

# OpenMicroanatomy Handbook

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This documentation is currently work in progress

#### NOTE

QuPath Edu Server and Cloud were recently renamed to OpenMicroanatomy Server and OpenMicroanatomy Cloud. QuPath Edu Extension continues with the previous name.

# Introduction to OpenMicroanatomy

## What is OpenMicroanatomy

OpenMicroanatomy is a project built on top of QuPath which contains three components: **OpenMicroanatomy Server**, **OpenMicroanatomy Cloud** and **QuPath Edu Extension**.

**QuPath Edu Extension** is an extension for **QuPath**, which allows QuPath projects (called *Lessons* in QuPath Edu) to be synced between multiple users via an **OpenMicroanatomy Server**. The **OpenMicroanatomy Server** handles all the heavy lifting required to authenticate users, upload new slides, manage data and so on. *QuPath Edu* is also compatible with other data sources, such as **Omero**.

OpenMicroanatomy also includes **OpenMicroanatomy Cloud**, which is a web application that communicates with a **OpenMicroanatomy Server** and can be used for **viewing** projects.

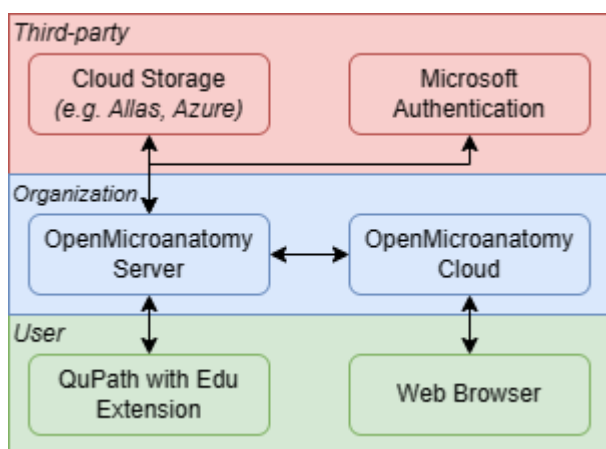


Figure 1. Visual representation of different OpenMicroanatomy components and how they communicate with each other. Green components are downloaded by the end-user and the blue components are set up by the system administrator. Red are optional third-party features.

## Hierarchy

A **OpenMicroanatomy Server** is “compartmentalized” as shown in **Figure 2**. Each server can host one or multiple *Organizations*. Each organization has its own *Workspaces*, which hold *Classes*, which contain the *Lessons*. See **Table 1** for how to think about these.

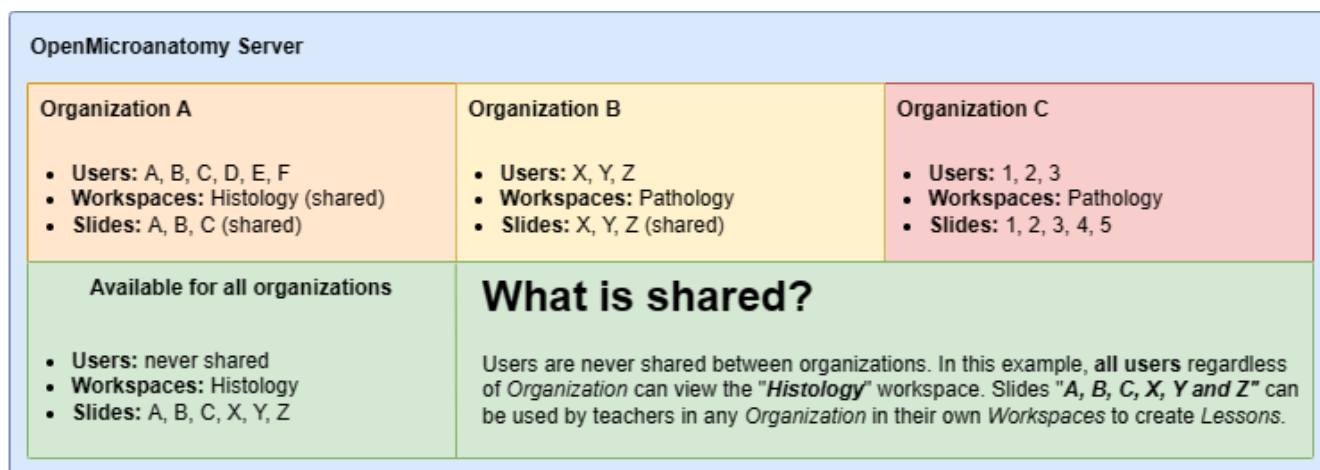


Figure 2. A demonstration of the OpenMicroanatomy hierarchy, with a server with three different organizations.

Table 1. Translations for different OpenMicroanatomy components

Name	Translation
Organization	Represents a university, school, department, or such – depending on your needs
Workspace	A course, such as <i>Histology</i> or <i>Pathology</i> .
Class	A class such as <i>Basic Histology</i> or <i>Advanced Histology</i> .
Lesson	A lesson within that class, such as <i>Epithelium</i> or <i>Connective tissue</i> .

## Getting started

### Feature comparison

☑ = supported ☐ = not supported (and currently no plans to implement) ☐☐ = work in progress

Feature	Browser / Mobile	Desktop app
View slides	☐	☐
Slide tours	☐☐	☐
Creating content	☐	☐
Administrative tasks	☐	☐
Authentication	☐☐☐	☐

### Prerequisites

#### QuPath & QuPath Edu Extension

- A 64-bit Windows, macOS or Linux machine, with at least 250 MB of disk space

#### OpenMicroanatomy Cloud

- None

## OpenMicroanatomy Server

- See [OpenMicroanatomy Server](#) chapter.

# Installing QuPath Edu Extension

1. Install [QuPath](#) by following the instructions on the QuPath website
2. Download the [QuPath Edu extension](#)
3. Install the extension by drag and dropping the downloaded `.jar` file to the QuPath viewer

See [here](#) for more detailed instructions on how to install QuPath extensions

## QuPath Edu Extension

### Connecting & authenticating

#### First time setup

When starting QuPath Edu for the first time, you'll see the *First-time setup* dialog. You must either select a *public host* or enter your **QuPath Edu Servers** address to continue. If you are unsure what your institutions address is, try contacting your IT-services. Public hosts are QuPath Edu Servers which can be freely viewed by anyone. Currently the only public host is the demo server provided by the University of Oulu.

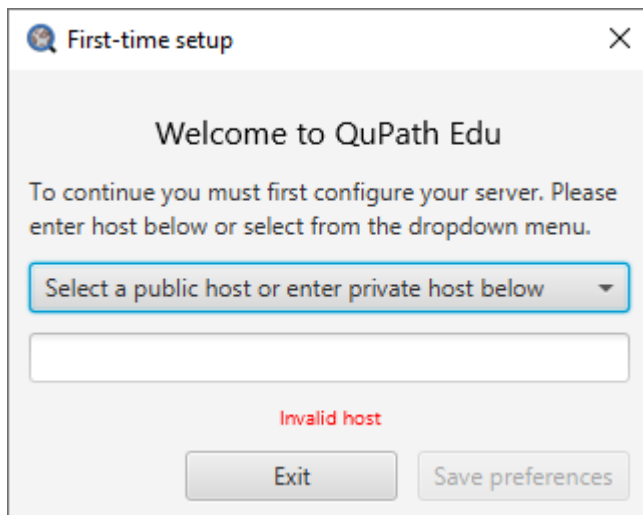


Figure 3. First-time setup dialog

You can change your host later by clicking the **Change host ...** link on the **Login dialog** (see [Figure 4](#)) or from the QuPath settings **Edit > Preferences > Edu**

#### Logging in

You can continue either **Continue as a guest** (*only read permissions*) or authenticate using

**Credentials** (regular email & password combination) or a **Microsoft account**.

#### NOTE

Logging in using Credentials and/or Microsoft Authentication may not be available on your organization depending on your *OpenMicroanatomy Server* setup.

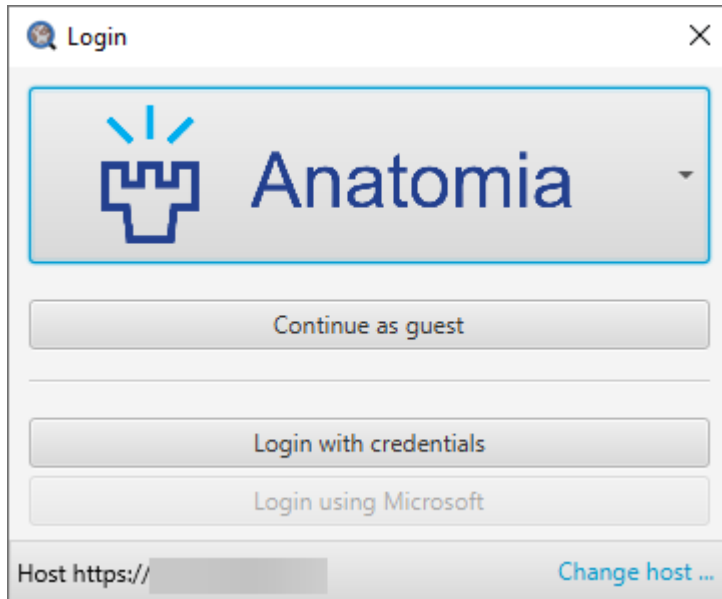


Figure 4. Login dialog. Change host by pressing the [ **Change host ...** ] on the bottom-right hand corner.

## Password recovery

If you forgot your password, you can recover your password by pressing [ **Login with credentials** ] and then [ **Forgot password** ] from the bottom right-hand corner.

## Creating content

Going further, it's assumed the reader is already familiar with QuPath. If you have never used QuPath before, it's advised to read the [QuPath documentation](#) first.

Before making changes anywhere, confirm that you have **Editing mode enabled** by pressing [ **Turn editing on** ] on the QuPath toolbar (see [Figure 5](#) below). If any button is disabled, try checking first that **a)** edit mode is enabled, **b)** you're logged in **b)**, you have the required permissions to make changes (see [Users & Roles](#)).

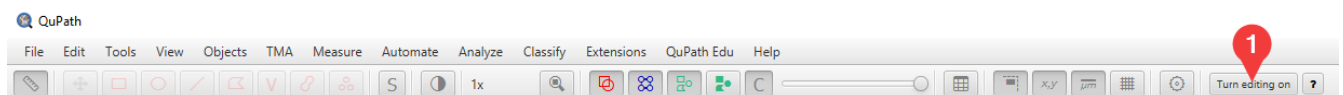


Figure 5. QuPath Toolbar. Notice how the annotation tools are disabled because editing mode is not turned on.

## Creating workspaces, courses and lessons

Begin by opening the **Select lesson** (see [Figure 7](#) below) interface by pressing either [ **Open lesson** ] or [ **Create lesson** ] buttons in the main QuPath interface on the left sidebar (see [Figure 6](#) below).

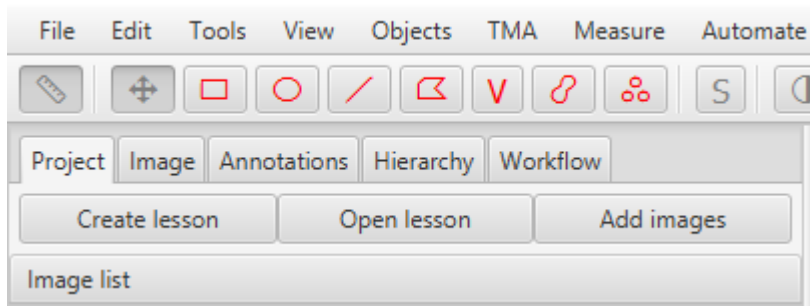


Figure 6. Buttons to open and create lesson, and add images

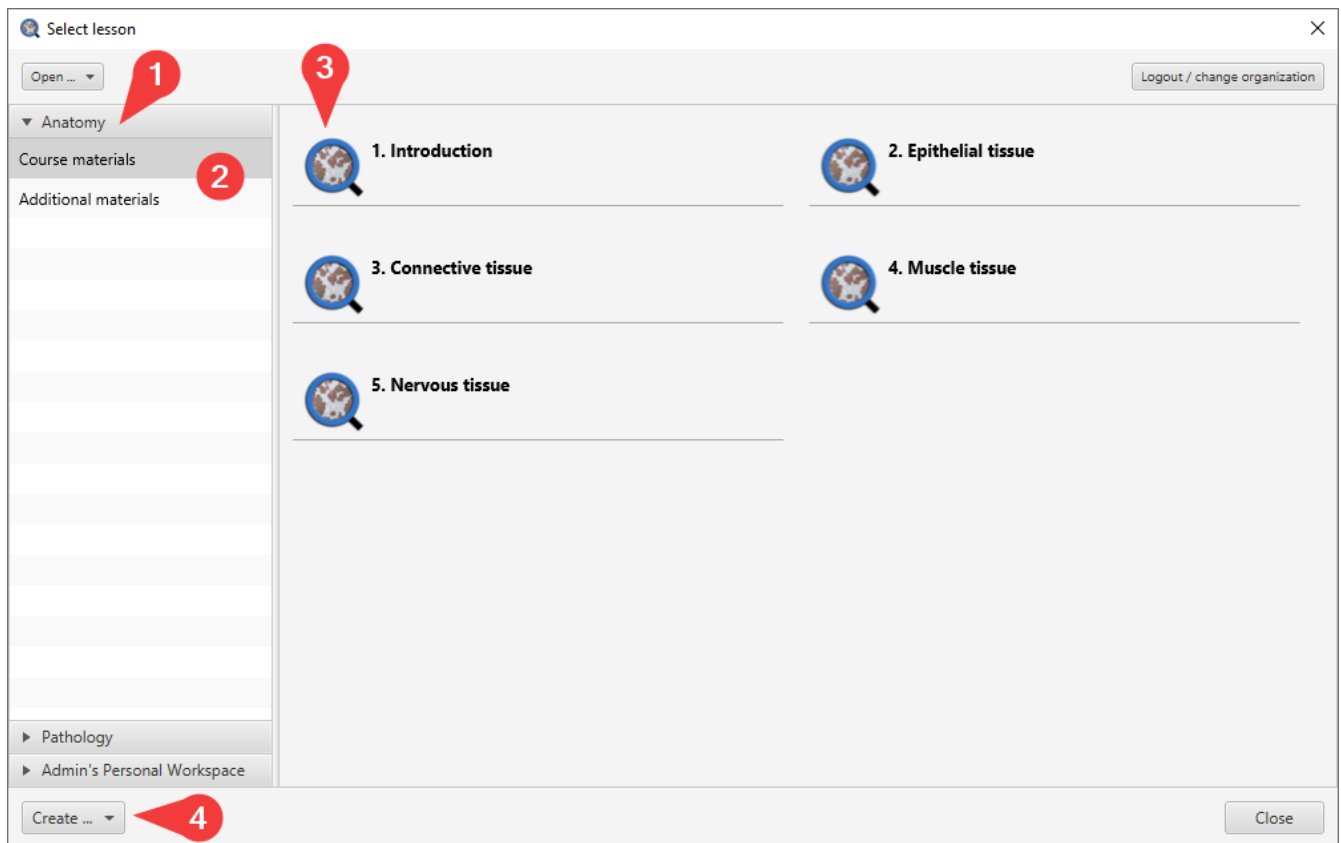


Figure 7. 1: A workspace named Anatomy. 2: Two courses named Course materials and Additional materials. 3: Five lessons belonging to the Course materials course. 4: Create a workspace, course or a lesson.

Create new workspaces by pressing **[ Create ... ]** and selecting either **Workspace**, **Course** or **Lesson**. **Course** and **Lesson** are disabled until you select a **Workspace**.

**Delete or rename** any **Workspace**, **Lesson** or **Class** by right-clicking on it. You can also **hide** Classes or set a **description**. Hiding a Class will hide that Class from guests and users without write permissions. Deleting a Workspace will delete all Lessons and Classes belonging to that Workspace and similarly deleting a Lesson will delete all Classes belonging to that Lesson.

#### WARNING

Deleting a workspace, lesson or class is currently not reversible. See [Backups](#) for more details.

## Adding slides to a lesson

To add a new slide click on **[ Add images ]** (next to **[ Open lesson ]**, see [Figure 6](#) above) to open the

**Slide manager** interface. From here, select any slide you wish to add and click on [ **Add selected** ]. This will open the **QuPath Image Import** interface. These settings are important if you're planning on doing any analysis on the slides later. The default options and setting the **Image type** to **Brightfield (H-DAB)** is usually enough for teaching purposes. Clicking on [ **Import** ] will add the slide to the lesson.

## Making changes to slides

Adding annotations, modifying slide description or such work identically as in QuPath, just make sure you have **enabled editing mode** (see [Figure 5](#)). Read the [QuPath documentation](#) for detailed information on annotating and such.

Any changes will be saved when either **a)** clicking on **File > Save** or **File > Save as**, **b)** changing slides, **c)** closing the lesson.

## Modify Lesson Information

Edit the **Lesson Information** by either **a)** double-click anywhere on the **Lesson Information** tab **b)** **File > Project... > Edit lesson information**.

Lesson Information supports **rich text**, which includes custom fonts, colors, tables, images, videos, hyperlinks and much more.

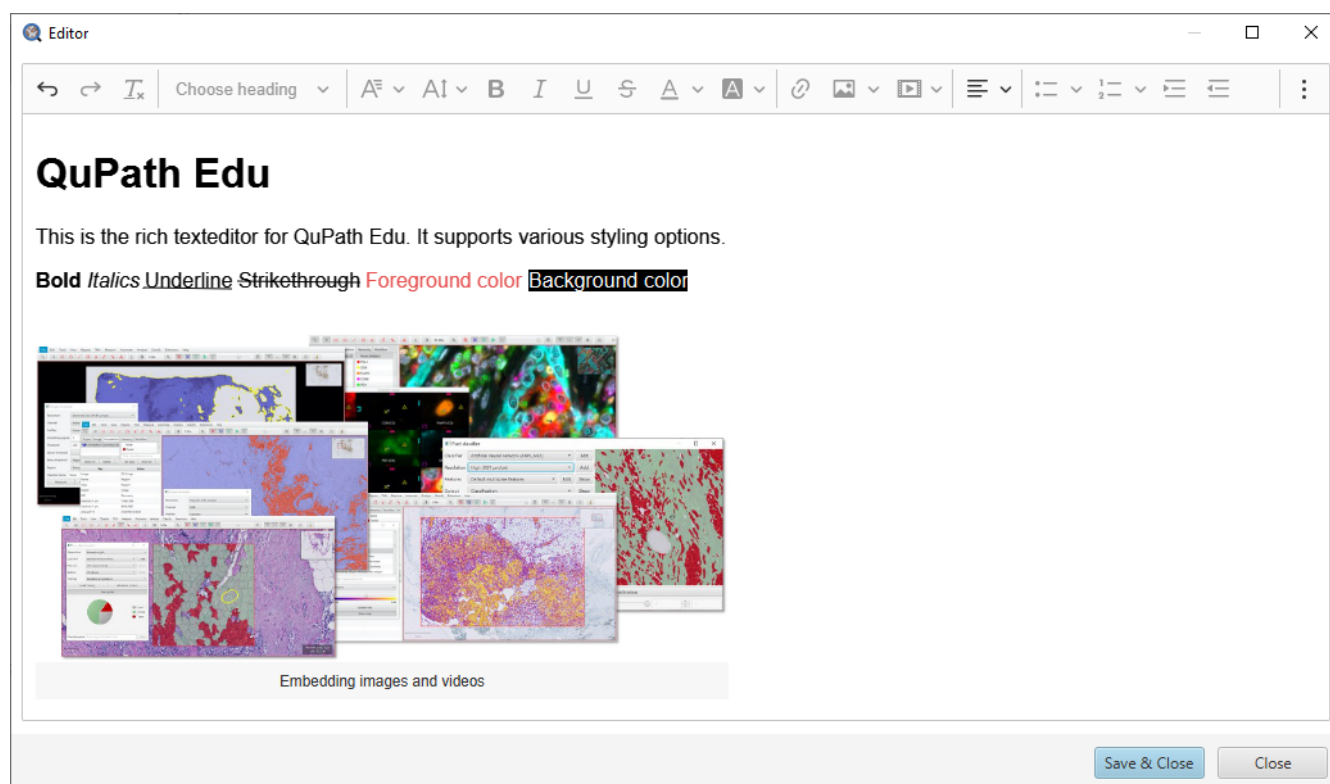


Figure 8. Rich text editor.

## Creating slide tours

**Slide tours** are a feature introduced by QuPath Edu, it allows teachers to create short guided tours of slides, going through the key points of a slide.

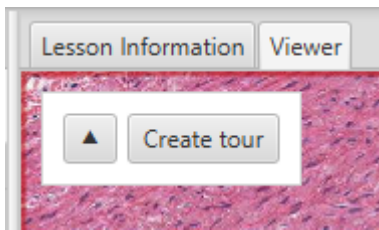


Figure 9. Create slide tour button on viewers top-left corner.

Slide tours consists of "**frames**", which the user views one-by-one. To create a **Slide tour**, press on **[ Create tour ]** tour on the Viewers top-left corner. Next click on **More ▾ > Create new frame**, and pan & zoom on the point of interest, make any annotations you wish. Set a description for this frame by pressing **More ▾ > Edit text**. Save changes by clicking on **More ▾ > Save changes**. Create as many frames you wish by clicking **More ▾ > Create new frame** and again making any annotations, panning & zooming, setting a description and saving the changes with **More ▾ > Save changes**. Preview your slide tour by clicking on **[ Previous ]** and **[ Next ]**.

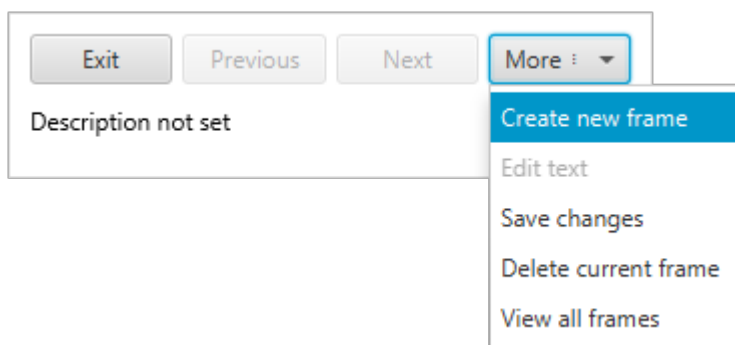


Figure 10. Slide tour editing interface

## Administrative tasks

Most administrative tools are available by selecting **QuPath Edu > ...** from the QuPath top bar. Some administrative tasks requires access to the server and are detailed in the [OpenMicroanatomy Server](#) chapter.

### Users & Roles

Manage users by opening the **User management** interface using **QuPath Edu > Manage users**.



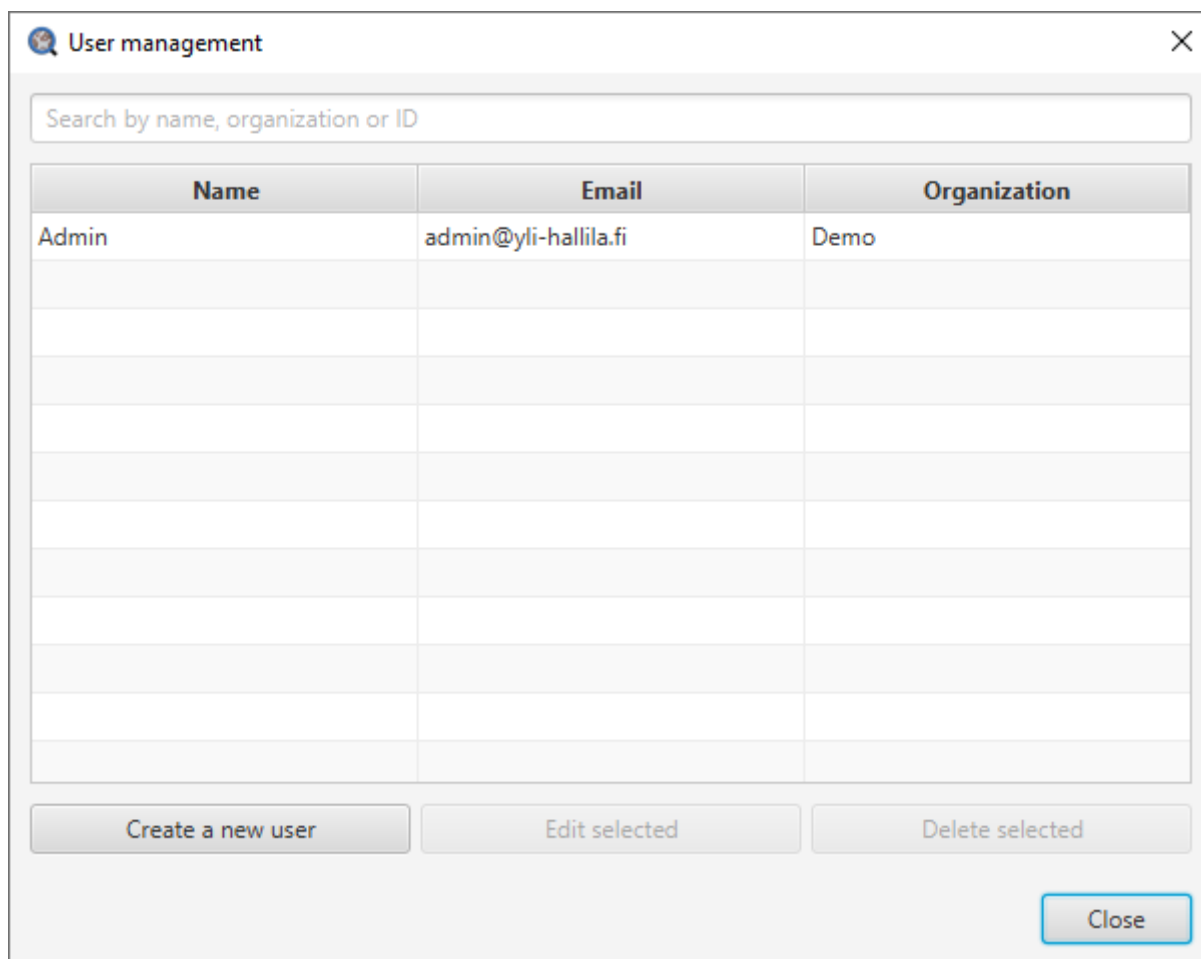


Figure 11. User management interface

Users with the **Administrative tasks** role are able to view & modify all users regardless of organization. Users with only the **Manage users** roles can only view & modify users that belong to the users organization.

Only users with the **Administrative tasks** role are able to migrate users to a different organization.

Passwords are required to have at least 3 characters, no other requirements.

Table 2. Explanation for different roles

Role	Explanation
Manage slides	Upload new slides and delete / modify slides that are owned by the users organization.
Manage users	Create new users and edit existing users on the users organization.
Moderator tasks	Create new workspaces, courses and lessons on the users organization.
Administrative tasks	All permissions, regardless of organization.

## Slides

Manage slides by opening the **Slide management** interface using **QuPath Edu > Manage slides**.

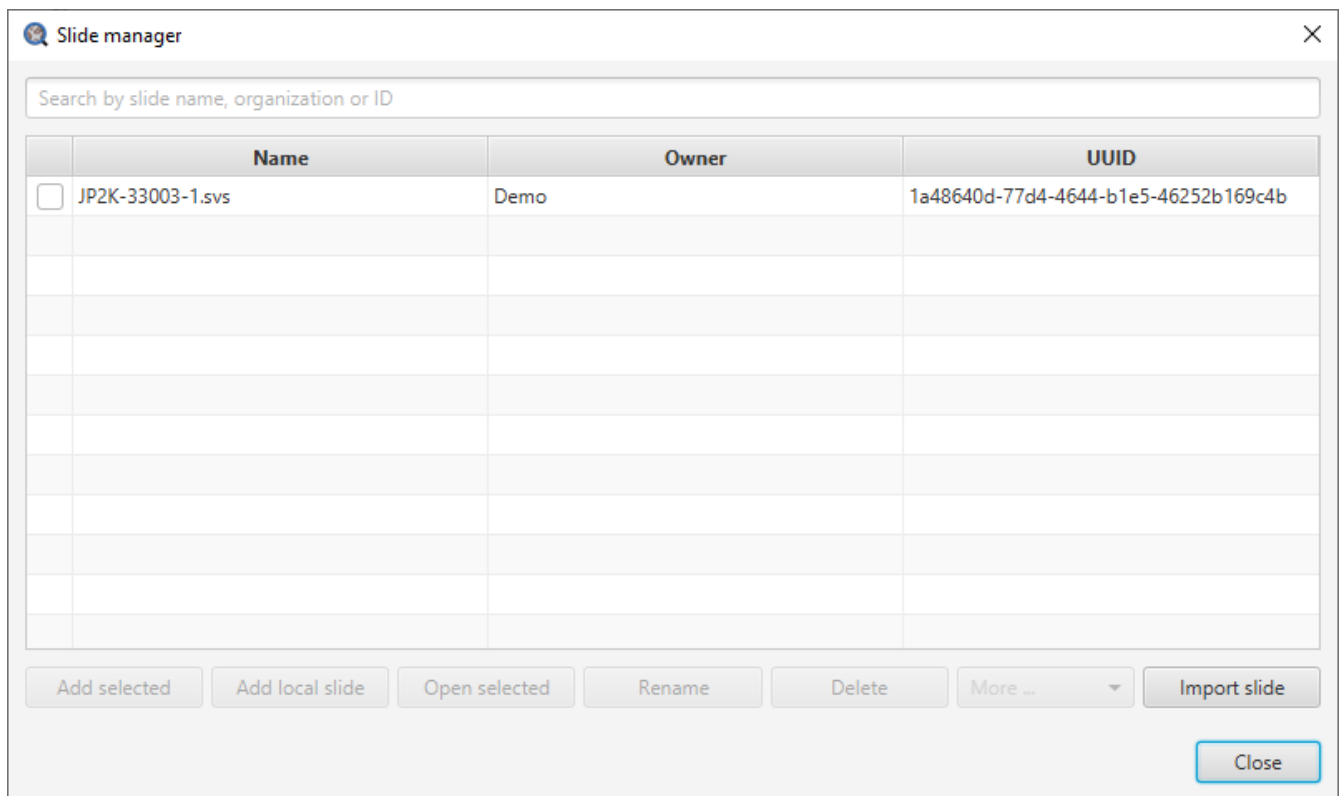


Figure 12. Slide management interface. Each slide has an UUID (Universal Unique Identifier) which distinguishes it from others.

Users with the **Administrative tasks** roles are able to view & modify all slides regardless of organization. Users with only the **Manage slides** roles can only view & modify slides that belong to the users organization.

**Import new slides** by clicking the [ **Import slide** ] button. QuPath verifies that the selected slide is compatible with QuPath Edu and starts uploading it. After upload the OpenMicroanatomy Server processes the slide which can take up to 30 minutes depending on the slide size and server performance.

**Deleting** a slide will make it inaccessible from any Lesson that contains it but **will not** remove it from the slide listing. Deleted slides must be removed manually from each lesson also. **Renaming** a slide will only affect slides added in the future.

## WARNING

In OpenMicroanatomy Server **version 1.0** deleting slides only makes them inaccessible but **does not** remove the data stored. It is up to the server administrator to delete any associated data.

You can view any slide by clicking on **[Open selected]**. If you have a lesson open, you will be prompted to add that slide to the current project.

## Backups

Manage **lesson** backups by opening the **Backup management** interface using **QuPath Edu** › **Manage backups**.

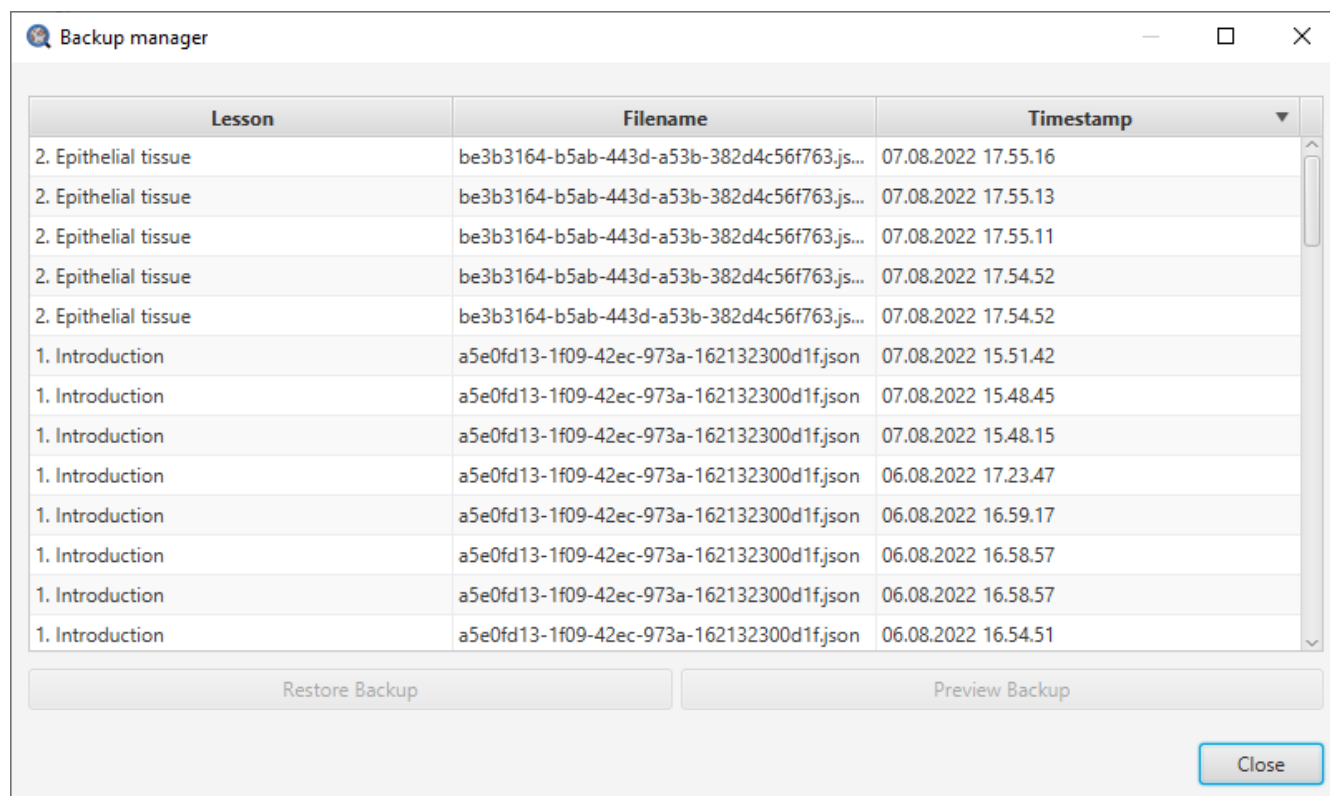
Restore a lesson by selecting the lesson and pressing **[ Restore backup ]** or preview it first by pressing **[ Preview backup ]**. Backups are automatically deleted after 30 days.

## WARNING

Currently there's no way to restore a deleted workspace / class or a lesson without administrative tools. A whole database backup is performed every 24 hours, which can be used to restore any deleted workspace / class or lesson.

## NOTE

In QuPath Edu Server version 1.0 a bug exists, which allows users with write permissions to preview all backups regardless of organization. Restoring backups is still limited to users with proper write permissions to a specific workspace.



Lesson	Filename	Timestamp
2. Epithelial tissue	be3b3164-b5ab-443d-a53b-382d4c56f763.js...	07.08.2022 17.55.16
2. Epithelial tissue	be3b3164-b5ab-443d-a53b-382d4c56f763.js...	07.08.2022 17.55.13
2. Epithelial tissue	be3b3164-b5ab-443d-a53b-382d4c56f763.js...	07.08.2022 17.55.11
2. Epithelial tissue	be3b3164-b5ab-443d-a53b-382d4c56f763.js...	07.08.2022 17.54.52
2. Epithelial tissue	be3b3164-b5ab-443d-a53b-382d4c56f763.js...	07.08.2022 17.54.52
1. Introduction	a5e0fd13-1f09-42ec-973a-162132300d1f.json	07.08.2022 15.51.42
1. Introduction	a5e0fd13-1f09-42ec-973a-162132300d1f.json	07.08.2022 15.48.45
1. Introduction	a5e0fd13-1f09-42ec-973a-162132300d1f.json	07.08.2022 15.48.15
1. Introduction	a5e0fd13-1f09-42ec-973a-162132300d1f.json	06.08.2022 17.23.47
1. Introduction	a5e0fd13-1f09-42ec-973a-162132300d1f.json	06.08.2022 16.59.17
1. Introduction	a5e0fd13-1f09-42ec-973a-162132300d1f.json	06.08.2022 16.58.57
1. Introduction	a5e0fd13-1f09-42ec-973a-162132300d1f.json	06.08.2022 16.58.57
1. Introduction	a5e0fd13-1f09-42ec-973a-162132300d1f.json	06.08.2022 16.54.51

Restore Backup Preview Backup Close

Figure 13. Backup management interface.

## Organizations

Manage organizations by opening the **Organization management** interface using **QuPath Edu › Manage organizations**.

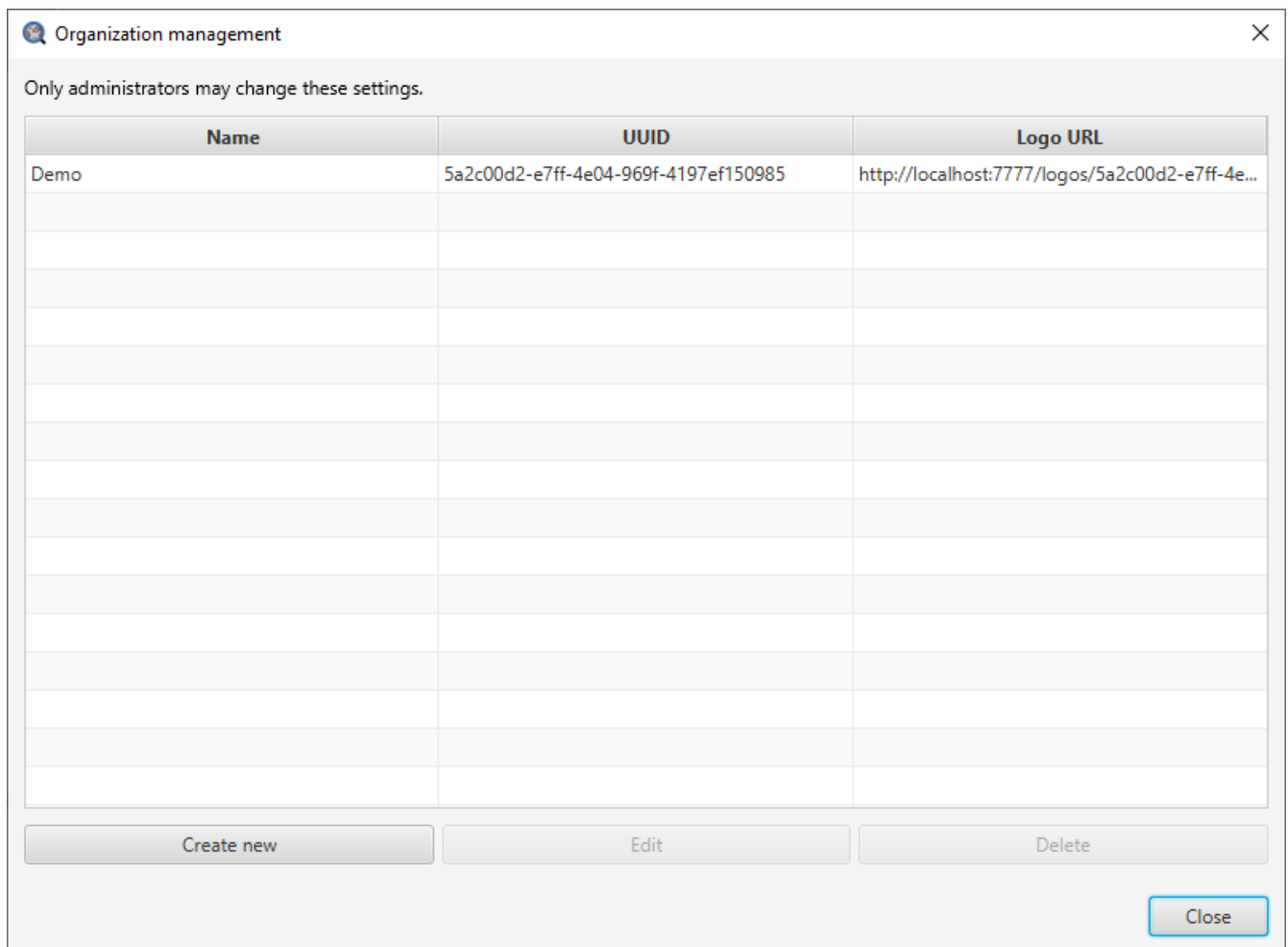


Figure 14. Organization management interface. Each organization has an UUID (Universal Unique Identifier) which distinguishes it from others.

**Making any changes to an organization requires the *Administrative tasks* role.**

**Deleting** an organization will delete **permanently all data** associated with that project, including **workspaces, lessons, courses, users, and slides**.

Clicking **[ Edit ]** allows you to **rename** and **upload a logo** for that organization, see [Figure 13](#).

## Organization logo requirements

- PNG filetype
- Size of 400x80 px or greater
- Aspect ratio of 5:1

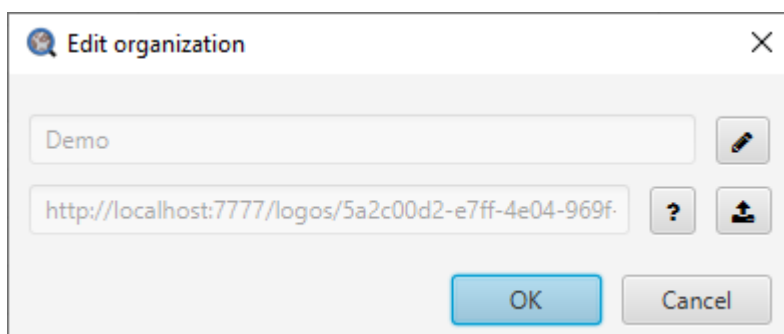


Figure 15. Edit organization dialog.

## Permissions

Manage permissions by opening the **Permission management** interface using **QuPath Edu › Manage permissions**.

By default, when creating a new workspace, it is automatically assigned the **Write** access for **yourself** and **Read** access to **no-one**. You can restrict access to either **a)** only yourself, **b)** specific organizations, **c)** specific users, **d)** combination of users and organizations.

Simply use **[Add]**, **[Remove]**, **[All]** and **[Only]** to add/remove permissions. Double-arrows moves **all items** and single-arrows move **only the selected item**. Clicking **[?]** will give you an analysis of who has read/write permissions in plain English.

Remember to press **[ Save changes ]** (bottom right-hand corner) separately on "Read" and "Write" respectively; currently QuPath Edu gives **no warning** if forgetting to save any changes.

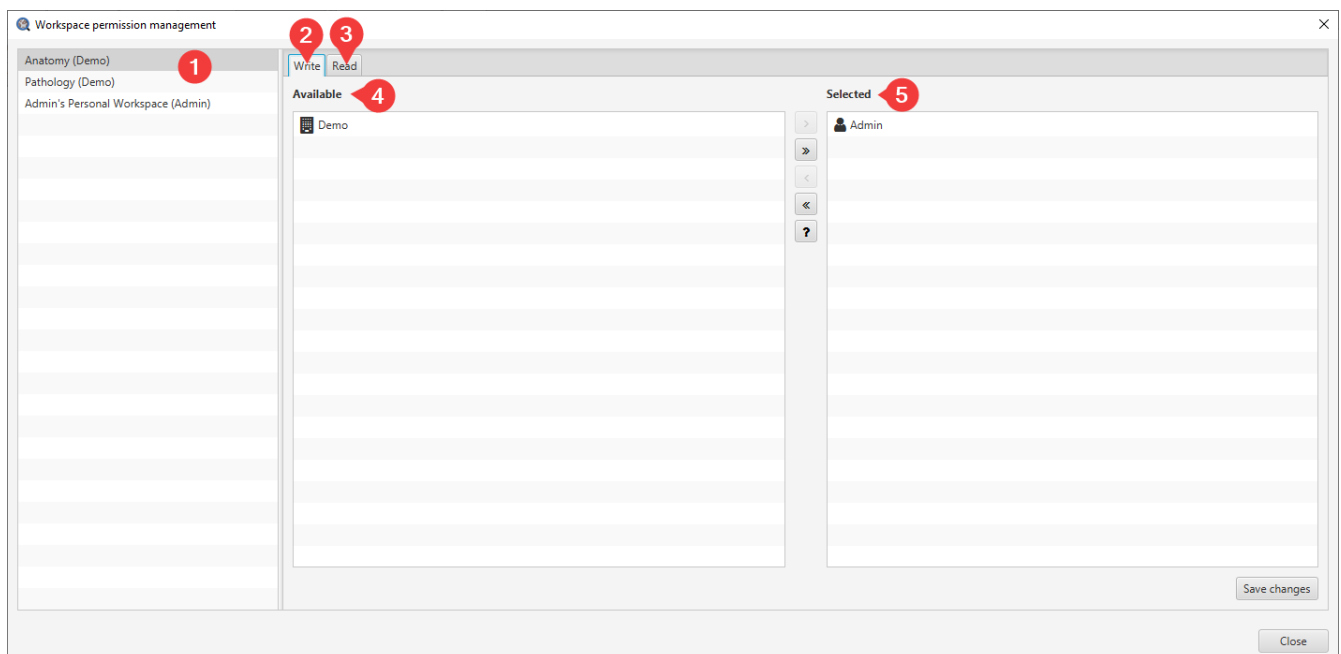


Figure 16. Permission management interface. **1:** List of all workspaces, the organization is specified in parentheses. **2 & 3:** Read & write permissions separated in different tabs. **4 & 5:** Left pane indicates any users/organizations available and right pane indicates users/organizations with active permissions.

## OpenMicroanatomy Cloud

Documentation in progress.

Source code and more details are available at [openmicroanatomy/web](https://openmicroanatomy/web).

## OpenMicroanatomy Server

**NOTE** | The Docker container is still in beta but is stable for production use.

# Installation & Running

OpenMicroanatomy Server consists of two components: a **HTTP server** which handles authentication, data (slides, projects, backups, etc...) and so on, and of a **tiler** which runs in the background and converts slides into smaller chunks called **tiles**. Without the **tiler** running you cannot upload new slides; this separation of tasks is due to legacy reasons and both components are hopefully bundled together in version 2.0.

## Installation (Docker)

### Prerequisites

- Server with Docker support

### Installation

1. To get started, download the OpenMicroanatomy Docker configuration: `wget https://raw.githubusercontent.com/openmicroanatomy/hosting/main/docker-compose.yml`
2. `cd hosting`
3. Start the server for the first time using `docker-compose run server`
4. Follow the instructions to create the initial organization and administrator account.
  - Organization name and administrator account can be edited later
5. After creating the initial organization and administrator account stop the server by inputting `stop` into the terminal or by pressing `CTRL + A + CTRL + C` to exit.
6. Edit the `application.conf` using e.g. `nano` or `vi`
  - Most important step is to configure `server.host` to match your reverse proxy address; otherwise slides *will not work* and fixing them later is can be cumbersome — see [Fixing Incorrect Slide Paths](#).
  - See [Configuration](#) chapter below for more details.
7. Start the server using `docker-compose up -d` which will start both the **Server** and **Tiler**.

*If you wish to run OpenMicroanatomy without the **Tiler**, just comment the lines for **Tiler** inside `docker-compose.yml`.*

### Updating

OpenMicroanatomy uses semantic versioning `MAJOR.MINOR.PATCH`, meaning no breaking changes happen unless the major version changes (e.g. from 1.X.X to 2.X.X). If you're using `:latest` (default) as the Docker container version you may accidentally update to a newer major version. It is recommended that you pin your version to e.g. `:v1` to allow minor and patch upgrades or `v1.1` to allow only patches by editing `docker-compose.yml`.

1. `docker-compose down`
2. `docker pull openmicroanatomy`
3. `docker-compose up -d`

## Installation (Manually)

### WARNING

Manual OpenMicroanatomy installations are no longer supported. Assistance for any issues with manual installations **cannot be guaranteed**.

### Prerequisites

- Server with Java 14 support

### Installation

*These instructions assume you're familiar with Linux already and skips multiple crucial steps such as creating a new user.*

It's advised to create a separate user, such as `openmicroanatomy` and to use software such as `screen` to create separate sessions for both instances. Both the tiler and server must be running on the same server.

1. Download the latest `open-microanatomy-server.jar` from [GitHub](#).
2. Save it to e.g. `/home/openmicroanatomy/server/open-microanatomy-server.jar`
3. Extract OpenSlide Binaries
  - *these are currently only available from the [QuPath repository](#) — download the `.jar` file specific to your operating system and **extract** it to where you saved `qupath-edu-server.jar`.*

### Running the server

1. Start the server with `java -jar <jar> [-port <port>]`
2. During your initial start-up, you will create your first administrator account.

### Running the tiler

1. Start the tiler with `java -jar <jar> --tiler`
2. Tiler validates that everything is working as expected and will wait for new slides.

### Updating

Download the latest `open-microanatomy-server.jar` from GitHub and restart any running `screen`.

### Systemd service

To start OpenMicroanatomy automatically or restart it in case the process gets killed, you can create a **Systemd** service for it.

## Configuration

Configuration is available at `application.conf` which will be generated during the initial start-up, it contains comments for instructions. The default configuration has sensible defaults, but you're free to tweak anything you wish.

The **only required configuration step** is setting the `server.host` parameter — this should point to your reverse proxy address (see [SSL](#) chapter). **Your server will not function properly if you do not set the host parameter.**

For storing the tiles there are two options. **Flatfile (default)** storage uses the servers disk to store any tiles. For **Cloud storage** currently [CSC Allas](#) is only supported, with initial support for **Amazon S3** existing. If you're interested in support for [Amazon S3](#) or any other cloud provider, please create a [GitHub issue](#) regarding this.

To **generate a new configuration** simply delete the old one and restart the server. To **reload the configuration** you must restart the server.

## SSL

OpenMicroanatomy does **not** include SSL by default and it is up to the end-user to set up a **reverse proxy** using software such as [Caddy](#), [nginx](#) or [Apache](#) to provide a secure connection.

### No existing reverse proxy

If your DNS includes an automatic SSL proxy option, feel free to try that. Alternatively you can set up your own Caddy server as a reverse proxy or use the provided Caddy Docker container as described below.

#### Setting up a Caddy server using Docker

1. Shut down any Docker instances: `docker-compose down`
2. Download the *Caddy Docker configuration* using `wget https://raw.githubusercontent.com/openmicroanatomy/hosting/main/docker-compose.caddy.yml`
3. Edit the *Caddy Docker configuration*: `nano docker-compose.caddy.yml`
4. Change `virtual.host` to your domain name without `https://` e.g.: `virtual.host: 'example.com'`
5. Change `virtual.tls-address` to your administrator email account e.g. `virtual.tls-address: 'john.smith@example.com'` — this is not revealed to anyone and only used by CertBot to notify about any issues with the SSL certificate.
6. **Save and exit**
7. Edit the *OpenMicroanatomy Docker configuration*: `nano docker-compose.yml`
8. Under `ports` change - `'7777:7777'` to - `'127.0.0.1:7777:7777'` to prohibit access using insecure HTTP
9. **Save and exit**
10. Run `docker-compose -f docker-compose.yml -f docker-compose.caddy.yml up -D` to restart server
11. **Done:** OpenMicroanatomy should be accessible via <https://example.com>

### Existing reverse proxy

Configure your existing Apache / nginx server to behave as a reverse proxy for OpenMicroanatomy.



Below is an example nginx reverse proxy configuration using [Certbot](#).

```
server {
    server_name open.microanatomy.server;

    access_log /var/log/nginx/reverse-access.log;
    error_log /var/log/nginx/reverse-error.log;

    include /etc/nginx/conf/proxy.conf;

    location / {
        proxy_pass http://127.0.0.1:7777;
    }

    listen [::]:443 ssl;
    listen 443 ssl;
    ssl_certificate /etc/letsencrypt/live/open.microanatomy.server/fullchain.pem;
    ssl_certificate_key /etc/letsencrypt/live/open.microanatomy.server/privkey.pem;
    include /etc/letsencrypt/options-ssl-nginx.conf;
    ssl_dhparam /etc/letsencrypt/ssl-dhparams.pem;
}

server {
    if ($host = open.microanatomy.server) {
        return 301 https://$host$request_uri;
    }

    listen 80;
    listen [::]:80;

    server_name open.microanatomy.server;
    return 404;
}
```

## Troubleshooting

### Fixing Incorrect Slide Paths

Uploading slides with an incorrect `server.path` inside `application.conf` will result in QuPath and OpenMicroanatomy Cloud not knowing where the slides are actually stored and making them inaccessible. The `server.path` is encoded within each slides `.properties` file when uploaded, thus requiring them to be manually updated if the `server.path` is changed.

To check for any incorrect paths run the following command in the server root directory.

```
cd slides && cat *.properties || grep "<your previous server.path>"
```

1. Backup slides: `cp -R slides slides-backup`
2. Switch to slides directory: `cd slides`
3. Perform a Search & Replace: `sed -i -e 's/<previous server.path>/<new server.path>/g' *`
4. Validate that all instances have been replaced: `cat *.properties || grep "<your previous server.path>"``

## HTTP API

OpenMicroanatomy Server includes a **REST API** — documentation is available [here](#).