# *Software Engineering*
# *System Requirements Specifications (SRS) Document*
# *https://github.com/aolson078/biokit*

**Project: BioKit**

**05/01/2024**

**Version: 3.0**

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# 1. Introduction

## 1.1. Purpose

The Biotool application aims to enable scientists and managers to quickly find biological data from protein/organism data banks, produce phylogenetic graphs, and other information derived from biological data, and easily compile them in a holistic report.

## 1.2. Document Conventions

The purpose of this Software Requirements Document (SRD) is to describe the client-view and developer-view requirements for the Biotool web application. Client-oriented requirements describe the system from the client's perspective. These requirements include a description of the different types of users served by the system. Developer-oriented requirements describe the system from a software developer's perspective. These requirements include a detailed description of functional, data, performance, and other important requirements.

## 1.3. Definitions, Acronyms, and Abbreviations

| | |
|---|---|
| Python | Java: A programming language originally developed by James Gosling at Sun Microsystems. We will be using this language to build the Restaurant Manager.]<br><br>Python: |
| HTML | Hypertext Markup Language. This is the code that will be used to structure and design the web application and its content. |
| Flask | Flask: Python web framework, used to create and run our application. |
| MVC | Model-View-Controller. This is the architectural pattern that will be used to implement our system. |
| PyCharm | An integrated development environment (IDE) for Python. This is where our system will be created. |
| API | Application Programming Interface. This will be used to implement a function within the software where the current date and time is displayed on the homepage. |

## 1.4. Intended Audience

[Describe which part of the SRS document is intended for which reader. Include a list of all stakeholders of the project, developers, project managers, and users for better clarity.]

End User: 2.1 Product Features, 2.3 Operating Environment, 3.1 Primary
Project Manager:
Administrator:

## 1.5. Project Scope

The goal of the software is to provide a quick and reliable web app to be used by researchers, managers, and admins of a company to facilitate the processing of usually unwieldy biologic data. This aligns with the overall business goals of the company as the less time is spent on routine data procurement and processing, the more time can be spent doing critical analysis and creating value for the business.

The benefits of the project to business include:

- Operational efficiency: cutting down on time spent querying databases as users do not need to spend their valuable time working with low-level details, and can spend more time on high-level ideas.
- Employee happiness: Employees will be more available to do creative and meaningful work instead of being encumbered with rote data processing.

## 1.6. Technology Challenges

Ran into an issue where matplotlib would cause the program to crash because it uses tkinter as a backend, and tkinter and flask don't run well together on a single thread, and python has a global interpreter lock. This was fixed by changing the backend the matplot lib used.

## 1.7. References

BioPython tutorial: https://biopython.org/DIST/docs/tutorial/Tutorial.pdf

# 2. General Description

## 2.1. Product Features

The product features include the ability for end users to create accounts, and administrators to manage those accounts. Users can then query databases for biologic data, save the data, and produce reports containing phylogenetic trees, and other chosen computed data that they may need. After a report is generated, a user can view, print, or delete their own reports. The manager can view, edit, print, or delete any user reports, and can also choose which data gets included in the user's reports. The administrator can create and delete accounts along with changing passwords.

## 2.2. User Class and Characteristics

Our web app will not require users and managers to have any technical knowledge about computers except to be able to access a web page and create an account. Users and managers will be expected to have knowledge of biology and an understanding of the data being processed.

## 2.3. Operating Environment

The application is designed to be accessed on the internet from any internet-capable device, including but not limited to Windows, Mac, Unix-like OS, iOS, and Android.

## 2.4. Constraints

My main thought about constraint is how the user will interact with the API. In the end, we need the API to return a string of nucleotide data (ie: “ATCGTCCGA”) to be processed. But how is the end user going to input information to search for the specific protein/gene/organism, and how are we going to verify the input, if we are at all.

## 2.5. Assumptions and Dependencies

The software will be dependent on Flask to create and execute the MVC architecture that will be developed within PyCharm. The application will also use the MyGene API (http://mygene.info/) that will return data about desired nucleotide strings, proteins, or entire genes.

# 3. Functional Requirements

## 3.1. Primary

- **FR0: The system will allow the user to look up biologic information using a symbol (i.e.: CDK2 for the protein "cyclin-dependent kinase 2"), and save this information in a database.**
- **FR1: The system will allow the user to generate a phylogenetic tree using selected items from the database.**
- **FR2: The system will allow the user to generate a report with the specific details of the selected biologic data, including the phylogenetic tree, and comparative data derived from the chosen nucleotide strings.**

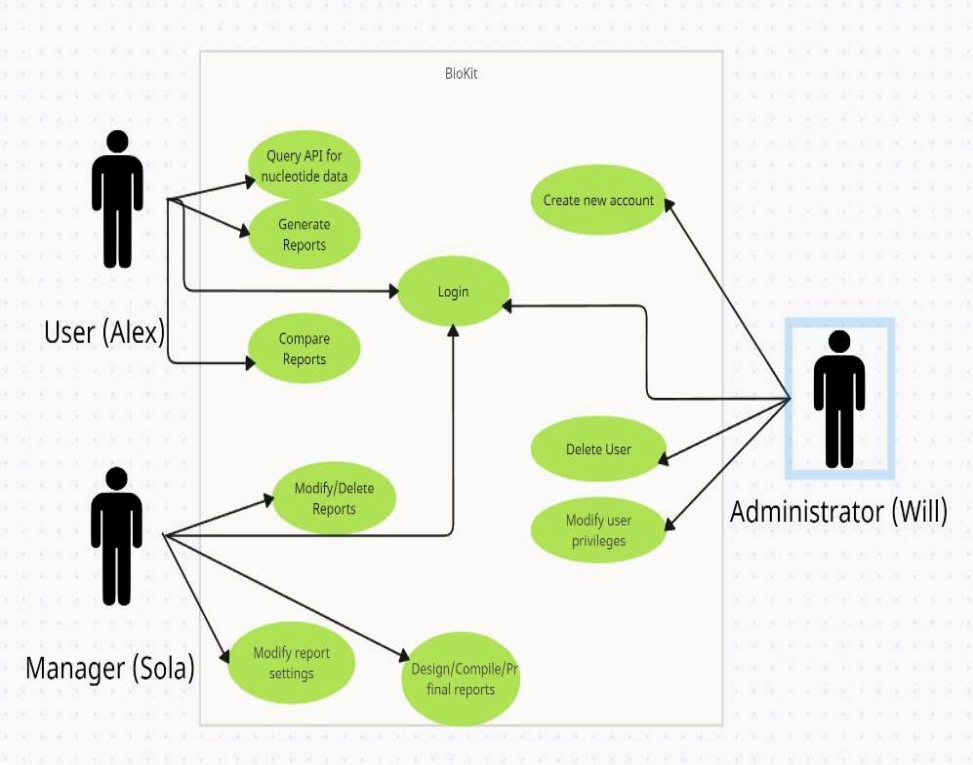
## 3.2. Secondary

- **Password protection for information only accessible to end users and their managers.**

- **Authorization scheme so that individual users will not be able to view or change other end user's reports.**

## 3.3. Use-Case Model

### 3.3.1. Use-Case Model Diagram




### 3.3.2. Use-Case Model Descriptions

#### 3.3.2.1. Actor: User (Alex)

**- Query API for nucleotide data : The user can search for the nucleotide string / protein / gene / organism to save to the database.**

**- Generate Report: The user can generate a report using chosen biologic data from the Database**

**- Login: The user can enter a username and password to login to the application and authenticate themselves.**

**- Compare reports: The user can review their own saved reports, and see the summarized data side by side for comparison.**

#### 3.3.2.2. Actor: Manager (Sola)

**- Modify/Delete reports: The manager can modify existing reports to change the information displayed and can delete the reports.**

**- Modify report settings: The manager can modify the settings to change the look of the final reports, including font sizes and color, spacing, and what is included.**

**Compile/Print reports: The manager can select multiple reports to create a final compiled product to print.**

**- Login: The manager can enter a username and password to login to the application and authenticate themselves.**

#### 3.3.2.3. Actor: Administrator (Will)

**- Create new account: The Admin can create a new account for a User, Manager, or another Admin and assign them a username and password.**

- **Delete user: The Admin can delete an existing User, Manager, or Admin (but only if there is more than one)**

- **Change passwords: The Admin can change the password of any previously created account.**

- **Login: The user can enter a username and password to login to the application and authenticate themselves.**

### 3.3.3. Use-Case Model Scenarios

#### 3.3.3.1. Actor: User(Alex)

- **Use-Case Name: Query API**

  - **Initial Assumption: The user has access to the webapp and has the user role.**

  - **Normal: The user will enter the keyword for the protein / gene / organism they would like to include in their report**

  - **What Can Go Wrong: The user queries the API with an invalid identifier. The system should alert the user about this error.**

  - **Other Activities: n/a**

- **System State on Completion:** The biologic data is saved in the next available space of the CSV file, and is accessible when compiling a report.

- **Use-Case Name:** Generate Report

  - **Initial Assumption:** The user has access to the webapp and has the user role.

  - **Normal:** The user selects the data to be compiled from a check box of all available specimen data. Once desired data is chosen, a phylogenetic tree is produced, and the related information is compiled and saved.

  - **What Can Go Wrong:** n/a

  - **Other Activities:** n/a

  - **System State on Completion:** A report is compiled and saved to persistent storage, and viewable by the user who created it and the manager.

- **Use-Case Name:** Compare reports

  - **Initial Assumption:** The user has access to the webapp and has the user role.

  - **Normal:** The user will select the previously generated reports of their own, and be able to view them side by side.

- **What Can Go Wrong:** There are no previously generated reports, the system will notify the user.
- **Other Activities:** n/a
- **System State on Completion:** The system state is the same as before comparing reports.

3.3.3.2. **Actor:** Manager (sola)

- **Use-Case Name:** Modify reports
  - **Initial Assumption:** The manager has access to the webapp and has the manager role.
  - **Normal:** The manager opens the report page, and selects the report they would like to view. Then the manager is able to add or remove specific data sections,
  - **What Can Go Wrong:** There is no report saved for the manager to view. The page will notify the manager that there are none yet.
  - **Other Activities:** A manager can delete the viewed report.
  - **System State on Completion:** The report is saved again with the desired modifications, or if deleted, removed from persistent storage.

- **Use-Case Name:** Modify report settings

    - **Initial Assumption:** The manager has access to the webapp and has the manager role.

    - **Normal:** The manager opens the settings page and can modify the settings to change the look of the final reports, including font sizes and color, spacing, and what is included.

    - **What Can Go Wrong:** n/a

    - **Other Activities:** n/a

    - **System State on Completion:** The report settings are changed for future generated reports.

- - **Use-Case Name:** Print reports

    - **Initial Assumption:** The manager has access to the webapp and has the manager role.

    - **Normal:** The manager opens the print page, and selects the saved reports they would like to include in the printed

product. The manager then is able to print the finished report.

- **What Can Go Wrong:** There is no report saved for the manager to view. The page will notify the manager that there are none yet.
- **Other Activities:** n/a
- **System State on Completion:** The report is printed and the system returns to the state it was in previously.

#### 3.3.3.3. Actor: Admin (Will)

- **Use-Case Name:** Create new account
  - **Initial Assumption:** The admin has access to the webapp and has the admin role.
  - **Normal:** The admin selects the user who needs their password changed from a drop-down box. The admin is prompted to input a new password for the user. The password is then saved.
  - **What Can Go Wrong:** n/a

- **Other Activities:** n/a

- **System State on Completion:** The user's password is changed.

- **Use-Case Name:** Delete user

  - **Initial Assumption:** The admin has access to the webapp and has the admin role.

  - **Normal:** The admin selects the user to delete from a drop-down menu. After the user is selected, the system verifies that is not the last admin account, and prompts the admin for confirmation that they want to delete the account.

  - **What Can Go Wrong:** That there is only one admin account, and is selected to be deleted. The system will notify the admin, and not delete the account.

  - **Other Activities:** n/a

  - **System State on Completion:** The account is deleted from persistent storage.

- **Use-Case Name:** Modify user privileges

- **Initial Assumption:** **The admin has access to the webapp and has the admin role.**

- **Normal:** **The admin selects the user to modify from a drop-down menu. After the user is selected, the admin adds or removes privileges by selecting check boxes.**

- **What Can Go Wrong:** **n/a**

- **Other Activities:** **n/a**

- **System State on Completion:** **The modified user's new privileges are saved.**

# 4. Technical Requirements

## 4.1. Interface Requirements

### 4.1.1. User Interfaces

The user interface will have a login screen, if you do not have an account, you will be denied access to the features. There is a search bar and compile report button and display button for employees. Managers have a select employee dropdown menu, view the reports of a selected employee with a display and download button. Admin has a select employee dropdown menu, view all employees and with a delete button. Create an employee menu and modify the privileges menu.

### 4.1.2. Hardware Interfaces

The application is designed to be accessed on the internet from any internet-capable device, including but not limited to Windows, Mac, Unix-like OS, iOS, and Android.

### 4.1.3. Communications Interfaces

It must be able to connect to the internet.

The communication protocol, HTTP, must be able to connect to the MyGene.info API.

### 4.1.4. Software Interfaces

We will use Flask with Python along with HTML to build the front end.

For persistent storage, we will use a CSV file.

We will also use Flask to connect the frontend and backend.

# 5. Non-Functional Requirements

## 5.1. Performance Requirements

- NFR0(R): The local copy of the biologic data database will consume less than 50 MB of memory
- NFR1(R): The system (including the local copy of the biologic database) will consume less than 100MB of memory
- NFR2(R): The novice user will be able to create a report in less than 5 minutes.
- NFR3(R): The expert user will be able to create a report in less than 1 minute.

## 5.2. Safety Requirements

## 5.3. Security Requirements

- NFR4(R): The system will only be usable by authorized users.

## 5.4. Software Quality Attributes

### 5.4.1. Availability

The web app will maintain a high availability, and if it crashes, will be able to restart and load in persistent data in under a minute.

### 5.4.2. Correctness

The web app will use unit testing along with useful and comprehensible error handling to ensure the correctness of the product.

#### 5.4.3. Maintainability

This web app is designed to be easily modifiable, to assist in debugging, fixing, and extending the apps capabilities. The application is easily learned by new developers so training time is minimal.

#### 5.4.4. Reusability

This web app will be reusable as long as the API is maintained.

#### 5.4.5. Portability

This web app will be able to be ran on any device that is browser capable.

## 5.5. Process Requirements

#### 5.5.1. Development Process Used

We are using the Agile Development Process

#### 5.5.2. Time Constraints

Our time is constrained by the following due dates:

February 27th: Prototype presentation is due

April 2nd: Second iteration of design document is due

April 16th: First code review is due

April 30th: Final project is due

#### 5.5.3. Cost and Delivery Date

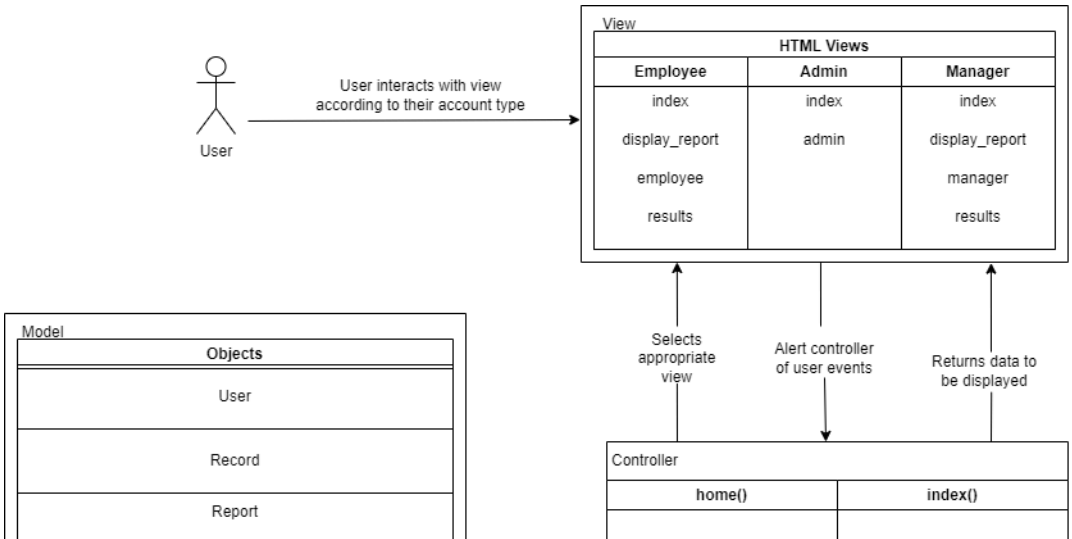
There is no cost for the software

The final product will be delivered by April 30th 2024

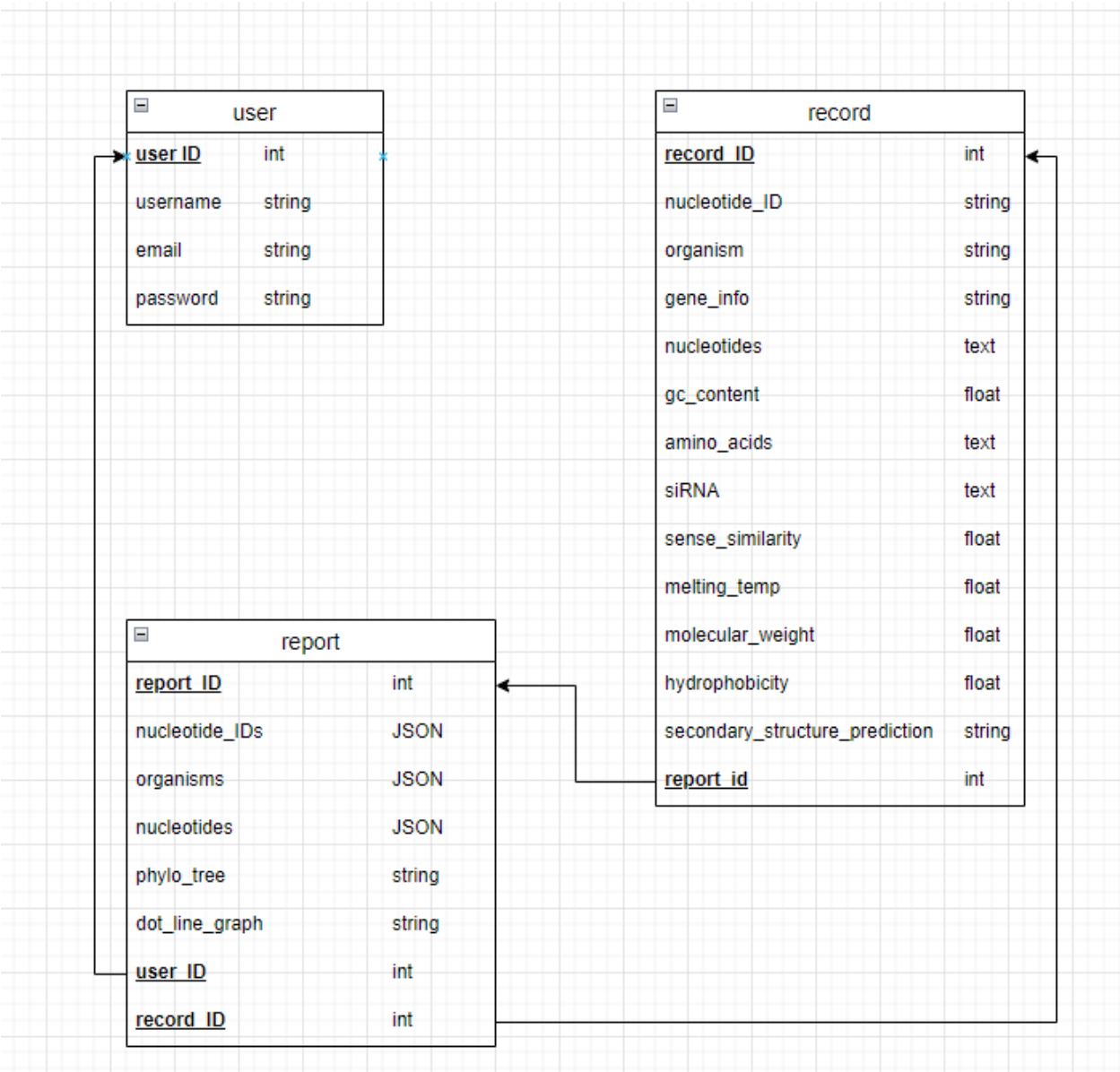
## 5.6. Other Requirements

# 6. Design Documents

## 6.1. Software Architecture

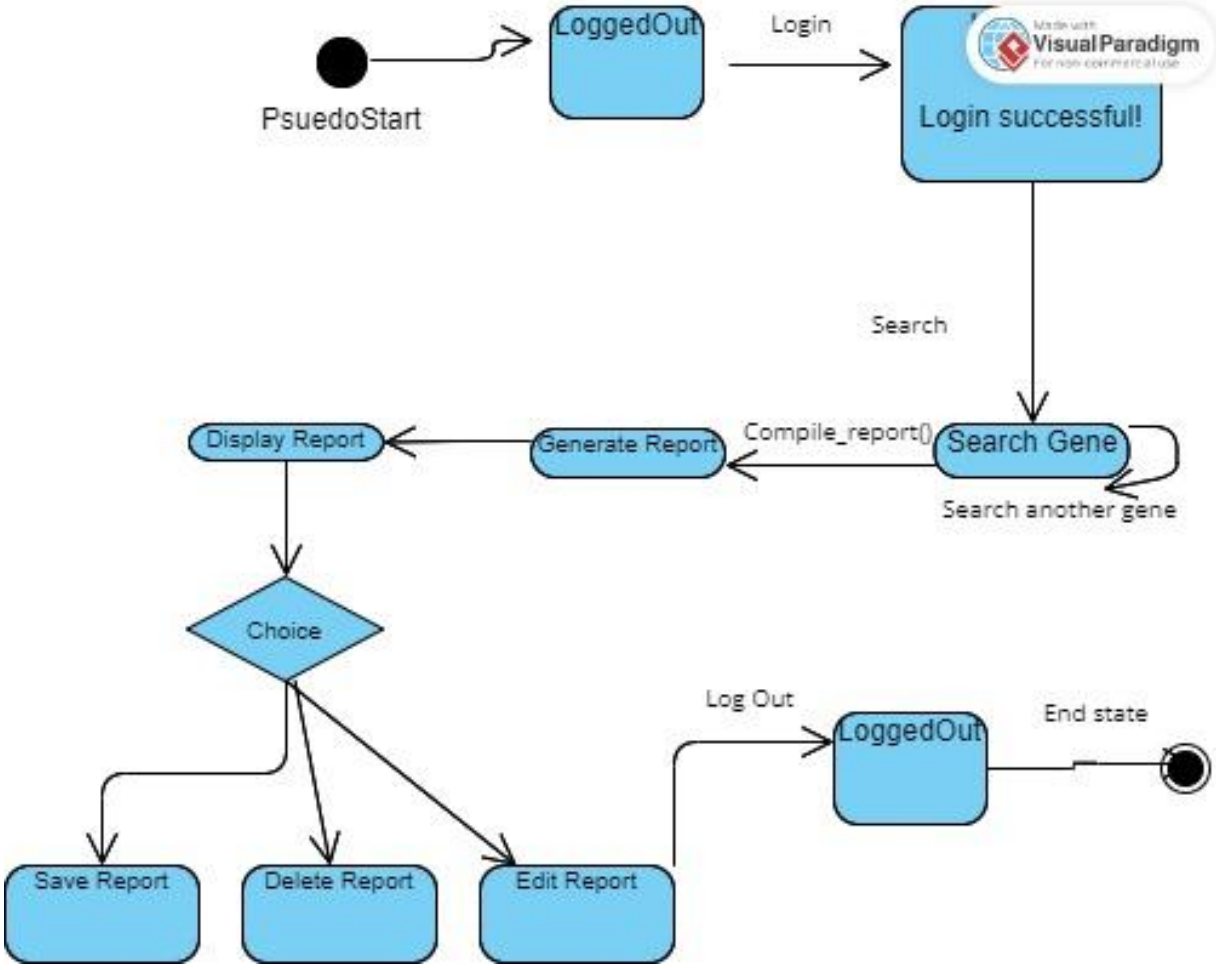


## 6.2. High-Level Database Schema

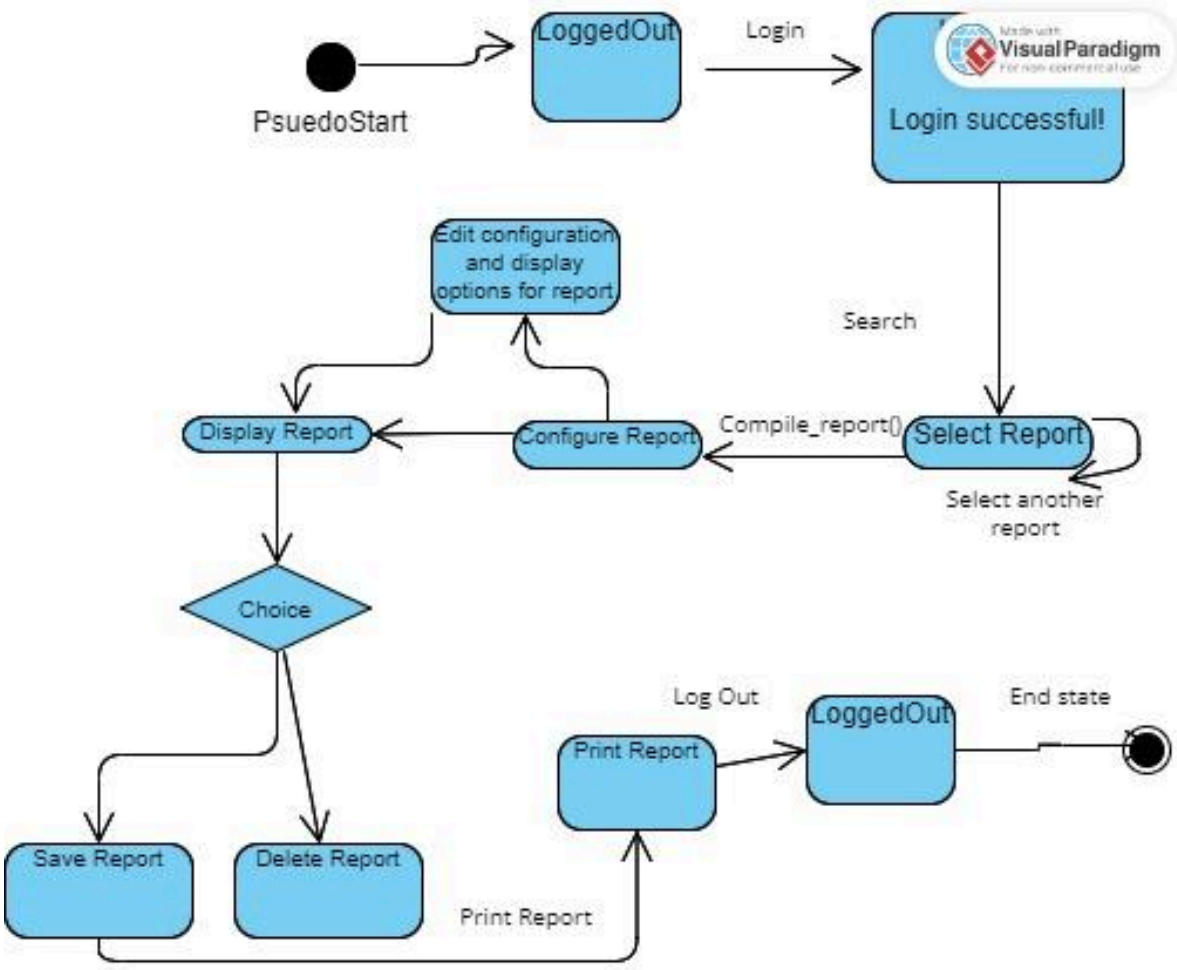


## 6.3. Software Design

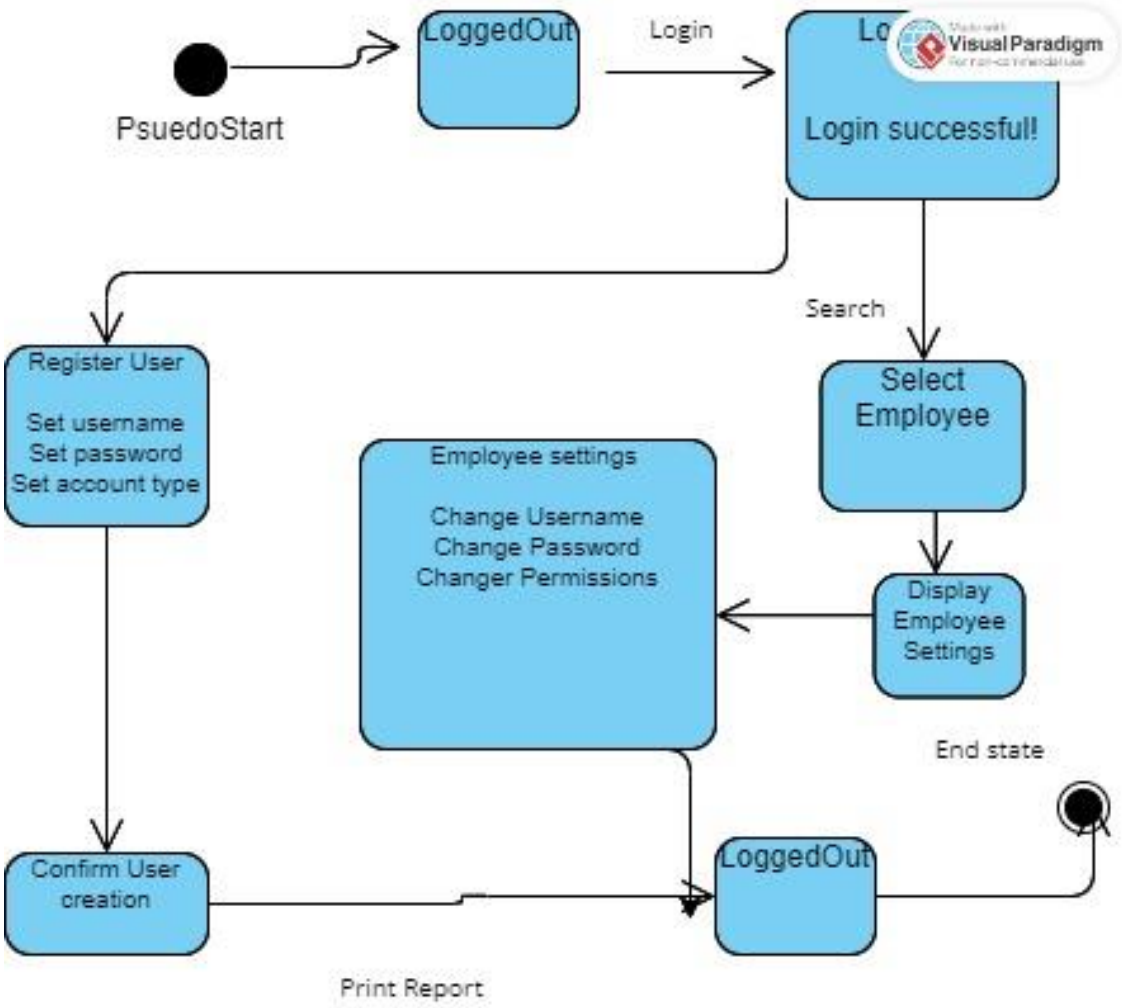
### 6.3.1. Employee



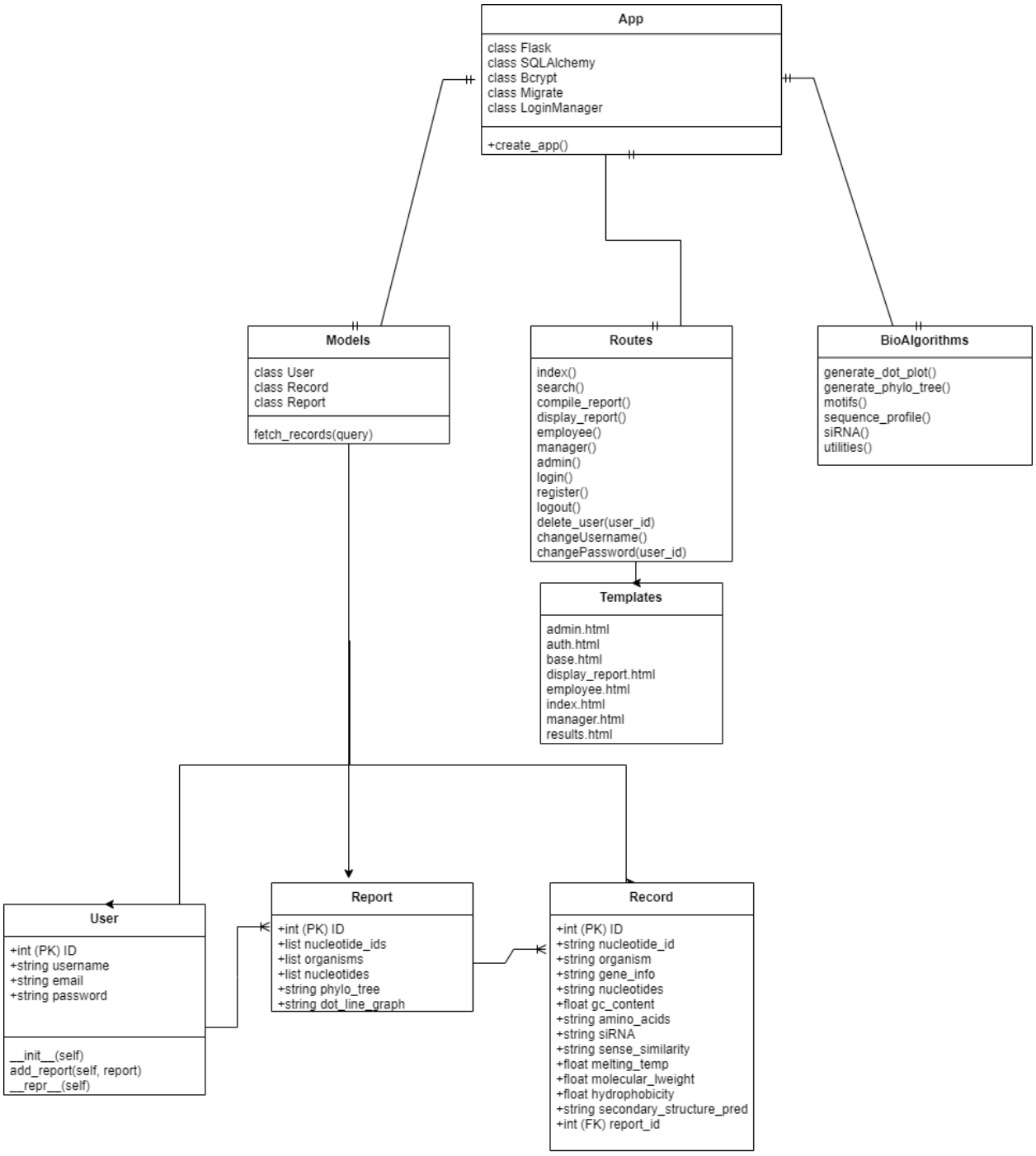
## 6.3.2. Manager


LoggedOut
Login
PsuedoStart
Login successful!
Edit configuration and display options for report
Search
Display Report
Configure Report
Compile_report()
Select Report
Select another report
Choice
Log Out
End state
LoggedOut
Print Report
Save Report
Delete Report
Print Report

### 6.3.3. Admin


PsuedoStart
LoggedOut
Login
Login successful!
Search
Register User
Set username
Set password
Set account type
Select Employee
Employee settings
Change Username
Change Password
Changer Permissions
Display Employee Settings
End state
Confirm User creation
LoggedOut
Print Report

## 6.4. UML Class Diagram



# 7. Brief Written Scenario with Screenshots

## 7.1. Written Scenario

Scenario:

Admin login

Admin creates a new employee

Employee login

Employee search and compile report

Employee Display report

Manager login

Manager shows the report made by employee

Manager print report

Manager modify report

Admin login

Admin delete employee

//Alex

Employee: Generate reports, Query API for nucleotide data.

Employee logs into employee account created by admin.

Employee searches for an organism using search bar, querying an API for nucleotide data.

Employee selects two or more organism and compiles report.

// Sola

Manager: View all employee reports, Save Report to the PDF, Modify Report Settings.

Manager logs in to view an employee's reports by employee name, can view any employee's report.

Manager views individual reports made by users.

Manager save report as pdf.

Manager can modify the report settings.

// Will

SysAdmin: Create new account use case:

SysAdmin A1 creates a new employee profile including user name, email, password, as well as account privilege status (employee, manager, admin)

SysAdmin: Delete new account use case:

SysAdmin A1 deletes an employee profile

SysAdmin:  Create accounts, Delete accounts, Modify account privileges

Admin logs in and creates a new employee

Admin modifies the employees privileges

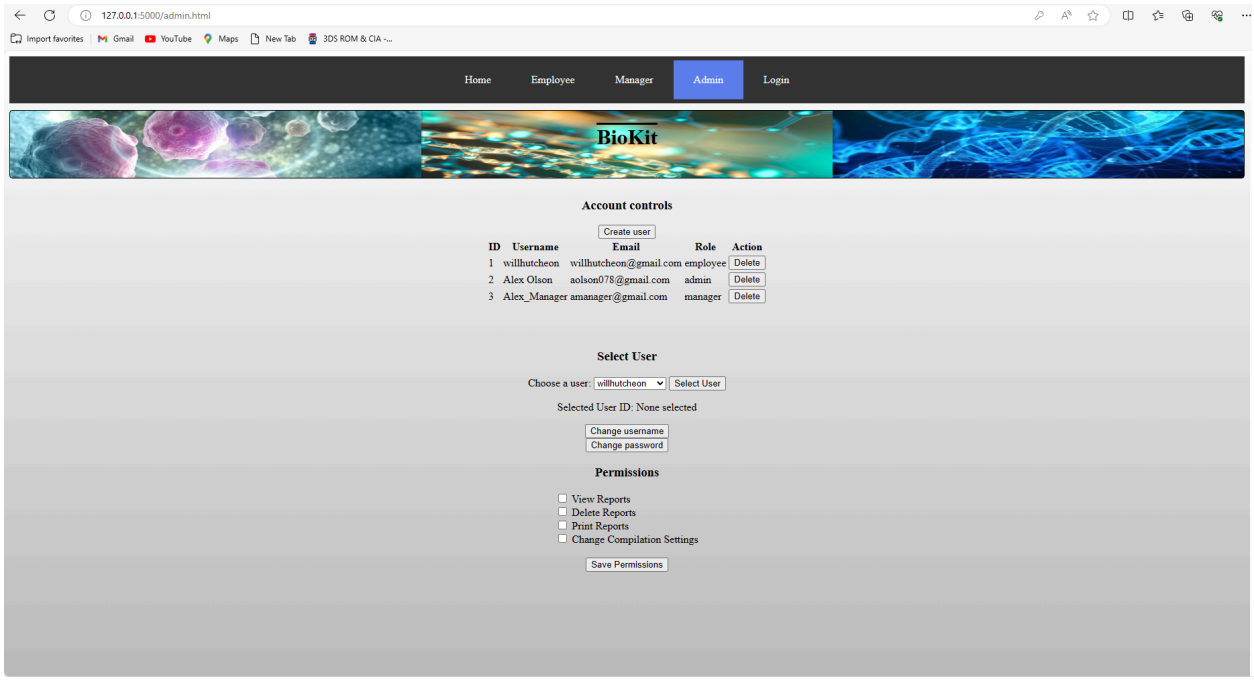
Admin deletes an employees account

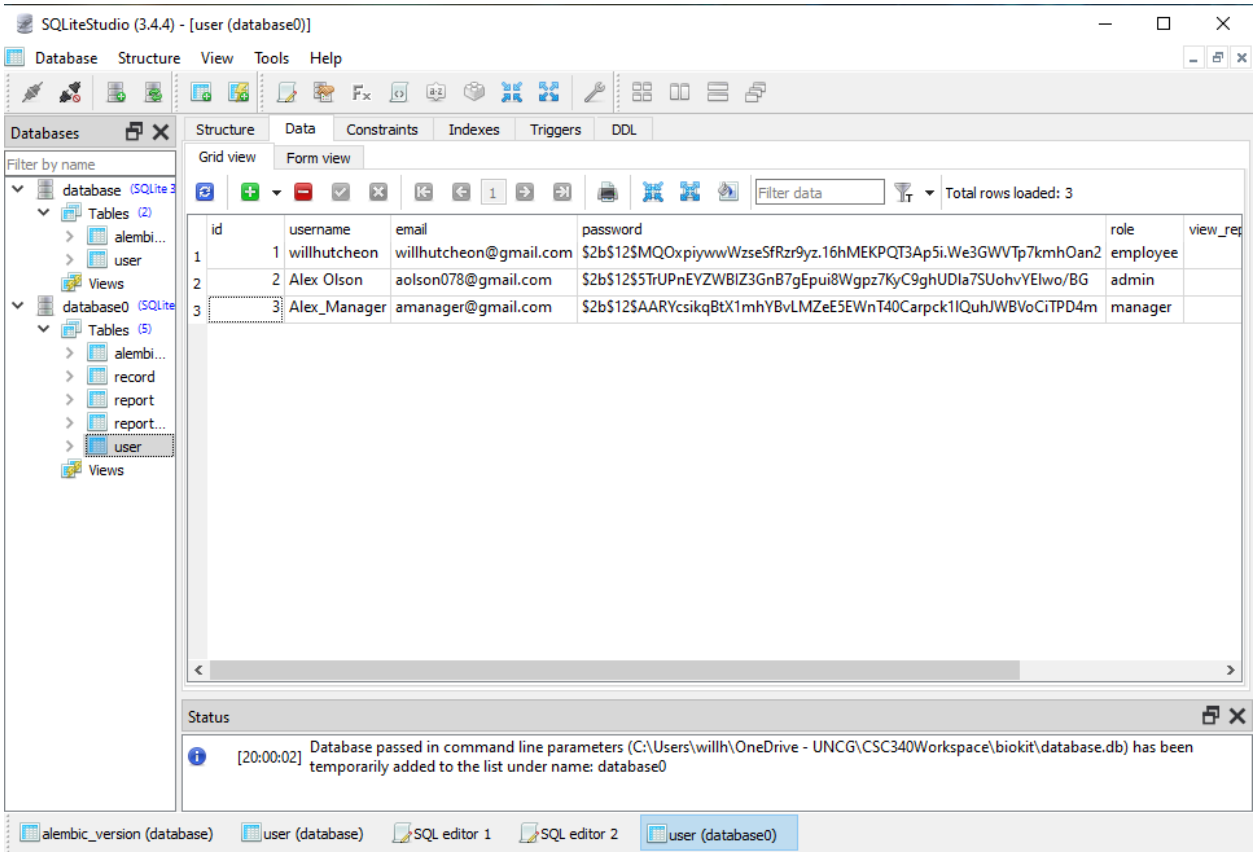
Admin checks that the employee's account is deleted.

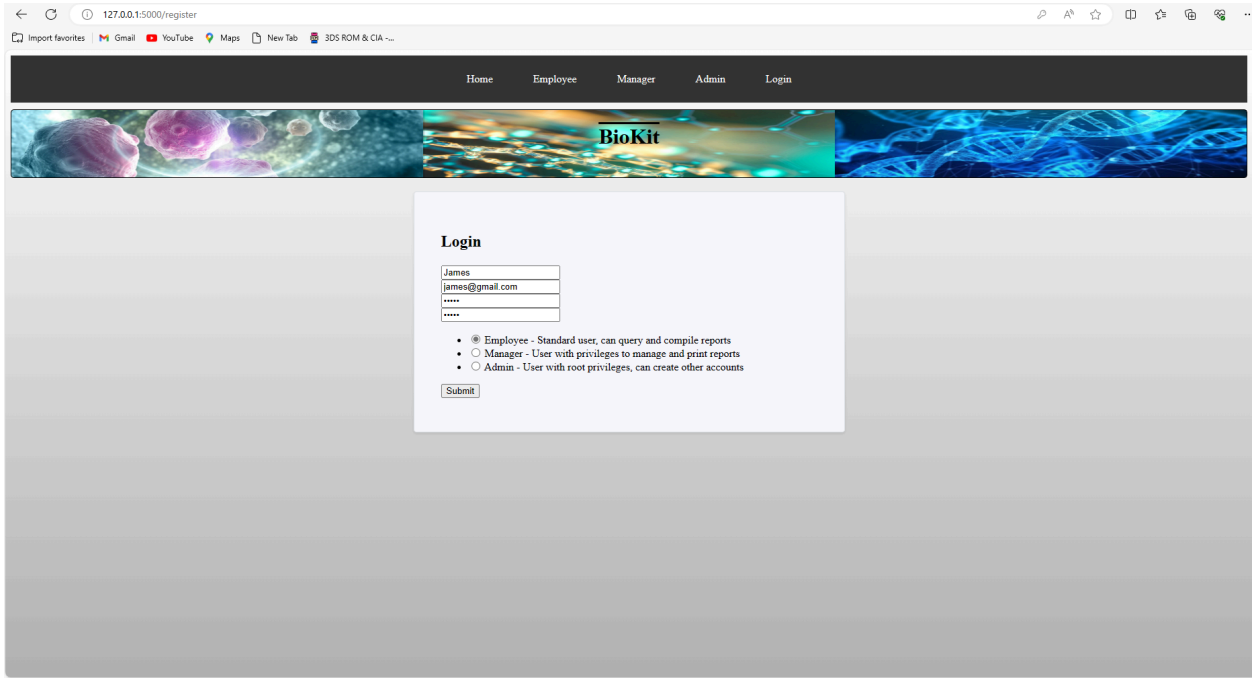
The employee tries to login but is unable to.

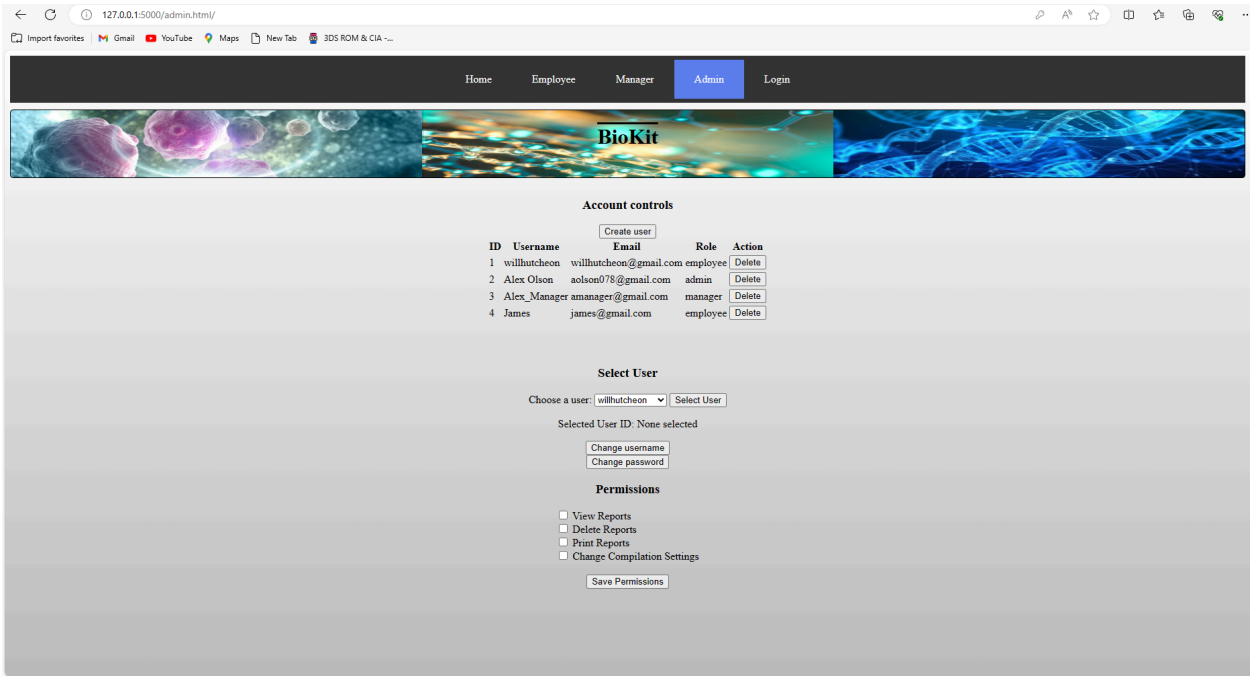
## 7.2. Admin (Will) Scenario Screenshots

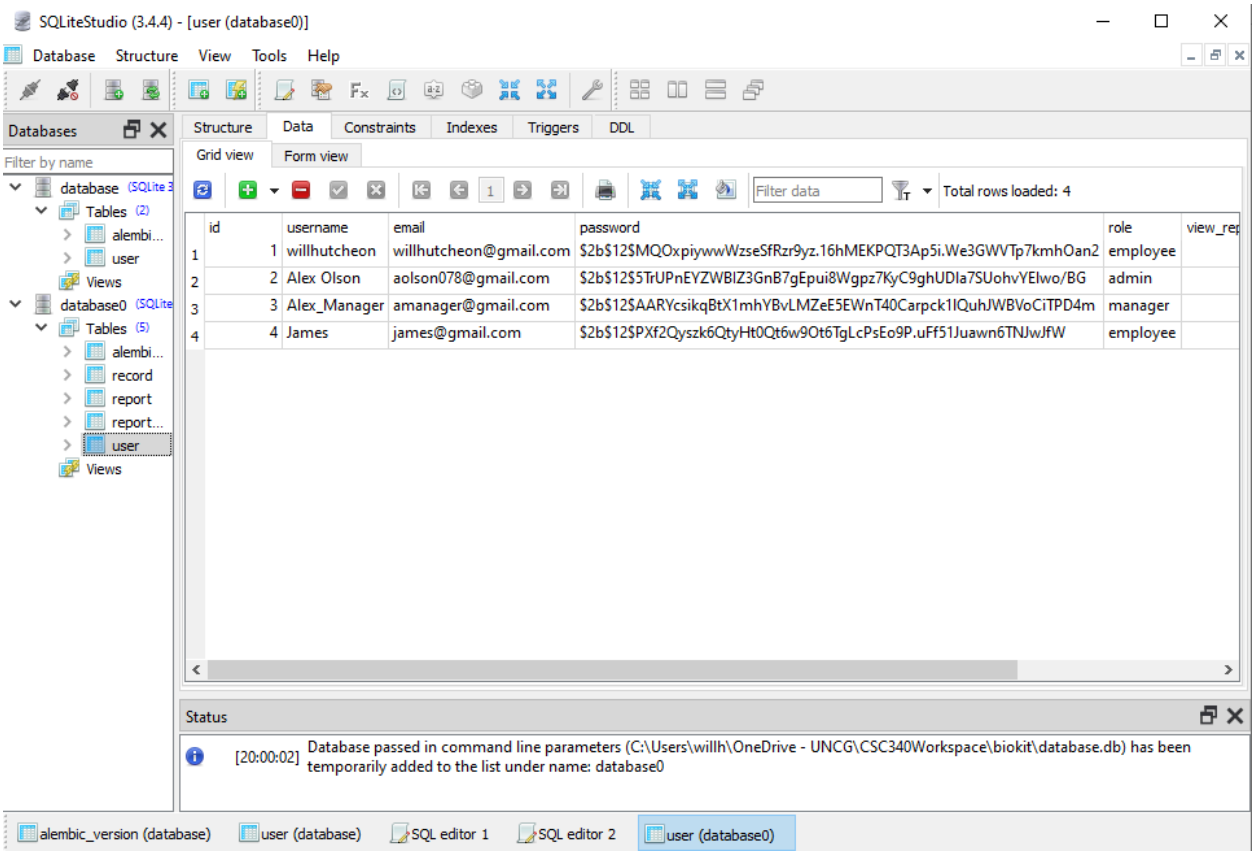
### 7.2.1. Creating employee



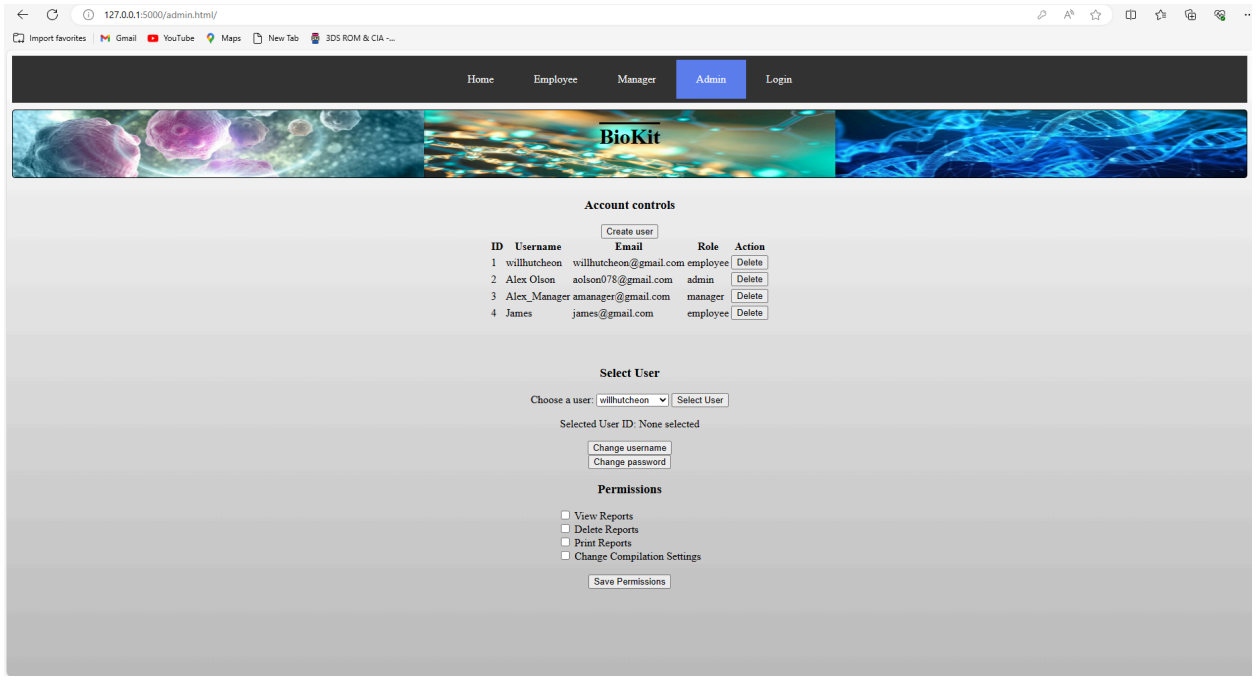

SQLiteStudio (3.4.4) - [user (database0)]
Database Structure View Tools Help
Databases
Filter by name
database (SQLite 3
Tables (2)
alembi...
user
Views
database0 (SQLite
Tables (5)
alembi...
record
report
report...
user
Views
Structure Data Constraints Indexes Triggers DDL
Grid view Form view
Filter data
Total rows loaded: 3
id username email password role view_rep
1 willhutcheon willhutcheon@gmail.com $2b$12$MQOxpiywwWzseSfRzr9yz.16hMEKPQT3Ap5i.We3GWVTp7kmhOan2 employee
2 Alex Olson aolson078@gmail.com $2b$12$5TrUPnEYZWBIZ3GnB7gEpui8Wgpz7KyC9ghUDIa7SUohvYElwo/BG admin
3 Alex_Manager amanager@gmail.com $2b$12$AARYcsikqBtX1mhYBvLMZeE5EWnT40Carpck1IQuhJWBVoCiTPD4m manager
Status
[20:00:02] Database passed in command line parameters (C:\Users\willh\OneDrive - UNCG\CSC340Workspace\biokit\database.db) has been temporarily added to the list under name: database0
alembic_version (database)
user (database)
SQL editor 1
SQL editor 2
user (database0)

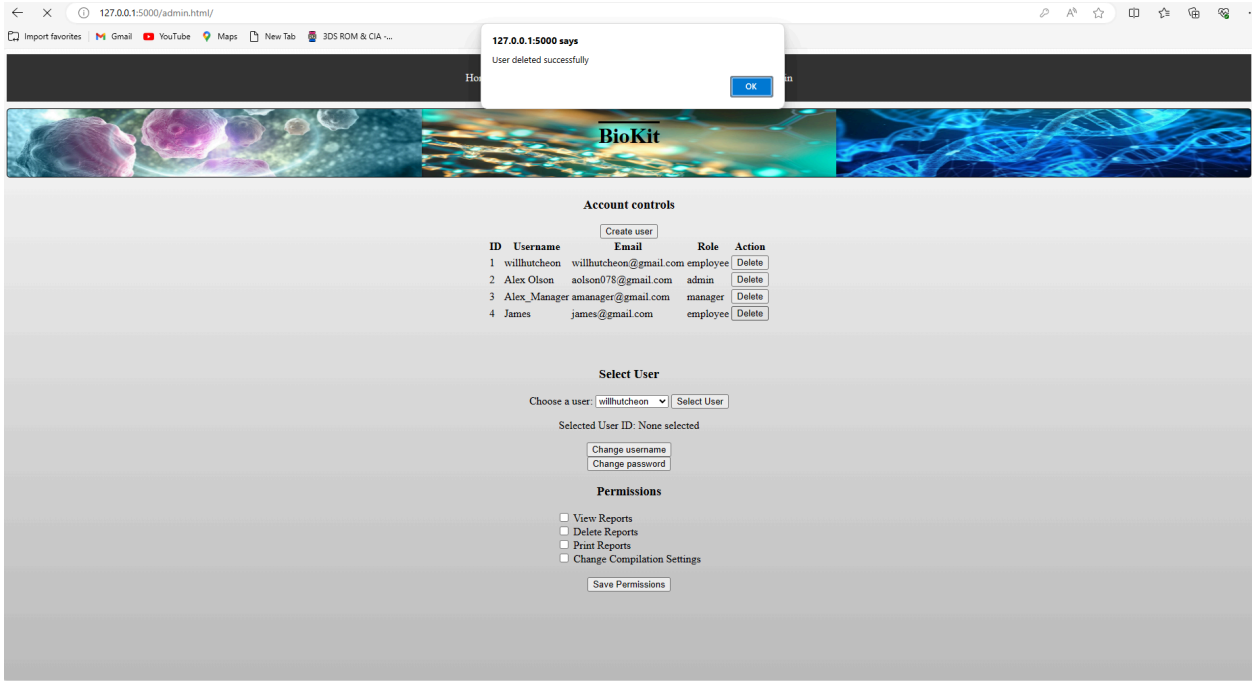

127.0.0.1:5000/register
Home Employee Manager Admin Login
BioKit
Login
James
james@gmail.com
Employee - Standard user, can query and compile reports
Manager - User with privileges to manage and print reports
Admin - User with root privileges, can create other accounts
Submit

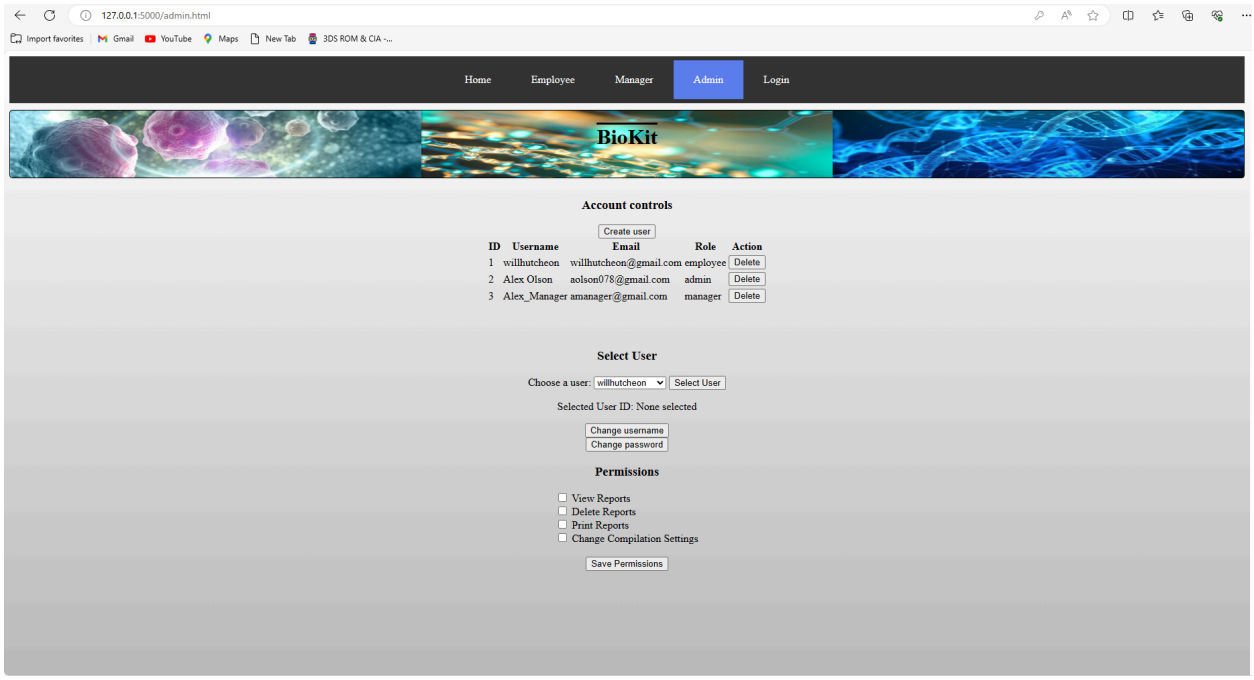

127.0.0.1:5000/admin.html/
Import favorites
Gmail
YouTube
Maps
New Tab
3DS ROM & CIA -...
Home
Employee
Manager
Admin
Login
BioKit
Account controls
Create user
ID Username Email Role Action
1 willhutcheon willhutcheon@gmail.com employee Delete
2 Alex Olson aolson078@gmail.com admin Delete
3 Alex_Manager amanager@gmail.com manager Delete
4 James james@gmail.com employee Delete
Select User
Choose a user: willhutcheon
Select User
Selected User ID: None selected
Change username
Change password
Permissions
View Reports
Delete Reports
Print Reports
Change Compilation Settings
Save Permissions

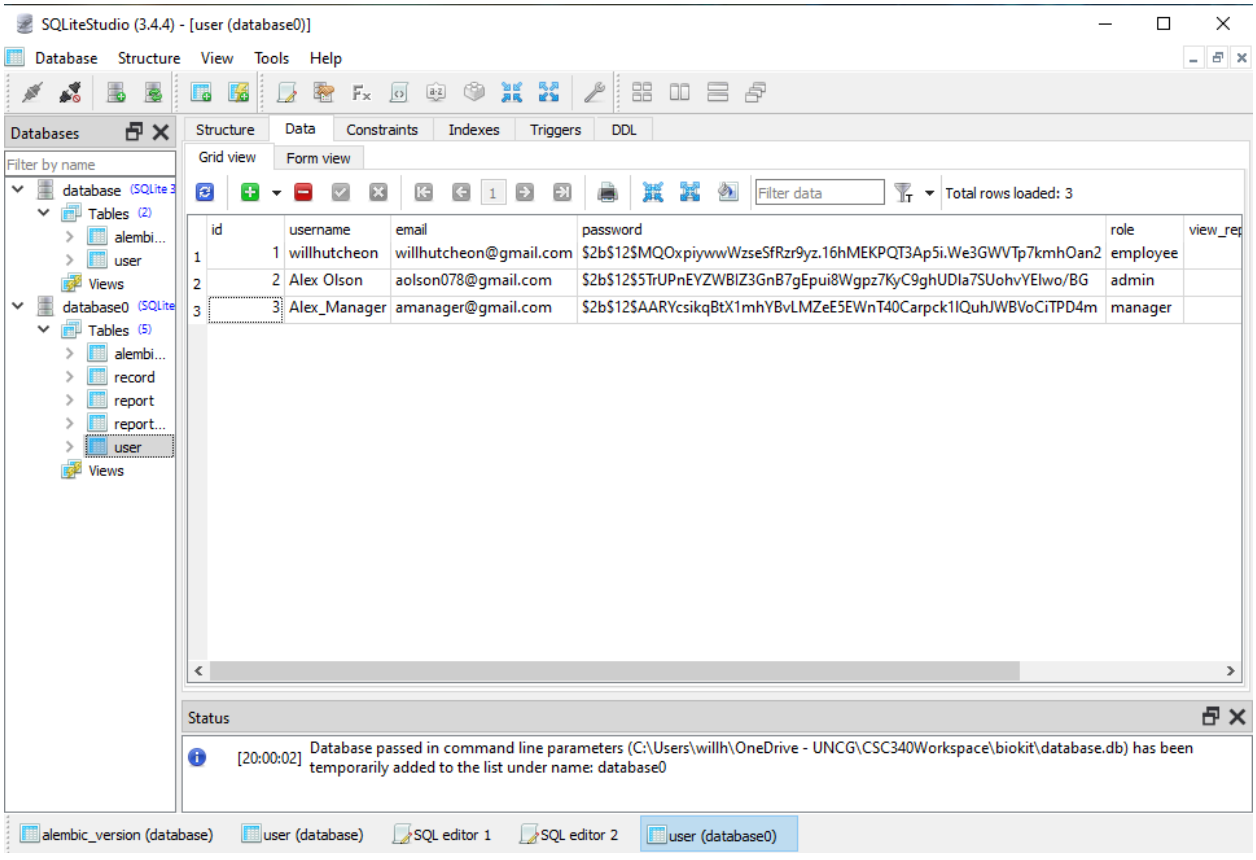

SQLiteStudio (3.4.4) - [user (database0)]
Database
Structure
View
Tools
Help
Databases
Filter by name
database (SQLite 3
Tables (2)
alembi...
user
Views
database0 (SQLite
Tables (5)
alembi...
record
report
report...
user
Views
Structure
Data
Constraints
Indexes
Triggers
DDL
Grid view
Form view
Filter data
Total rows loaded: 4
id username email password role view_rep
1 willhutcheon willhutcheon@gmail.com $2b$12$MQOxpiywwWzseSfRzr9yz.16hMEKPQT3Ap5i.We3GWVTp7kmhOan2 employee
2 Alex Olson aolson078@gmail.com $2b$12$5TrUPnEYZWBIZ3GnB7gEpui8Wgpz7KyC9ghUDIa7SUohvYElwo/BG admin
3 Alex_Manager amanager@gmail.com $2b$12$AARYcsikqBtX1mhYBvLMZeE5EWnT40Carpck1IQuhJWBVoCiTPD4m manager
4 James james@gmail.com $2b$12$PXf2Qyszk6QtyHt0Qt6w9Ot6TgLcPsEo9P.uFf51Juawn6TNJwJfW employee
Status
[20:00:02] Database passed in command line parameters (C:\Users\willh\OneDrive - UNCG\CSC340Workspace\biokit\database.db) has been temporarily added to the list under name: database0
alembic_version (database)
user (database)
SQL editor 1
SQL editor 2
user (database0)

# 7.2.2. Deleting employee

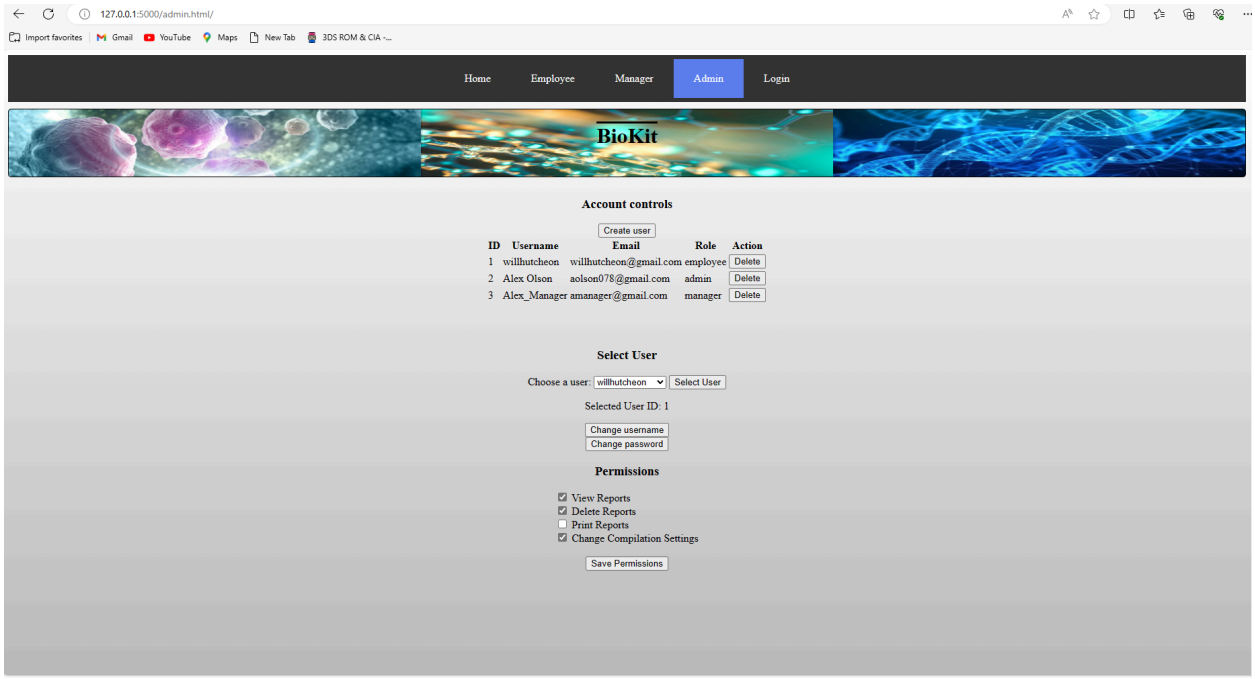



127.0.0.1:5000/admin.html
Import favorites
Gmail
YouTube
Maps
New Tab
3DS ROM & CIA -...
Home
Employee
Manager
Admin
Login
BioKit
Account controls
Create user
ID Username Email Role Action
1 willhutcheon willhutcheon@gmail.com employee Delete
2 Alex Olson aolson078@gmail.com admin Delete
3 Alex_Manager amanager@gmail.com manager Delete
Select User
Choose a user: willhutcheon Select User
Selected User ID: None selected
Change username
Change password
Permissions
View Reports
Delete Reports
Print Reports
Change Compilation Settings
Save Permissions

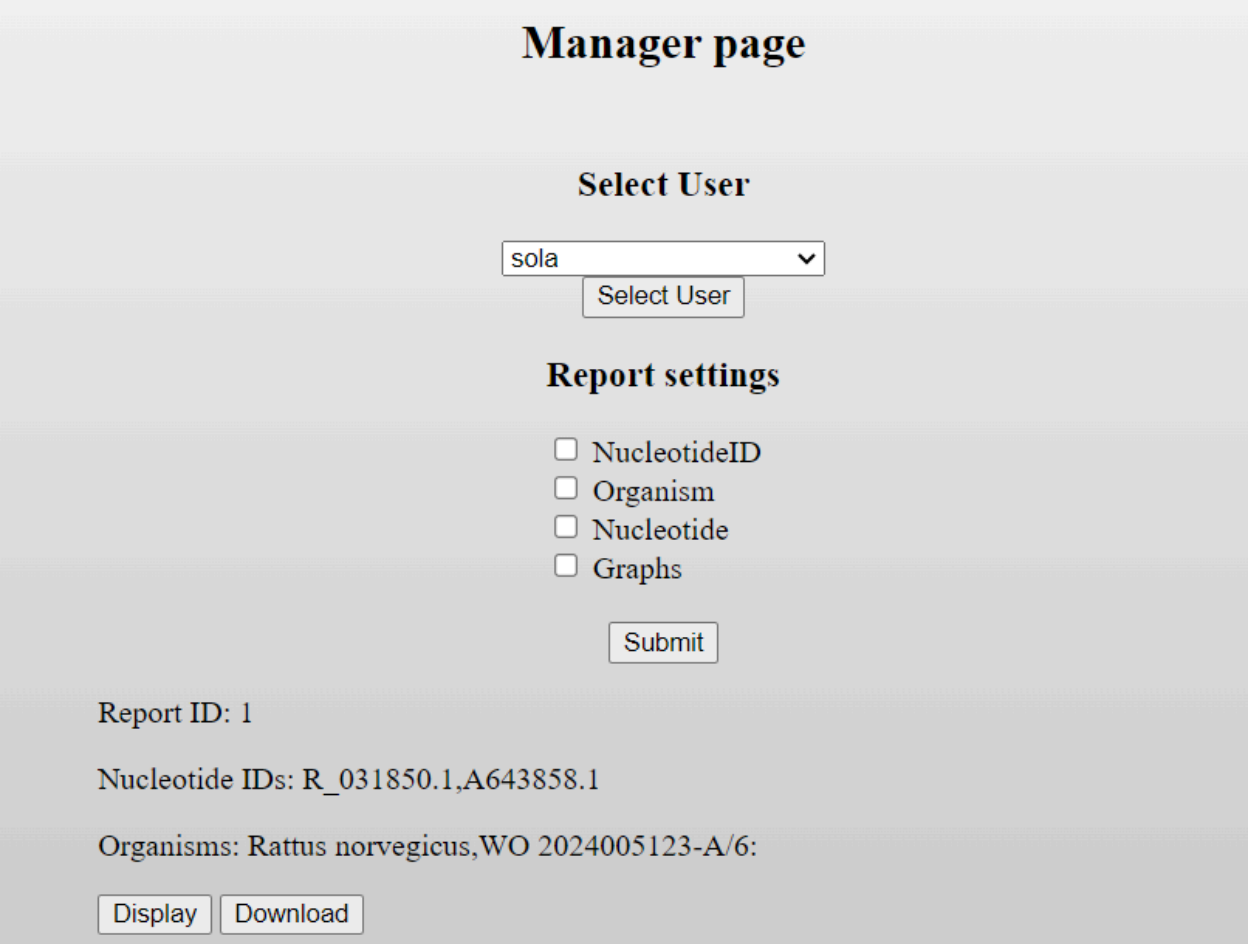

SQLiteStudio (3.4.4) - [user (database0)]
Database Structure View Tools Help
Databases
Filter by name
database (SQLite 3
Tables (2)
alembi...
user
Views
database0 (SQLite
Tables (5)
alembi...
record
report
report...
user
Views
Structure Data Constraints Indexes Triggers DDL
Grid view Form view
Filter data
Total rows loaded: 3
id username email password role view_rep
1 willhutcheon willhutcheon@gmail.com $2b$12$MQOxpiywwWzseSfRzr9yz.16hMEKPQT3Ap5i.We3GWVTp7kmhOan2 employee
2 Alex Olson aolson078@gmail.com $2b$12$5TrUPnEYZWBIZ3GnB7gEpui8Wgpz7KyC9ghUDIa7SUohvYElwo/BG admin
3 Alex_Manager amanager@gmail.com $2b$12$AARYcsikqBtX1mhYBvLMZeE5EWnT40Carpck1IQuhJWBVoCiTPD4m manager
Status
[20:00:02] Database passed in command line parameters (C:\Users\willh\OneDrive - UNCG\CSC340Workspace\biokit\database.db) has been temporarily added to the list under name: database0
alembic_version (database)
user (database)
SQL editor 1
SQL editor 2
user (database0)

# 7.2.3. Modify privileges

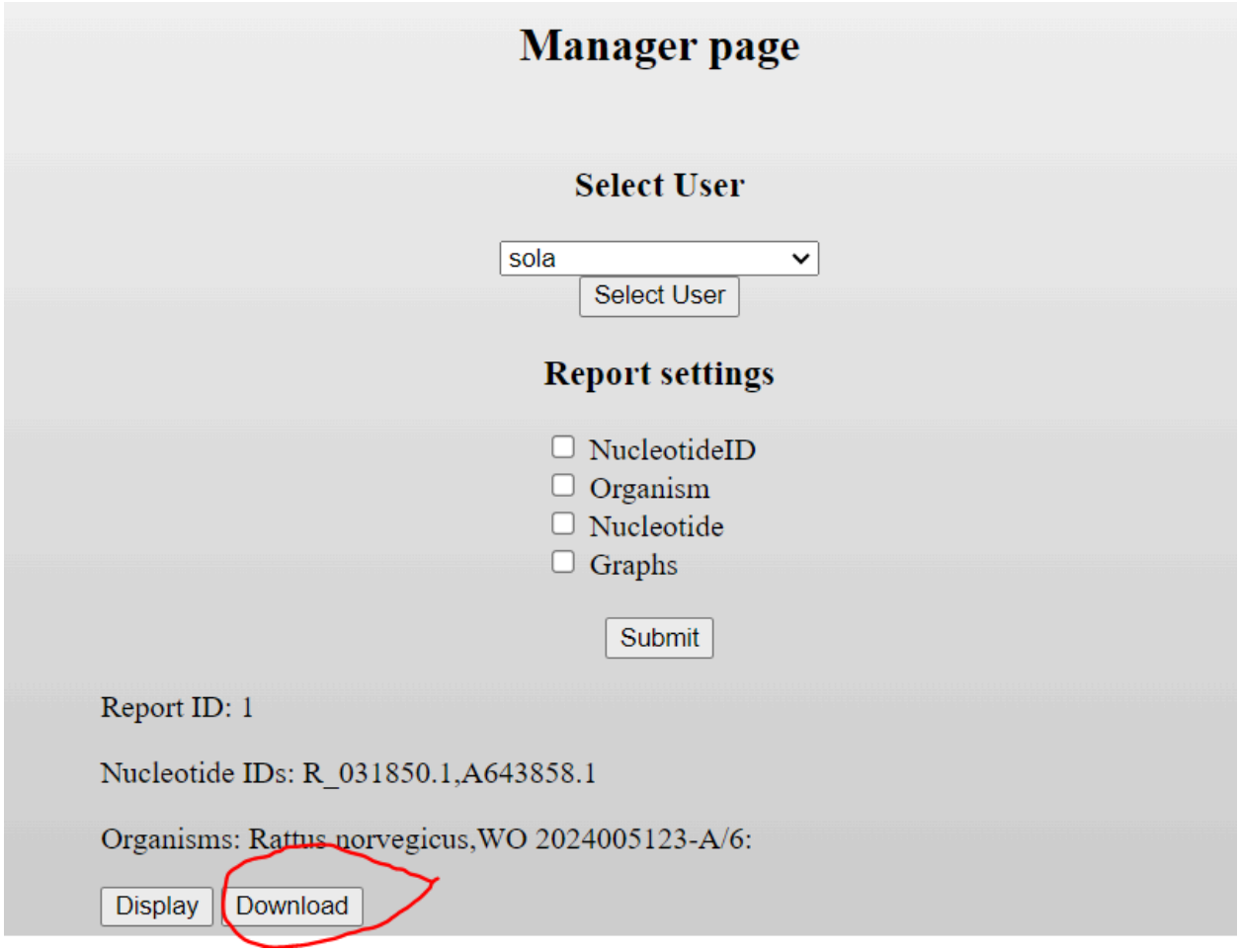


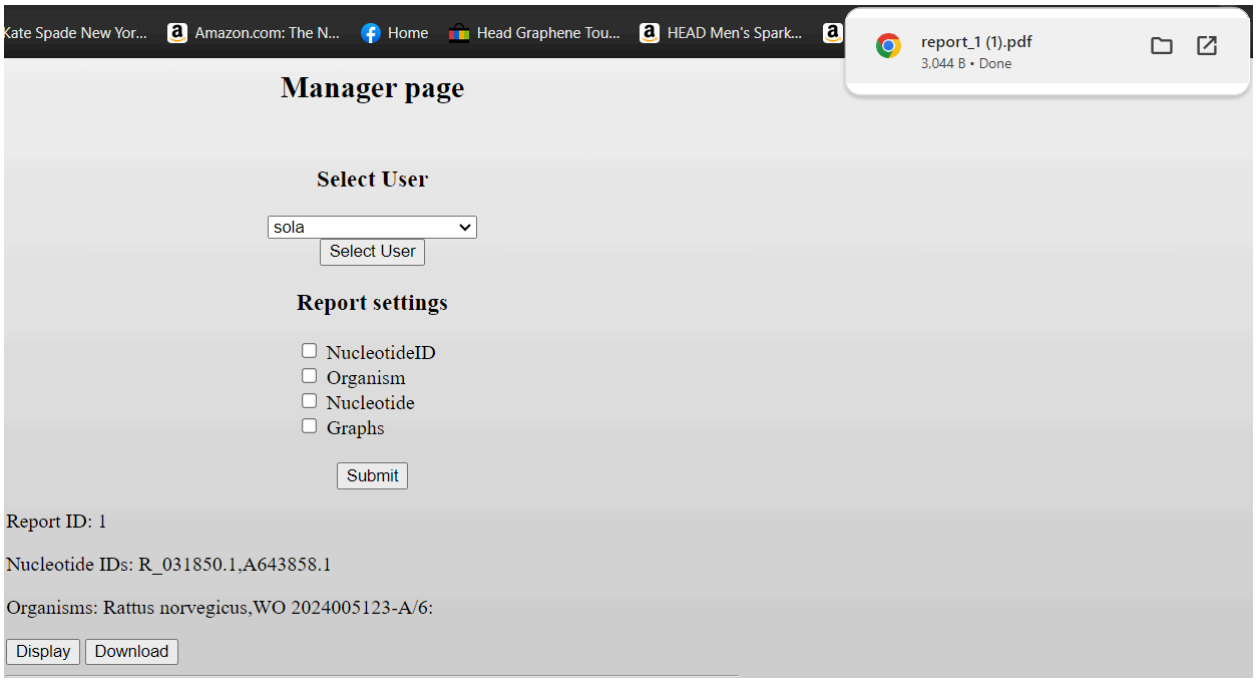
## 7.3. Manager (Sola) Scenario Screenshots

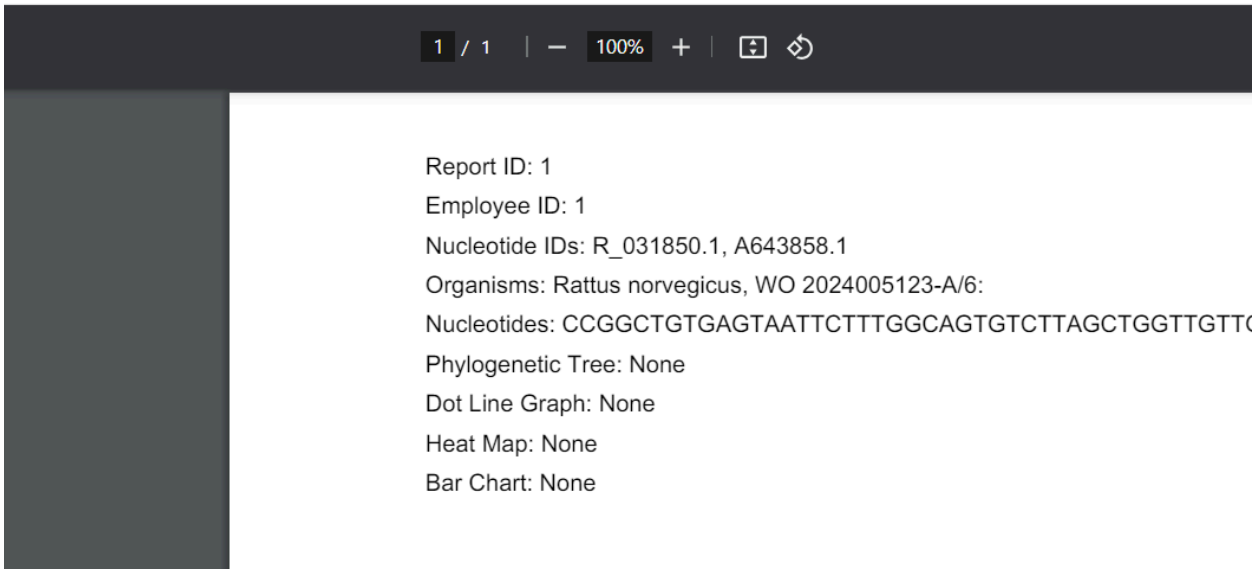
### 7.3.1. View Employee reports



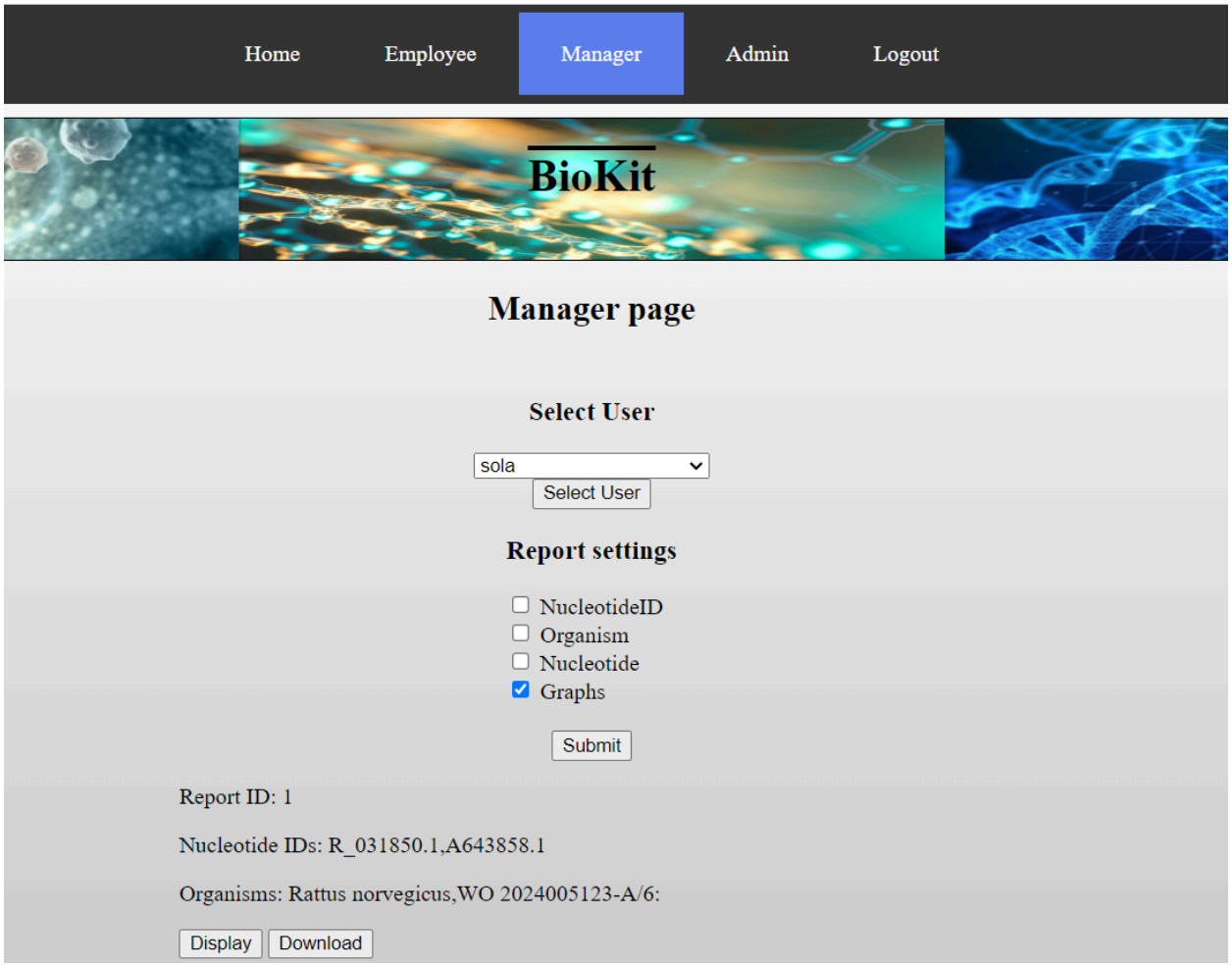
### 7.3.2. Download Employee report to PDF




Xate Spade New Yor...
Amazon.com: The N...
Home
Head Graphene Tou...
HEAD Men's Spark...
report_1 (1).pdf
3,044 B • Done
Manager page
Select User
sola
Select User
Report settings
NucleotideID
Organism
Nucleotide
Graphs
Submit
Report ID: 1
Nucleotide IDs: R_031850.1,A643858.1
Organisms: Rattus norvegicus,WO 2024005123-A/6:
Display
Download


/report_1%20(1).pdf
1 / 1
100%
Report ID: 1
Employee ID: 1
Nucleotide IDs: R_031850.1, A643858.1
Organisms: Rattus norvegicus, WO 2024005123-A/6:
Nucleotides: CCGGCTGTGAGTAATTCTTTGGCAGTGTCTTAGCTGGTTGTT
Phylogenetic Tree: None
Dot Line Graph: None
Heat Map: None
Bar Chart: None

## 7.3.3. Modify report settings (Show no graphs)



YQKSYYLFVLPFRKLIVKGLFSSHKDRTTIVSFILPGYGRKLFLFCMFFLSVILSLAHDTQIPHPCLGVKHNTL
YRVISP*LFEVAWKKQD*LLTLDKNQQISPRVIQMVIDKN*NISLREGVECGLAEQLHFTAFPVKLEH*TFRCI
PNYAWALNIKGWLPALTQHYSSSGQTTVVKQHM*IAF*QLIL**DKAKMQKLGFDWHFLKNMQQIWDVIW
MAASVLNVKYLDTFLNT*QFLLTMTFVRIGTIYHSL*CTLSVTNPQILLYCHLNWYRY**KYLMDNHNTLG
HMFFLQPEGF*KKKISNACCYHPFKLLSFEKHQYVF*IDFPILGK*QTVVSVLMV*AKQIKHVYKSCILKHW
CSTASSLCGSPHALLVFQILWLSPAAVSVVLAFI

## siRNA Prediction:

Small interfering RNA is a non-coding section of RNA that switches of the expression of the selected gene. Candidates are discovered, and then selected based on chosen heuristic values, primarily its precision, meaning the siRNA targets the desired gene, but has minimum side effects on other genes in the same sequence.

ACUUCACUCUUGACUGGACUU

## siRNA Sense Strand Similarity:

An siRNA consists of a sense and anti-sense strand. The sense strand is similar to the target mRNA that is selected to be silenced, so it will always be similar, but a higher % similarity causes more off-target effects, and reduced effectiveness and specificity.

0.14

## Secondary Structure Prediction:

Predicts whether the given nucleotide string is more likely to form an alpha-helix or a beta-sheet structure.

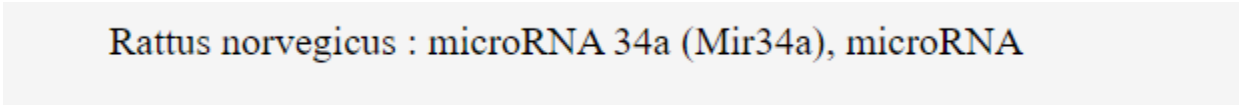
α-Helix

No graph

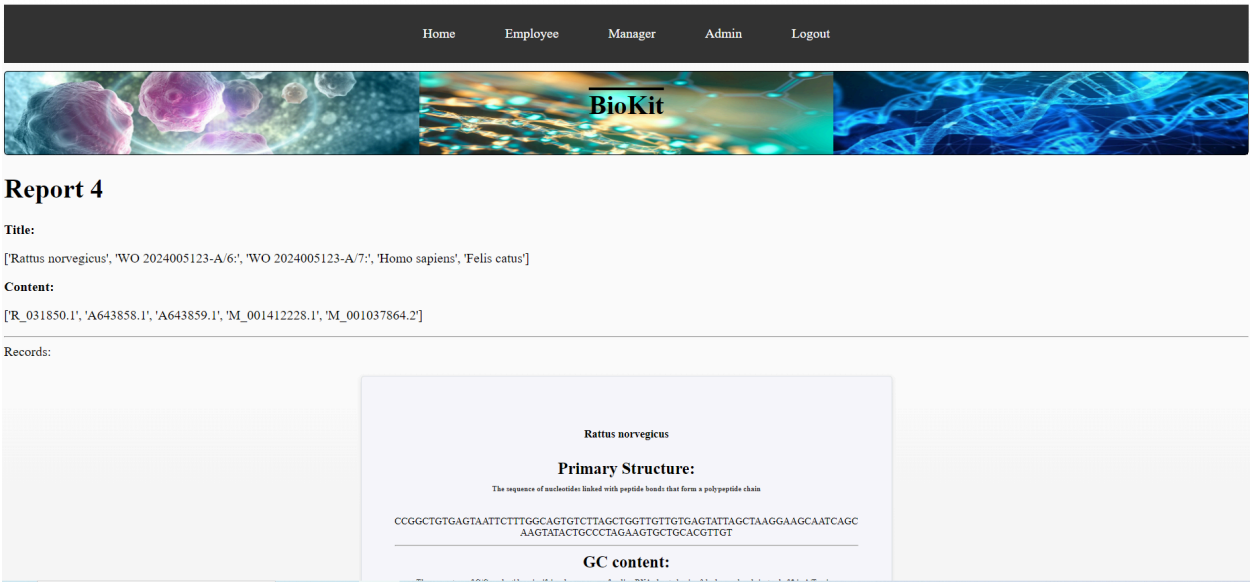
## 7.4. Employee (Alex) Scenario Screenshots

### 7.4.1. Search for organism to query API for nucleotide (cat)

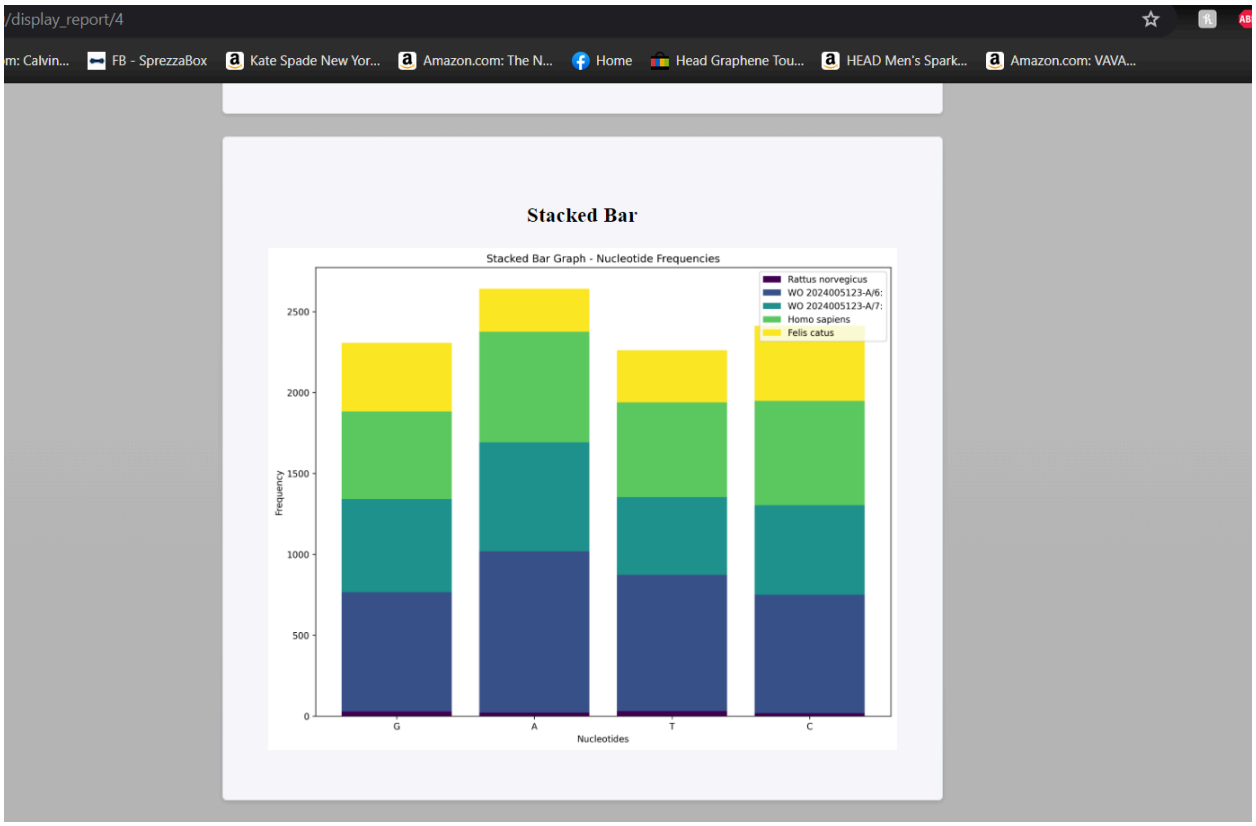

#### 7.4.1.2. Search for another organism



## 7.4.2. Compile the report to be displayed




With graph




# END