3	X	X	X	X			X				
REQ2	3	X	X	X	X			X				
REQ3	5					X			X			X
REQ4	5					X			X			
REQ5	4					X				X	X	
REQ6	4					X				X	X	
REQ7	4					X						X
REQ8	1						X					
REQ9	1			X	X							
Max pw	5	3	3	3	3	5	1	3	5	4	4	5
Total pw	36	6	6	7	7	26	1	6	10	8	8	9

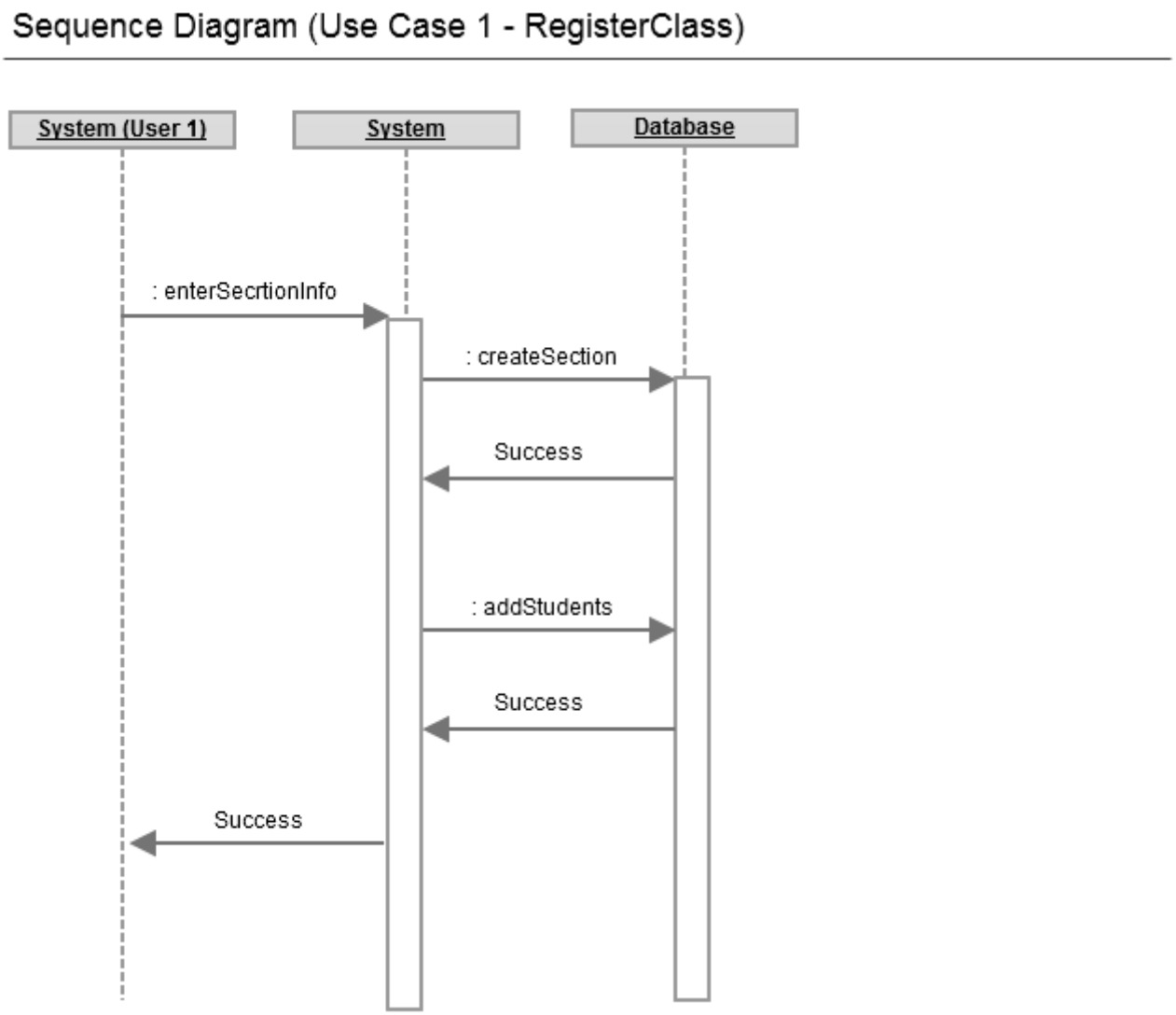
3.4 System Sequence Diagrams

Overview of Entire System:

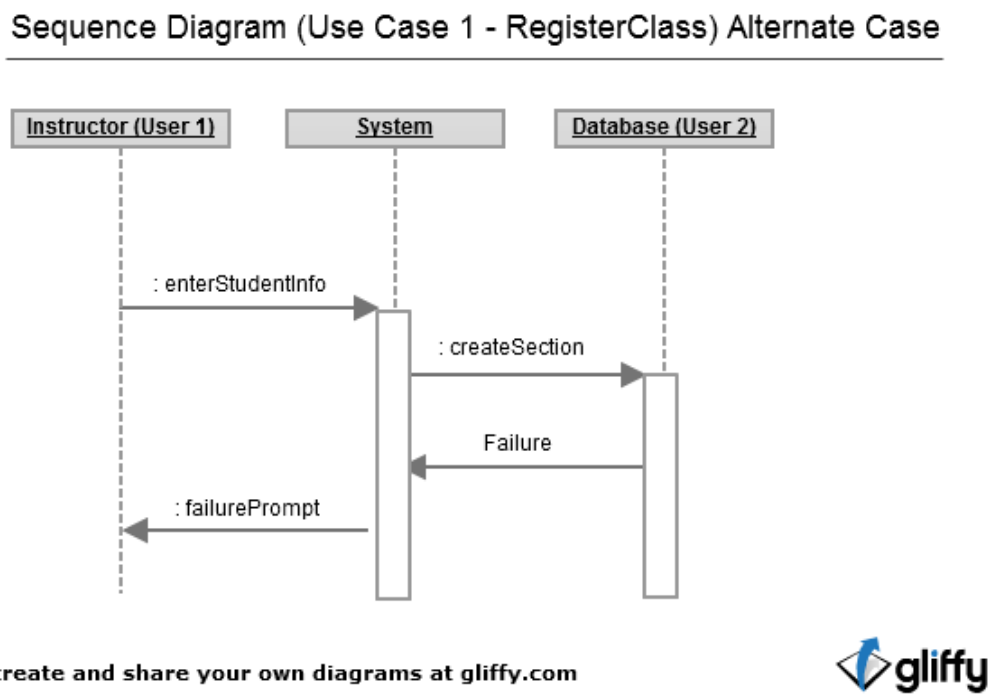


Use Case 1 (RegisterClass) Sequence Diagrams:

Success Case:

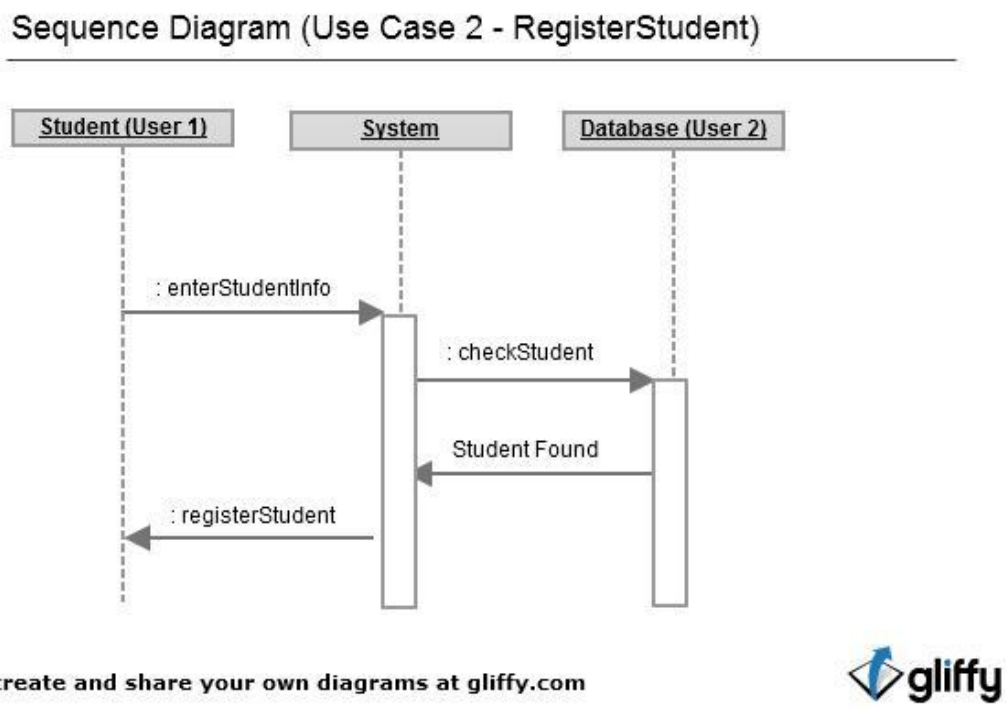


Alternate (Failure) Case:



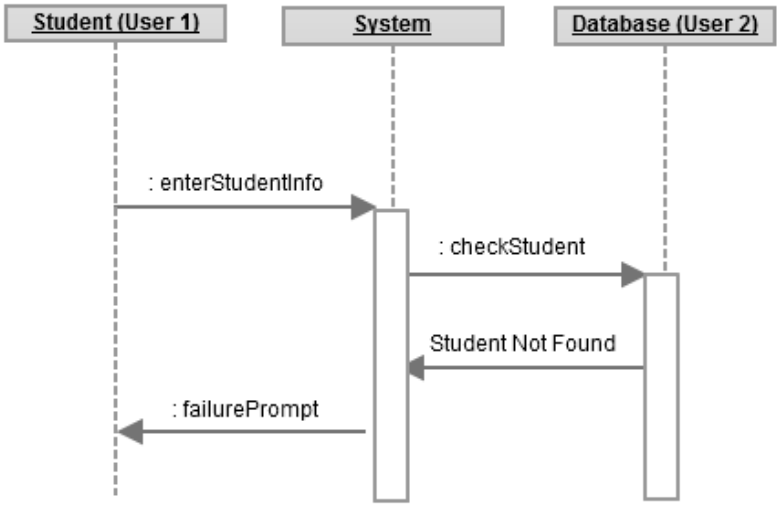
Use Case 2 (RegisterStudent) Sequence Diagrams:

Success Case:



Alternate (Failure) Case:

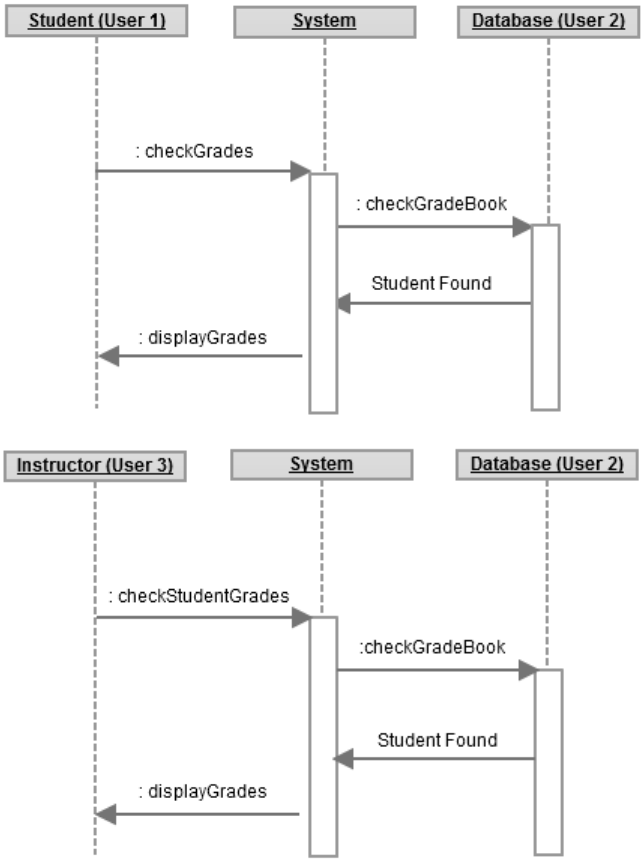
Sequence Diagram (Use Case 2 - RegisterStudent) Alternate Case



create and share your own diagrams at gliffy.com

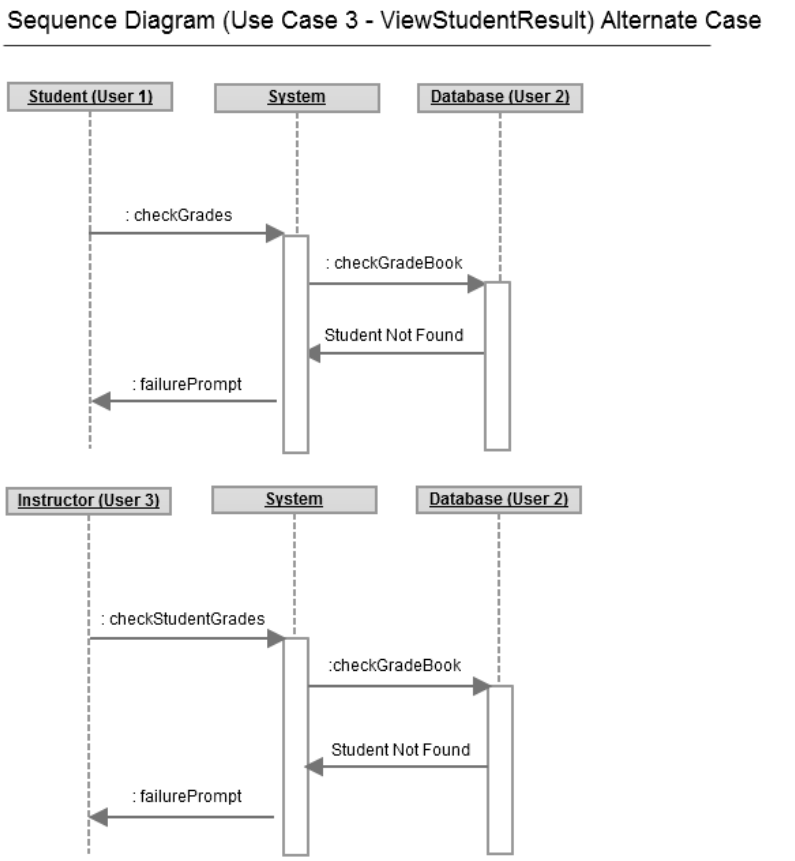
Use Case 3 (ViewStudentResult) Sequence Diagrams:
Success Case:

Sequence Diagram (Use Case 3 - ViewStudentResult)



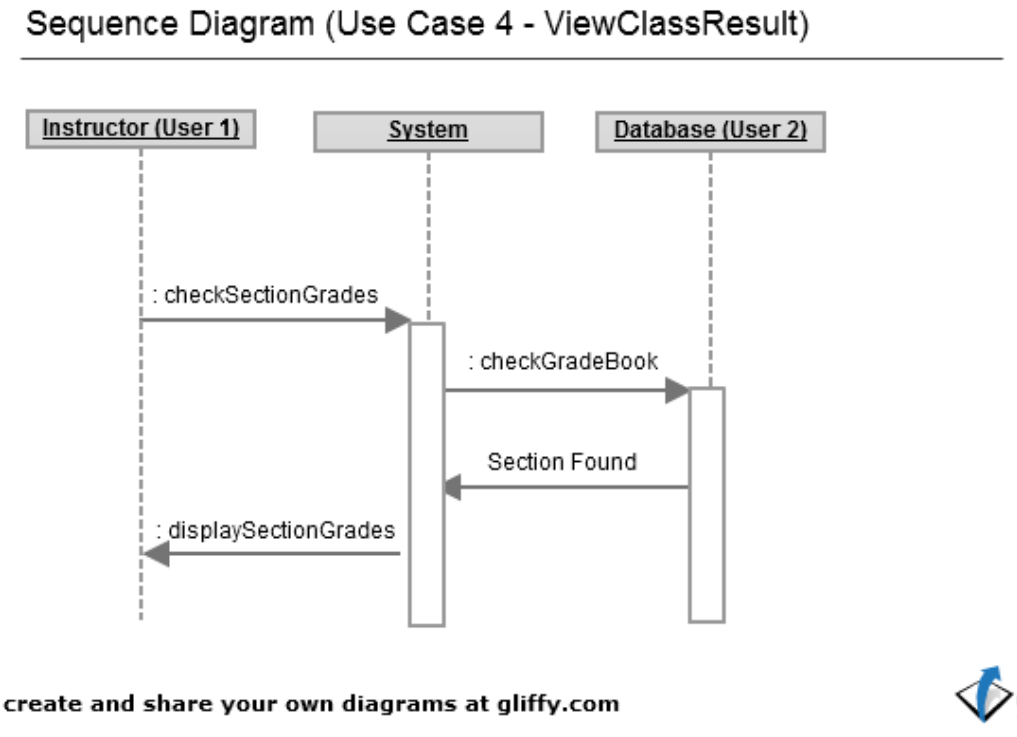
create and share your own diagrams at gliffy.com

Alternate (Failure) Case:

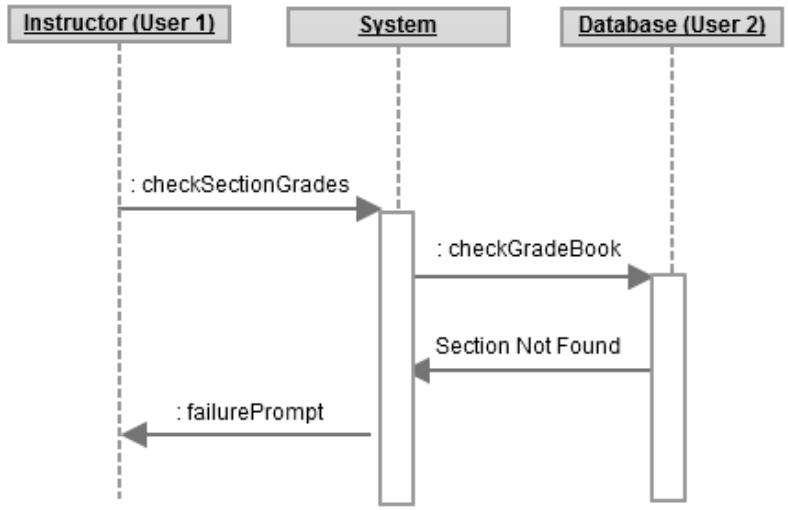


Use Case 4 (ViewClassResult) Sequence Diagrams:

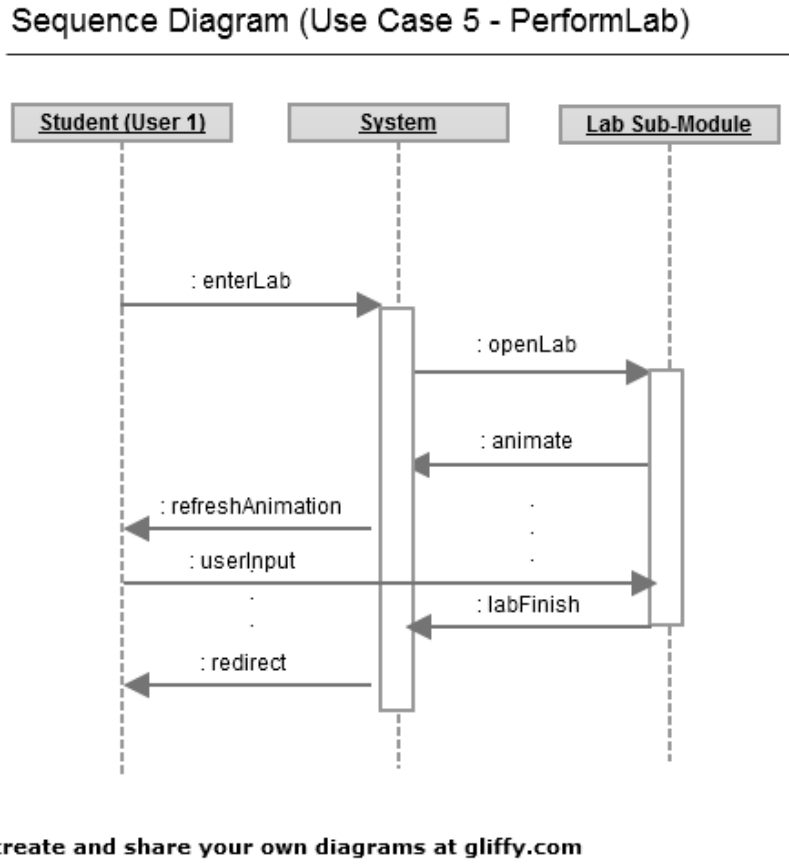
Success Case:



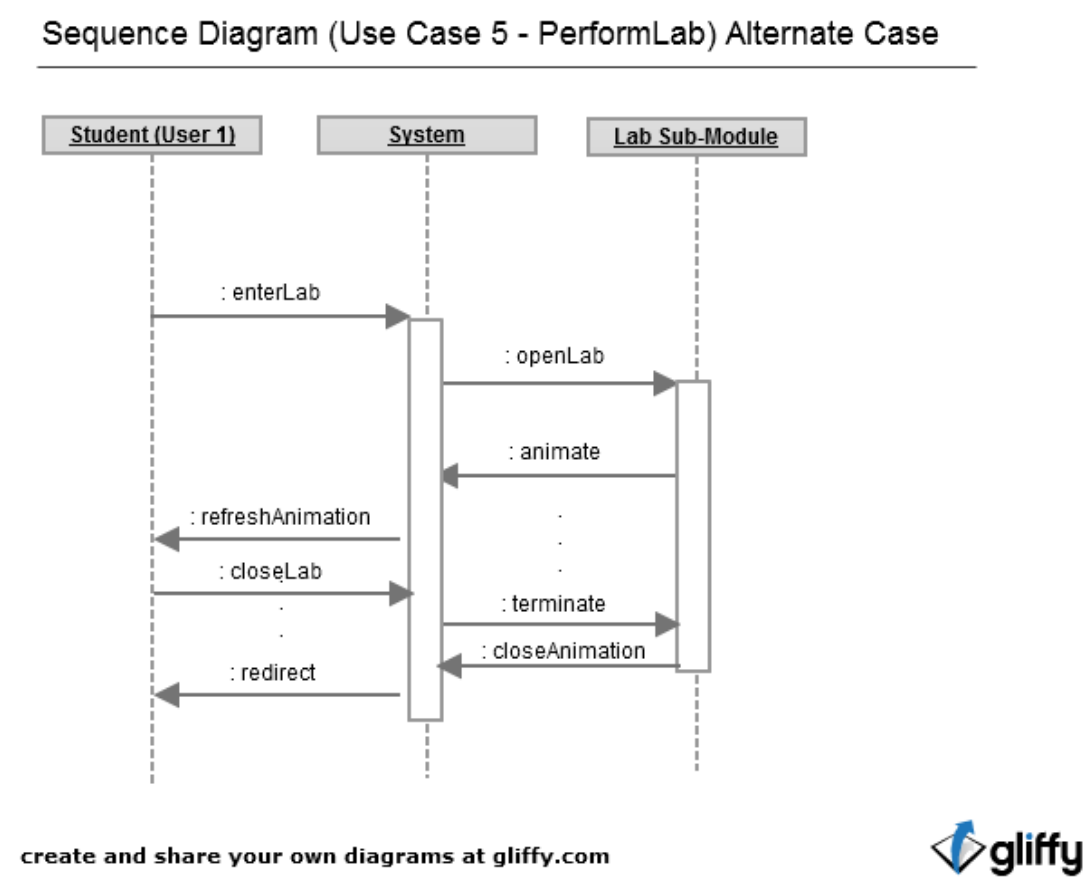
Alternate (Failure) Case:



Use Case 5 (PerformLab) Sequence Diagrams:
Success Case:

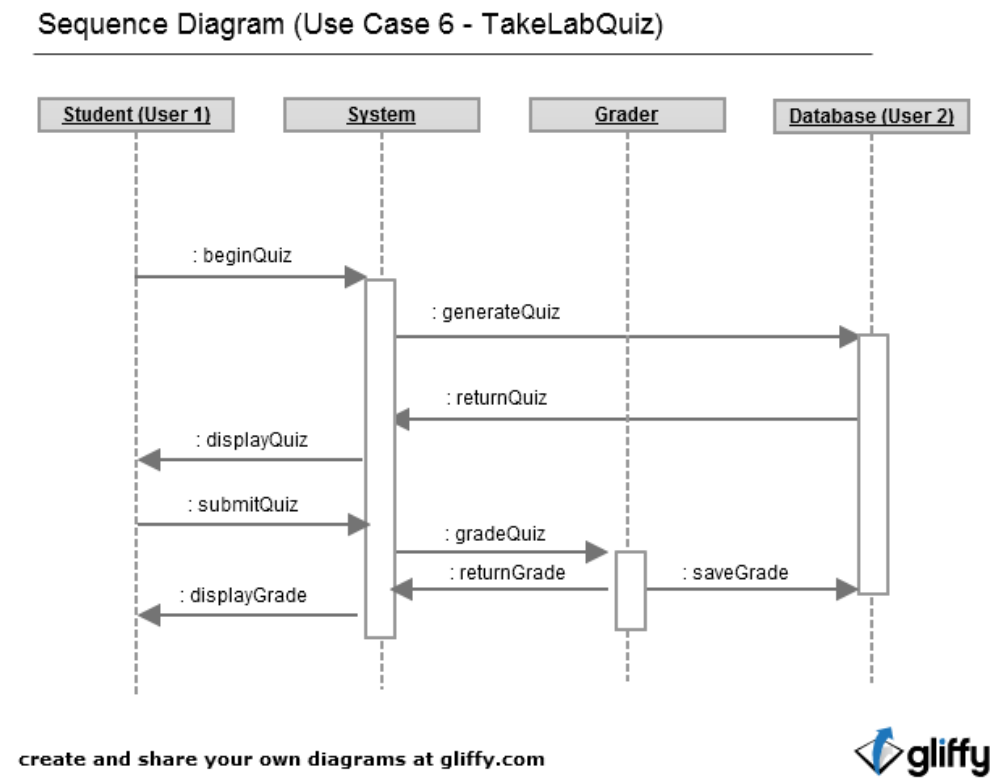


Alternate Case:

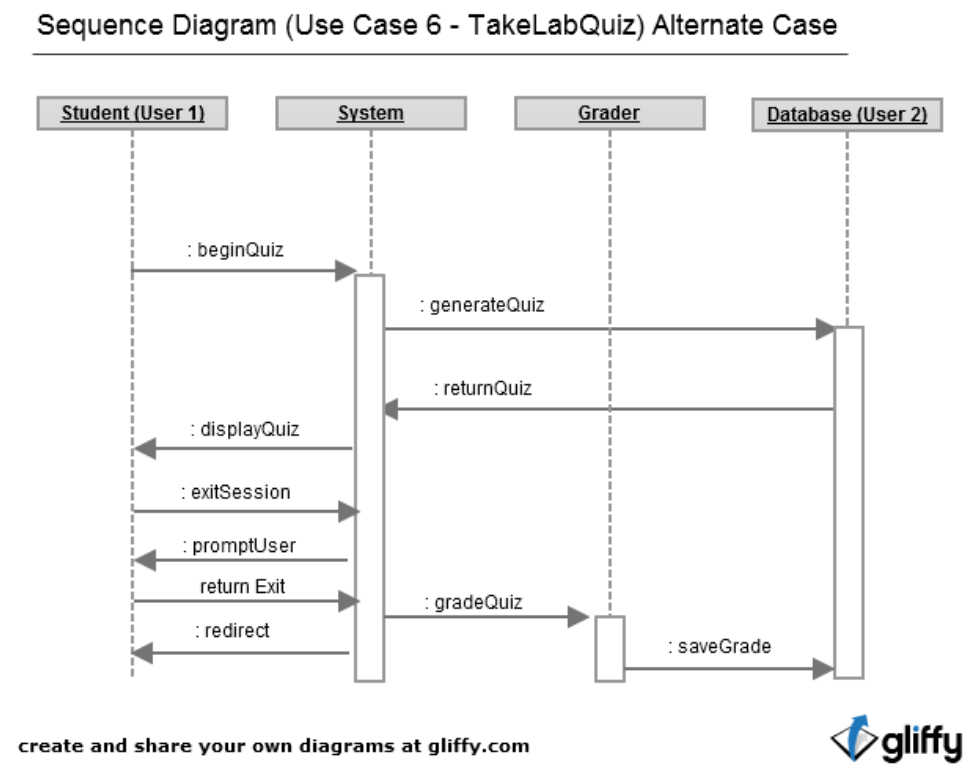


Use Case 6 (TakeLabQuiz) Sequence Diagrams:

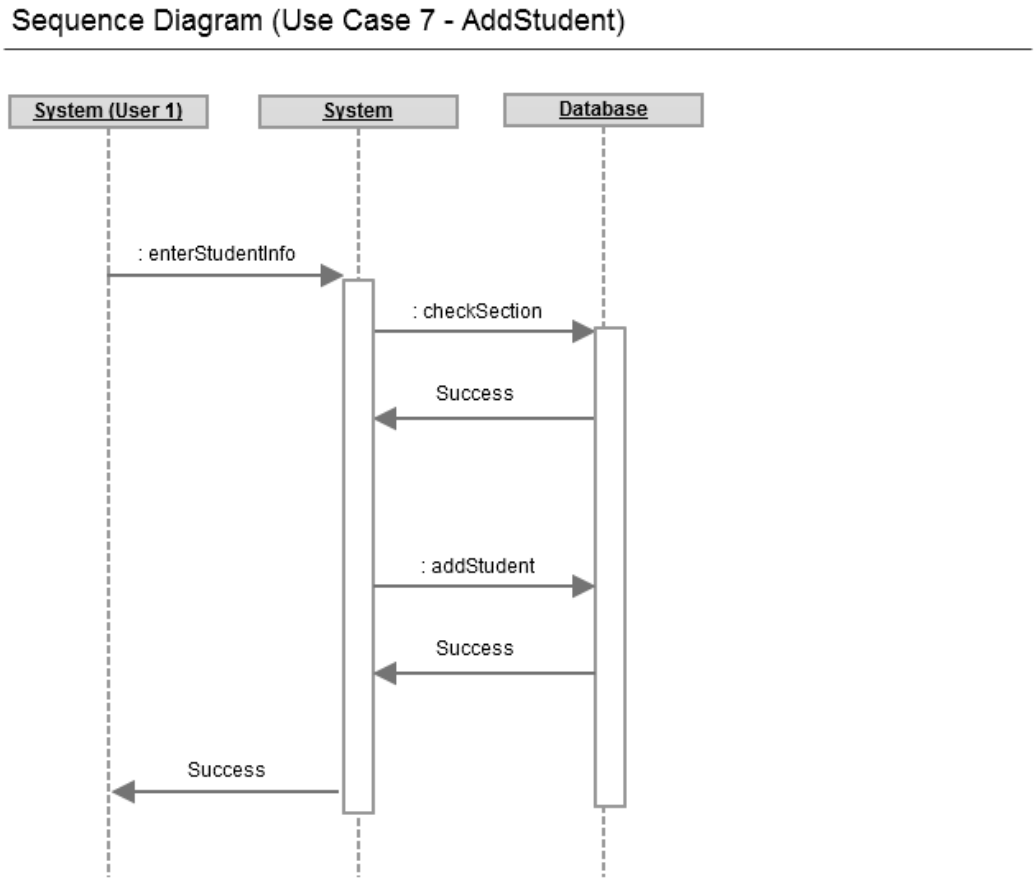
Success Case:



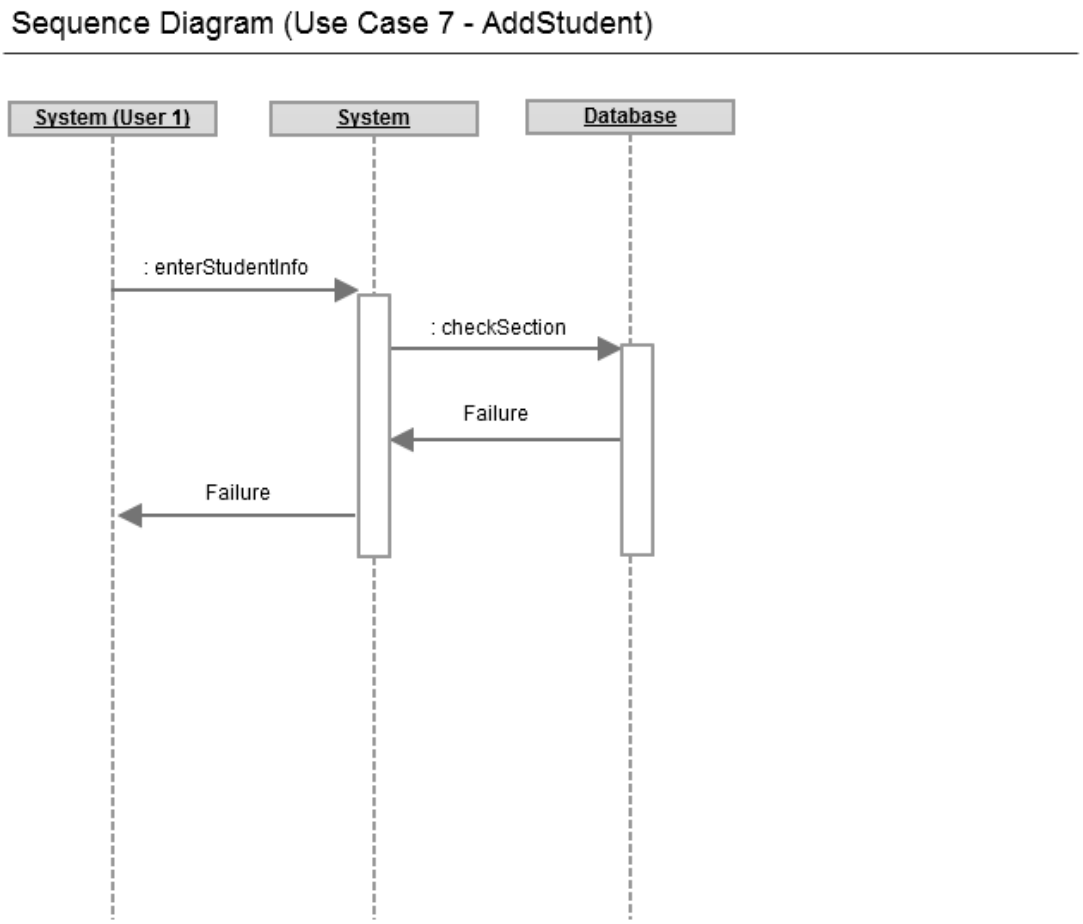
Alternate (Failure) Case:



Use Case 7 (AddStudent) Sequence Diagrams:
Success Case:



Alternate (Failure) Case:



4. User Interface Specification

4.1 Preliminary Design

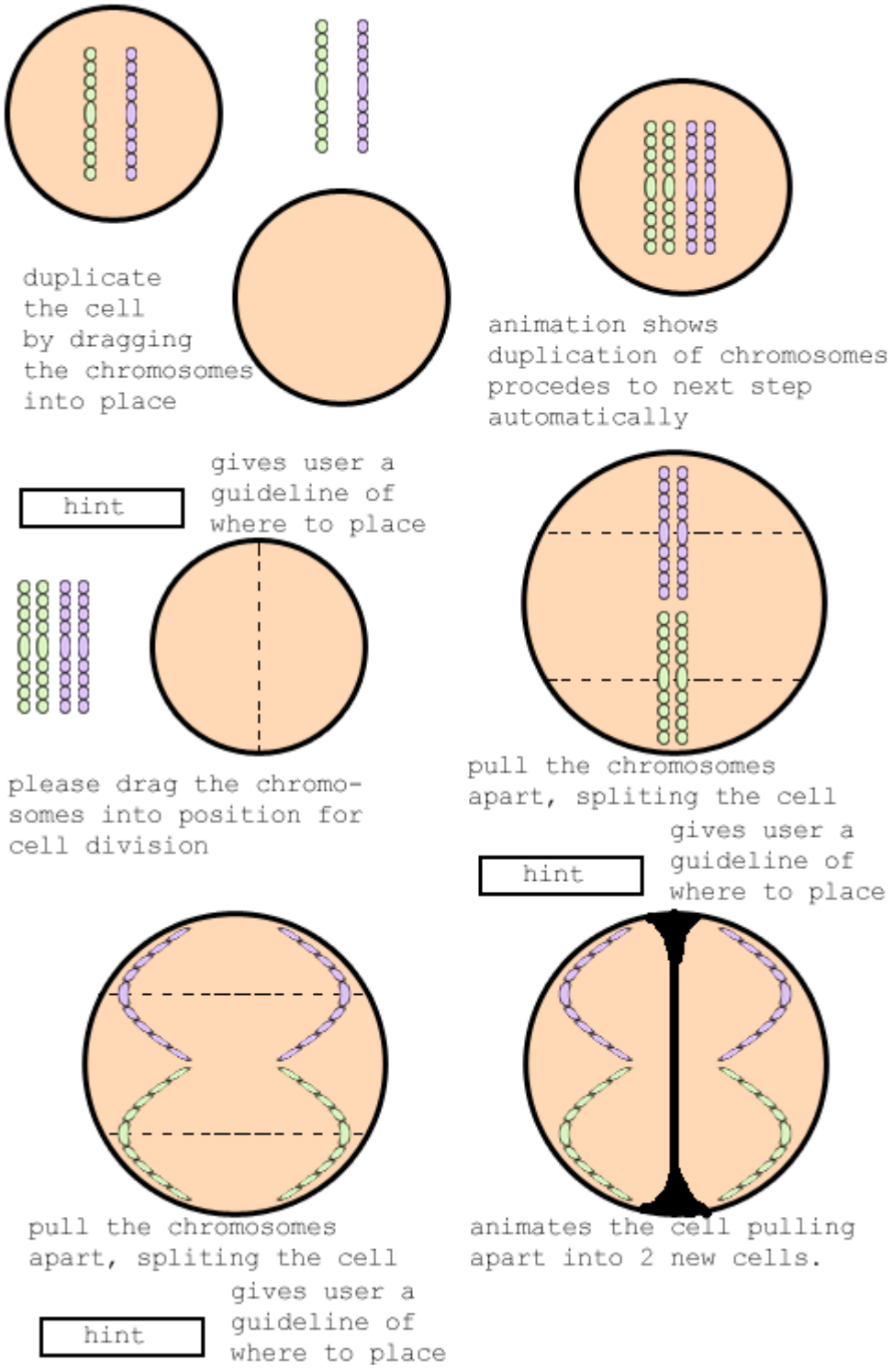
A description of the functionalities is listed in the text of the layout design. To see a full size image go to http://img638.imageshack.us/img638/2407/virtualbiolablayout4.jpg

For a general overview of the layout, we will have a central navigation bar located on the top which will be used to access to the main subsections of the application. Under Labs, the student will be able to find a drop down listing all the labs that are currently available on the site. Under student profile we will allow the student to view a grade book of the assignments that they have completed and how they did on them. In Supporting materials, the professor of the lab can choose to link to other content which can assist the students in their completion of the labs. Finally the Login/Logout will link to a simple page (or dropdown item) allowing the student/ professor to access their personal account. Further, professors will have an option when logged in to view different content than a student would. For example, “Student Profile” would be changed to give the teacher access to information about all the students who are registered for the course. Similarly in Supporting Materials there will be an option for the professor to add more content to the list.

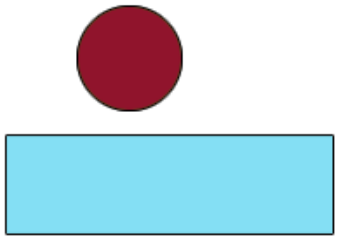
Here I have attached larger images showing the storyboard for the flash animation that the user will interact with for the Mitosis lab, biological molecules lab, Enzyme Activity Lab and Meiosis Lab:

Lab 1:

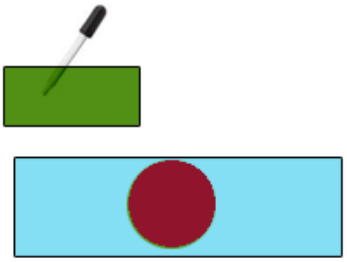
Part 1:


duplicate the cell by dragging the chromosomes into place
animation shows duplication of chromosomes procedes to next step automatically
hint
gives user a guideline of where to place
please drag the chromo-somes into position for cell division
pull the chromosomes apart, spliting the cell
hint
gives user a guideline of where to place
pull the chromosomes apart, spliting the cell
hint
gives user a guideline of where to place
animates the cell pulling apart into 2 new cells.

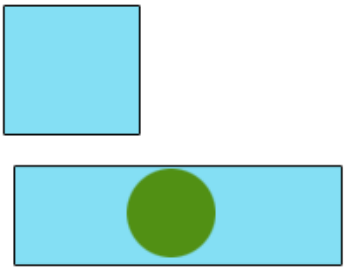
Part 2:



place the subject in the middle of the slide by dragging it.



apply the dye solution in order to observe the subject under the microscope



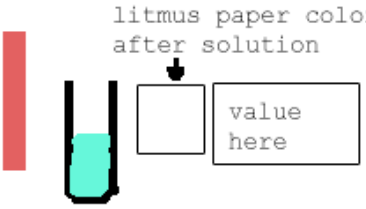
place the slide cover on to keep subject in place

place the slide under the microscope and observe.

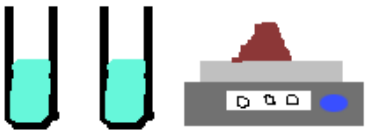
Lab 2:

turn the knobs on the meter to calibrate. Alter the zero and infinity ends to get proper calibration (turn and tell if correct)

insert your "blank" tube filled with distilled water and verify results. Drag tube into slot on top of meter.



insert the litmus paper and select the pH value you read. (If wrong will tell them to repeat and look more carefully)



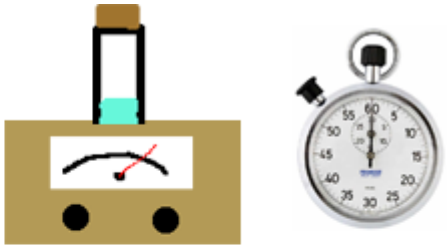
Here will be an animation showing the inspection of the Glycosuria, proteinuria, albumin, and hemoglobinuria
(may later evolve to be interactive with some sort of scale to weight compuptnds and make proper mixture)

Lab 3:

<u>Part 1 & 2: processes will use same animation, but measure different values</u>

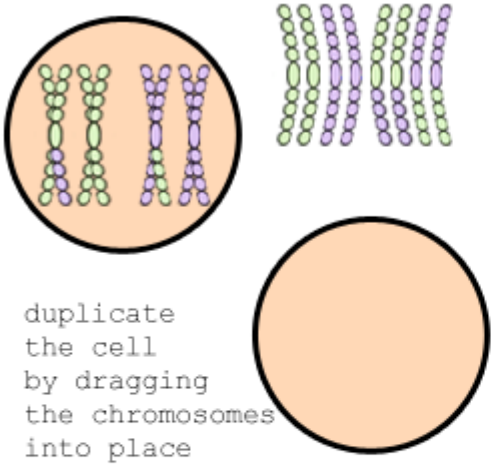
bottles of each solution will be shown to pick from test tubes are labelled 1-6

create the mixtures of the required amounts (will be listed in animation) by clicking the proper bottle and selecting the value to add



insert test tube required into the machine. start timer. (not sure about execution here) may just run timer for set duration as example

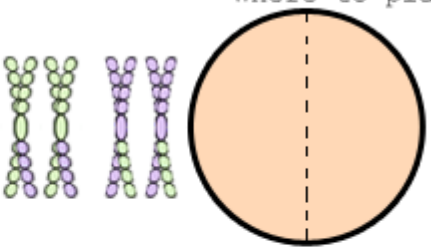
Lab 4:



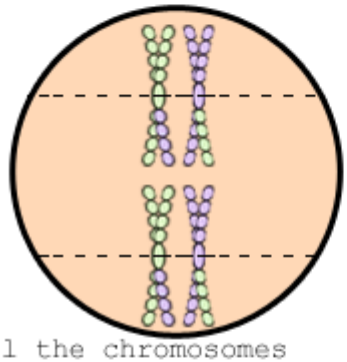
duplicate
the cell
by dragging
the chromosomes
into place

hint

gives user a
guideline of
where to place



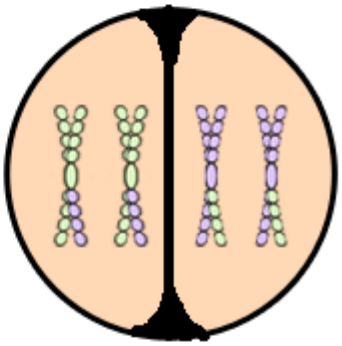
please drag the chromo-
somes into position for
cell division



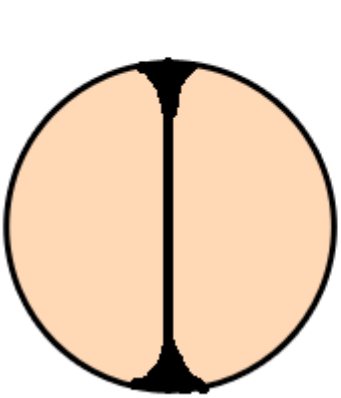
pull the chromosomes
apart, spliting the cell

hint

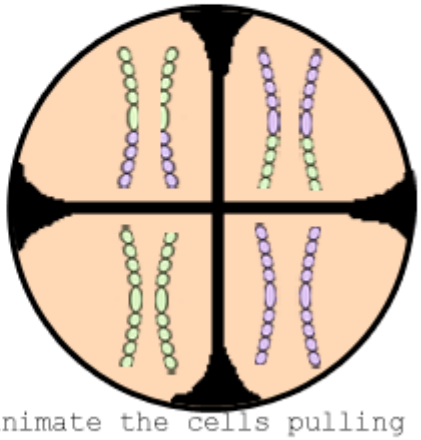
gives user a
guideline of
where to place



animates the cell pulling
apart into 2 new cells.



drag the cells into the
proper positions for anaphase
2



animate the cells pulling
apart to form 2 more cells.
now 4 daughter cells

4.2 User Effort Estimation

Login Process

1. Navigation: 2 mouse clicks

a. Click “Login” button

--- complete data entry as show below ---

b. Click “Confirm” button

2. Data Entry: 3 mouse clicks, keystrokes vary depending on login and password length

a. Click “username:” text field

b. Input account username in text field

c. Click “password:” text field

d. Input account password in text field

Logout Process

1. Navigation: 2 mouse clicks

a. Click “Logout” button

--- if a stage of a lab is in progress asks for confirmation ---

b. Click “Confirm” button

Student Profile

1. Navigation: 1 mouse click

a. Hover over “Student Profile” to enable dropdown

b. Click on the item which you would like to view

Sub-navigations:

Grade book

1. Navigation: varies based on user request

a. User can choose to view the overall grades for each lab (0 clicks)

b. User can choose a lab to expand and see subsections (varies)

Future items: will follow similar complexity as Grade Book

Lab Selection Process

1. Navigation: 1 mouse click

a. Hover over “Labs” to enable dropdown

b. Click on the lab title which you would like to work on

Lab Interaction

1. Navigation: varies on user choices

a. Can interact with the flash animation (clicks vary for each lab section)

b. Can select a specific section to work on (2 clicks)

i. Click Section Title, to expand content listed under it

(not necessary if section is already expanded)

ii. Select section (refreshes flash animation to proper step)

Professor Access

Grade book:

1. Navigation: varies on user choices

a. View Individual student (1 click, keystrokes vary)

i. Click “filter” button

ii. Enter Student Name

iii. Click “OK”

b. View by Assignment (1 click)

i. Click on assignments title (listed on side bar)

Professor Supporting Materials

1. Navigation: 1 click

a. Hover over Supporting Materials

b. Select “Add Material” from list

--- data entry as stated below ---

2. Data Entry: varies on user input

a. Select type of material from list (2 clicks, one to open, 1 to select)

b. Input Require information (undetermined at this point)

(Most likely contains title, link to content. Keystrokes vary per entry)

5. Domain Analysis

5.1 Domain Model

5.1.1 Concept Definitions

General Concepts

Responsibility Description	Type	Concept Name
Coordinates actions with use cases	D	Controller
Displays information to the user through their web browser	K	Interface
Keeps track of all users in the system	K	UserDatabase
Opens the selected laboratory at the point that student left off	D	LabOpener
Keeps track of where each student is in every laboratory, what grades each of them have received	K	LabProgress
Finds the grades for the selected student or class section and displays them	D	GradeAccessor
Keeps track of all students registered to the class, their log in	K	ClassInfo

information and what section they belong in		
Provides the correct quiz for that laboratory, randomize questions	D	Quizzer
Includes a database of questions to be asked	K	QuizQuestions
Creates a new section	D	ClassCreator
Edits a preexisting section	D	ClassEditor
Creates a student account	D	StudentCreator
Edits a preexisting student	D	StudentEditor
Starts the simulation of the Spectronic 20 Specrophotometer	D	Spec20
Starts the simulation of the Microscope	D	Microscope
Starts the simulation of the laboratory space	D	LabSpace
Keeps track of simulated karyotypes of human chromosomes	K	KaryotypeDatabase

Concepts for Laboratory One

Responsibility Description	**Concept Name**
Object, can zoom in to see cell shape and processes	OnionRootTip
Container that holds material	Slide
Liquid that colors in cell	DyeSolution
Machine used to heat up slide	HotPlate
Covers the slide	CoverSlip
Cell that exists within onion root	PlantCell
Example cell that shows mitosis	AnimalCell

Concepts for Laboratory Two

Responsibility Description	**Concept Name**
Container for liquids	TestTube
Subjects urine, what the student is running tests on	Urine
Tests the pH level of liquid	pHPaper
Concentrated glucose, used for comparison	Glucose
Concentrated protein, used for comparison	Protein
Water used for blank and to dilute liquids	DistilledWater

Concepts for Laboratory Three

Responsibility Description	**Concept Name**
Container for liquids	TestTube

Water used for blank and to dilute liquids	DistilledWater
Added to all of the test tubes, has a pH of 8.0	Buffer
A protein that increases the speed of rate of chemical reactions	pNPP
Liquid catalyst for a reaction	Sodium
Liquid catalyst for a reaction	Inorganicphosphate
Liquid catalyst for a reaction	Phenylphosphate
Water used for blank and to dilute liquids, used as a	DistilledWater

Concepts for Laboratory Four

Responsibility Description	**Concept Name**
Slide containing a cell that shows the stages of meiosis	Slide
Allows the student to circle the chromosomes on the karyotype	CircleChromosome
Allows the student to number the chromosome on the karyotype	NumberChromosome

5.1.2 Association Definitions

General Associations

Concept Pair	**Association Description**	**Association Name**
Controller <-> Interface	Fetches and displays appropriate data to the user through the web interface based upon their input	Controls and Displays Web Page
Controller <-> GradeAccessor	Fetches a student or classes grades	Provides/Retrieves Data
Controller <-> LabOpener	Fetches data related to the selected lab	Provides/Retrieves Data
Controller <-> Quizzer	Fetches data related to the selected quiz	Provides/Retrieves Data
Controller <-> UserDatabase	Stores data related user accounts	Provides/Retrieves Data
Controllder <-> ClassInfo	Processes actions related to user accounts	Provides/Retrieves Data
ClassCreator <-> ClassInfo	Generates the information on every student the professor registers and associates it with a new class	Creates and Records Data
ClassEditor <-> ClassInfo	Edits or deletes information about a specific class	Provides/Retrieves Data
StudentCreator <-> ClassInfo	Checks the list of registered students that the professor provided and records that students log in information	Provides and Verifies Data

StudentEditor<-> ClassInfo	Edits or deletes information about a specific student	Provides/Retrieves Data
GradeAccessor <-> ClassInfo	Check to see if the correct person is trying to access grades	Verifies Data
GradeAccessor <-> LabProgress	Finds and provides the correct grade for that student	Provides/Retrieves Data
LabOpener <-> LabProgress	Finds out where the student last left off and records how much the student had completed when they stopped working on the lab	Provides/Retrieves Data
Quizzer <-> QuizQuestions	Finds and provides randomized questions for that laboratory	Provides Data
Quizzer <-> LabProgress	Records what grades students receives while completing the quizzes and if they successfully finished that lab	Provides/Retrieves Data
LabOpener <-> Spec20	Opens the simulation for the spec20 where the student will use the spec 20 machine to find the absorbance	Generates Simulation
LabOpener <-> Microscope	Opens the simulation for the microscope where the student will view the stages of mitosis and meiosis	Generates Simulation
LabOpener <-> LabSpace	Opens the simulation for the lab space, where the student will prepare slides and test tubes	Generates Simulation
LabOpener <-> KaryotypeDatabase	Finds and provides a randomized picture of human chromosomes represented in a karyotype	Provides Data

Associations for Laboratory One

Concept Pair	**Association Description**
LabSpace <-> Slide	Student will put empty slide in lab space
OnionRootTip <-> Slide	Student will place the onion root tip onto the slide
DyeSolution <-> Slide	Student will drop dye solution onto slide
Slide <-> SlideCover	Student will cover slide with slide cover, squashing the onion root
Slide <-> HotPlate	Slide lays on hot plat, hot plate heats slide
Slide <-> Microscope	Slide goes onto microscope, microscope can be zoomed in and out
Microscope <-> AnimalCall	Microscope shows the structure of an animal cell going through mitosis
Microscope <-> PlantCell	Microscope shows the structure of a plant cell going through mitosis

Associations for Laboratory Two

Concept Pair	**Association Description**

LabSpace <-> TestTube	Student will place empty test tubes in lab space
Urine <-> TestTube	Students will specify how much urine to pour into test tube
Glucose <-> TestTube	Students will specify how much glucose to pour into test tube
Protein <-> TestTube	Students will specify how much protein to pour into test tube
DistilledWater <-> TestTube	Students will specify how much distilled water to pour into test tube
TestTube <-> pHPaper	Student will pour liquid from test tube to pH paper and pH paper will change color
TestTube <-> Spec20	Student will place test tube into sample slot of the Spectronic 20

Associations for Laboratory Three

Concept Pair	**Association Description**
LabSpace <-> TestTube	Student will place empty test tubes in lab space
TestTube <-> TestTube	Student will be able to drag one test tube to another and specify how much to add to the second from the first
Buffer <-> TestTube	Students will specify how much Buffer to pour into test tube
pNPP <-> TestTube	Students will specify how much pNPP to pour into test tube
Sodium <-> TestTube	Students will specify how much Sodium to pour into test tube
Inorganicphosphate <-> TestTube	Students will specify how much Inorganic phosphate to pour into test tube
Phenylphosphate <-> TestTube	Students will specify how much Phenylphosphate to pour into test tube
Enzyme <-> TestTube	Students will specify how much enzyme to pour into test tube
DistilledWater <-> TestTube	Students will specify how much distilled water to pour into test tube
TestTube <-> Spec20	Student will place test tube into sample slot of the Spectronic 20

Associations for Laboratory Four

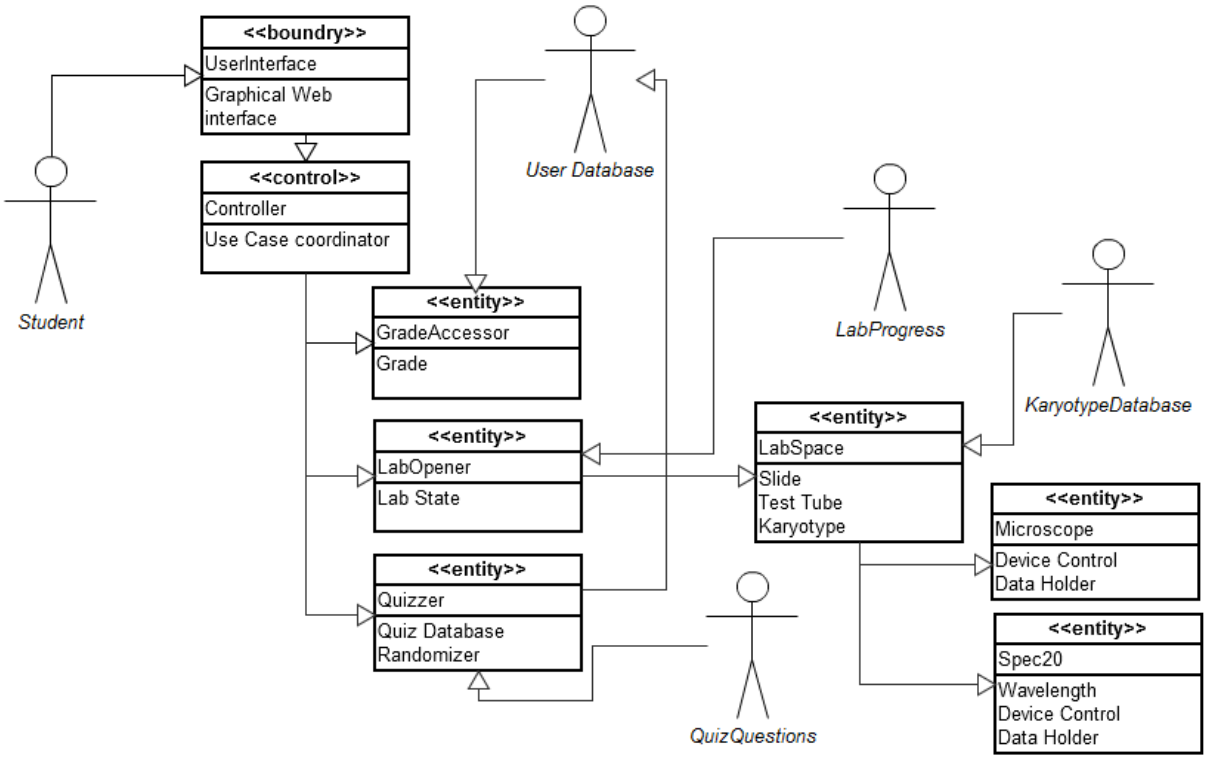
Concept Pair	**Association Description**
LabSpace <-> KaryotypeDatabase	Student will place empty test tubes in lab space
Slide<-> Microscope	Slide goes onto microscope, microscope can be zoomed in and out
CircleChromosome <-> KaryotypeDatabase	Student can select a chromosome on the karyotype to circle
NumberChromosome <-> KaryotypeDatabase	Student can select a chromosome on the karyotpye to number

5.1.3 Attribute Definitions

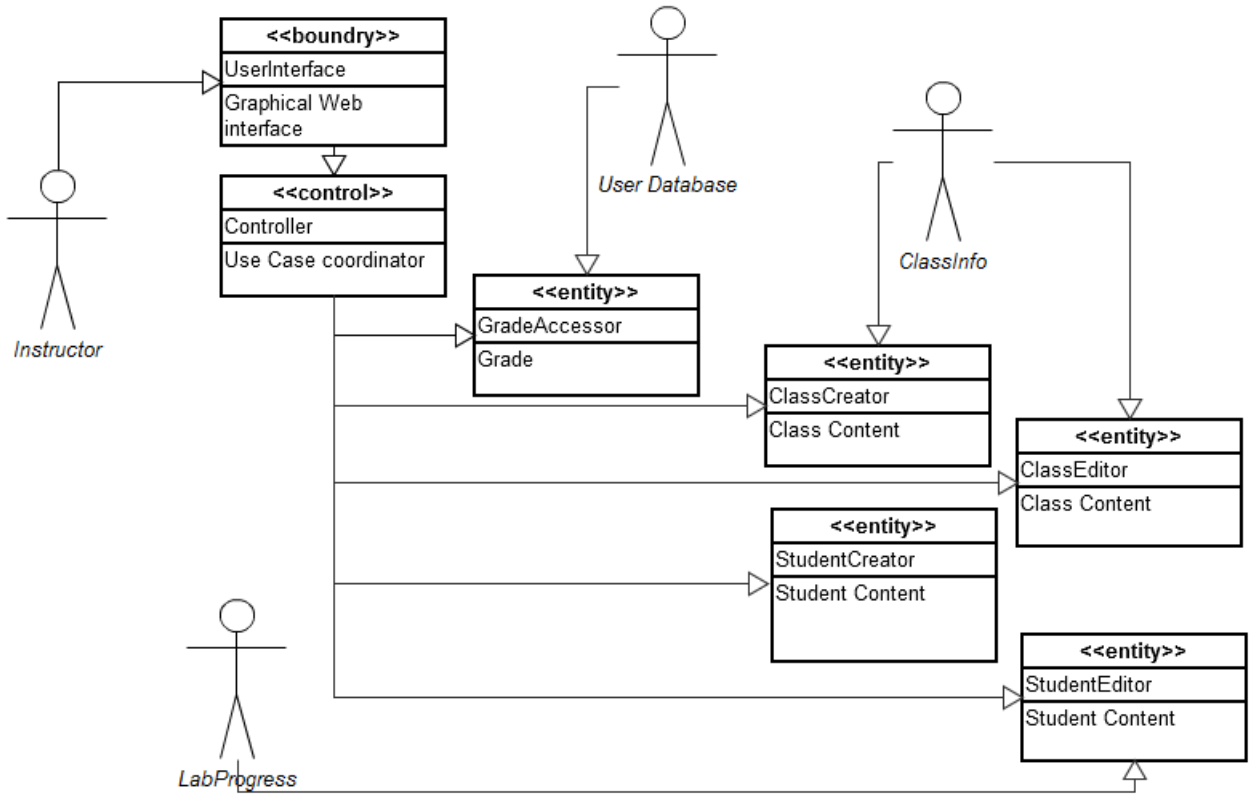
Concept	Attribute	Attribute Description
D1. Controller	Use case coordinator	Provides the medium between interface and execution of desired result
D2. Interface	Graphical Web Interface	Provides the medium between user and controller
D3. UserDatabase	Information Repository	Stores all information regarding Lab
D4. LabOpener	Lab Opener	Opens the desired available lab
	Lab State	The state of the lab being opened is identical to how it was when previously closed
D5. LabProgress	Lab State	Maintains the actually state of the lab
	Grade	Contains the grade according to the state of the lab
D6. GradeAccessor	Grade	Contains the grade for each student
D7. ClassInfo	Lab Info	Contains information about each individual with respect to lab dates, sections and login
D8. Quizzer	Quiz Database	Maintains the appropriate quiz questions pertaining to the lab
	Randomizer	Randomizes the quiz questions to be asked
D9 QuizQuestions	Quiz Content	Long list of possible questions pertaining to the lab
D10 ClassCreator	Class Content	Creates a new section to be further manipulated.
D11 ClassEditor	Class Content	Edits the content of a given section
D12 StudentCreator	Student Content	Creates a new student to be further manipulated
D13 StudentEditor	Student Content	Edits the content of a given student
D14 Spec20	Wavelength(nm)	Depicts the wavelength of light being analyzed
	Device Control	Adjusts the light and dark parameters for measurment
	Data Holder	Holds sample in place for further examination

D15 Microscope	Device Control	Allows for optical zoom
	Data Holder	Holds sample slide in place for further examination
D16 LabSpace	Slide	Used as platform for specimen to be examined on
	TestTube	Glass vial used to examine specific lab material
	Karyotype	Sample of human chromosomes
D17 KaryotypeDatabase	Karyotype Content	Contains information regarding test DNA samples

Domain Model for Student Interactions



Domain Model for Instructor Interactions



5.1.4 Traceability Matrix

UC	PW	D1 Controller	D2 Interface	D3 UserDatabase	D4 Labopener	D5 LabProgress	D6 GradeAccessor	D7 ClassInfo	D8 Quizzer	D9 QuizQuestions	D10 ClassCreator	D11 ClassEditor	D12 StudentCreator	D13 StudentEditor	D14 Spec20	D15 Microscope	D16 LabSpace	D17 Karyotype
1 RegisterClass	6	X						X			X							
2 RegisterStudent	6	X						X					X					
3 ViewStudentResult	7					X	X	X										
4 ViewClassResult	7					X	X	X										
5 PreformLab	26	X				X									X	X	X	X
6 TakeLabQuiz	1					X			X	X								
7 AddStudent	6																	
8 Lab1CellDivision	20				X											X	X	
9 Lab2BioMolecules	8				X										X		X	
10 Lab3EnzymeActivity	8				X										X		X	
11 Lab4Meiosis	9				X											X	X	X

5.2 System Operation Contracts

Operation:	RegisterClass
Precondition:	● User is an instructor with administrative abilities ● Section hasn't already been registered yet
Postcondition:	● ClassInfo contains information regarding section time and availability ● UserDatabase contains student NetID's associated with the

	section ● Class is recorded as being successfully registered ● Current section is unavailable to be registered again

Operation:	RegisterStudent
Precondition:	● Instructor has specified student to be in a section ● NetID has not already been registered
Postcondition:	● UserDatabase contains username and password for the student ● Student's NetID is recorded as being successfully registered in ClassInfo

Operation:	ViewStudentResult
Precondition:	● Student wishing to view is registered for class ● Instructor wishing to view is in charge of class ● Student has completed and submitted lab for grading
Postcondition:	● Grade assigned to student ● UserDatabase updated with appropriate grade information

Operation:	ViewClassResults
Precondition:	● Instructor in charge of class only one allowed to view ● UserDatabase contains all of the class grades
Postcondition:	● Instructor can see all of the grades to determine averages, curves, etc

Operation:	PerformLab
Precondition:	● Student has not yet completed the lab ● Student's lab progress is stored in UserDatabase (beginning of lab if no previous attempt was made or last completed task if lab was not finished in a previous attempt)
Postcondition:	● Student is not able to perform the lab ● Student's lab progress is stored in UserDatabase (complete) ● Student is able to take the quiz associated with the particular lab completed

Operation:	TakeLabQuiz
Precondition:	● Student has completed the lab associated with the selected quiz ● Student has not yet attempted to take the quiz after completing the lab
Postcondition:	● Student is not able to take the quiz ● Results are graded and stored in UserDatabase

Operation:	AddStudent
Precondition:	● ClassInfo contains information on the specified section ● UserDatabase does not already contain the new student's NetID
Postcondition:	● UserDatabase contains additional student's NetID associated with the specified section

5.3 Mathematical Model

For every question answered correctly counts as a correctly answered question. This total is then divided by the number of questions for the given quiz for that given lab. That calculation then shows as the user's grade for that given lab. Later after a user has fully completed all the labs, the system then takes care of calculating the average. The average is done by weighing each and every lab evenly, multiplying the available points for that lab by the grade for that lab. Adds all of them up accordingly and displays a final average.

The grading algorithm will look something of this formula:
Total grade = [q1(number of correct answers)/q1(number of questions)]*(100/(number of assignments))+...

There are no other areas which require mathematical models in our project. Many of the graphical units that require mathematical models to generate will be done manually through our animations using Adobe Flash. Although it may not be perfect, it will simulate an environment approrpiate enough for the lab's requirements.

7. Plan of Work

The virtual biology lab project is a fairly complex undertaking which involves the consideration of a wide range of developmental and scientific design. Before any work can be done implementing any part of the system, each lab topic being considered must be researched extensively. To accomplish this task, the lab manuals and textbooks used in the Rutgers Introductory Biology course will be used as primary resources during the preliminary design phase. Using existing labs as our model will ensure that our simulations are as similar to their real life counterparts as possible.

Once a basic understanding of the lab material is reached, planning of the virtual demonstrations and evaluations can begin. After determining the basic chain of events involved with each lab, the way in which the user will interact with the system must be assessed. To do this, various use case scenarios and requirement analyses must be considered. The ultimate goal of this type of research is a clear and concise list of specifications for the system as a whole as well as each individual lab.

The responsibilities outlined above demand a fairly good understanding of the domain material (Biology). Rather than have every member of the team take on such a large undertaking, a prudent alternative would be for one or two members to focus on achieving a firm grasp of the domain material while the others focus on other important parts of the project.. Throughout the developmental process, each member should maintain a general understanding of the system, but by specializing in different aspects of it, someone should always be able to identify potential problems in any part of development. Besides Topical Research, other aspects of development which will be the focus of team members include: Overall System Design, Graphical/User Interface Design, Presentation/Organization, and Analysis/Documentation. During the early planning staged of development, it was decided that at least two team members should attempt to focus on each of these specialties.

Due to the large amount of research that is required before any actual development can take place, the timetable is somewhat back heavy for most members of the group. The first phase of development consists mostly of research and requirement analysis. As every member of the team is an engineer (and has little preexisting knowledge of Biology), this stage will take longer than any other as a basic plan of action comes together. It is estimated that it will take approximately one month to complete what needs to be done. While the pertinent topics discussed earlier are being researched, other members of the group will be able to organize and prepare for that latter stages of development.

The second phase of development builds upon the first. During this stage, the system's requirements are analyzed and methods of implementation can be considered. Team members specializing in Overall System Design and User Interface/Graphical Design will most likely have the most work to do in this stage. Where the first phase involved asking "what" had to be done, this phase asks "how" things will be implemented. By this point, the team should have a very good idea of the project's desired outcome. This is expected to take anywhere from 4 weeks to a month but will most likely overlap with the third phase. By the end of that time, the basic underlying system should be in place and the animations/dialogue should be well on their way to completion.

As was previously stated, the final phase of development overlaps with the second. At this point, the team members specializing in Analysis/Documentation as well as those dealing with Presentation/Organization will probably be the most active. Before completion, an extensive amount of testing and debugging must take place. Although the aforementioned members will have

the heaviest load to carry during this stage, every member will be contributing heavily to ensure that all requirements which were initially presented are successfully met. Approximately 4 weeks to a month will be required to wrap things up and complete the project during this phase.

The plan of work presented in this document is an early analysis of what is required to achieve the goals outlined in the initial proposal. This will of course evolve over time as the project comes to fruition and will be updated accordingly. At the time of submission, phase 1 of development is nearly complete and the team members specializing in development are starting to consider how various requirements can be met. In the next month, the basic groundwork of the system should be in place so that the more complex development associated with the final stage can begin.

Fri Jan 20	All day	E-mail Professor Marsic with group members & project selection
Wed Jan 25	All day	Submit proposal for feedback
Fri Jan 27	All day	PROPOSAL DUE
Fri Feb 10	All day	submit report 1 rough draft for feedback
Wed Feb 15	All day	Submit revised report 1 for feedback
Fri Feb 17	All day	FIRST REPORT DUE (SPECIFICATION ONLY)
Fri Mar 2	All day	Submit report 2 rough draft for review
Wed Mar 7	All day	Submit revised report 2 for feedback
Fri Mar 9	All day	SECOND REPORT DUE (DESIGN ONLY)
Tue Mar 20	All day	Submit first demo for feedback
Fri Mar 23	All day	Submit revised first demo for feedback.
Tue Mar 27	All day	FIRST DEMO DUE
Fri Apr 13	All day	Compile third report
Mon Apr 16	All day	Submit third report rough draft for feedback
Wed Apr 18	All day	Complete Second demo
Fri Apr 20	All day	Submit working webpage for feedback
	All day	Submit revised third report for feedback
Fri Apr 27	All day	THIRD REPORT DUE (ALL REPORTS COLLATED)
Tue May 1	All day	SECOND DEMO DUE
Thu May 3	All day	ELECTRONIC PROJECT ARCHIVE DUE

8. References

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