Developing a web-based microscopy tool for teaching oral histology virtually

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Background

Histology is the study of the microanatomy of cells, tissues, and organs. The traditional histology teaching labs rely on light microscopes and a limited array of slides, inhibiting simultaneous observation by multiple learners, and preventing in-class discussions. The COVID-19 pandemic has moved most of the University teaching online, necessitating an alternative way to continue histology teaching virtually. We have developed a web-based microscopy tool called Histoscope for teaching oral histology. This dynamic web-based tool allows users to interact with the histology slides, replicating the experience of observing and manipulating a slide under a real microscope.

Methods

The School of Dentistry has an existing collection of oral histology glass slides to teach histology labs with light microscopes. We curated those slides for quality and rarity and selected the best slides for whole-slide scanning with 25 layers of z-stacking. Z stacking is useful for capturing in-focus images of objects under high magnification as the depth of field decreases with magnification. We also prepared a series of questions for learners to self-assess their learnings. Our website is programmed with the Python programming language and uses Flask as a web framework, resulting in a dynamic platform, capable of processing user requests and interacting with them accordingly.

Snapshots from Histoscope
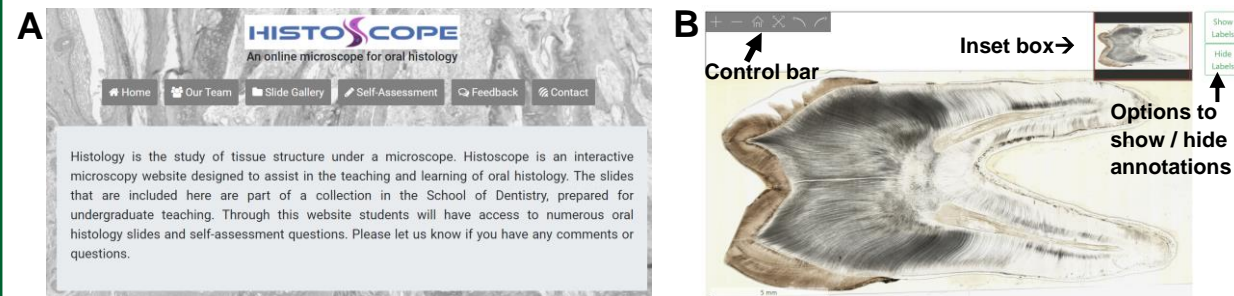
Figure 1: Snapshots from the 'Histoscope' website. (A) Homepage of Histoscope. The contents of the website are organized under six tabs. (B) Snapshot of a digital slide showing the longitudinal section of tooth. The control bar on the top left corner allows user the zoom in, out, rotate and toggle to full-screen mood. The 'Show Labels' and 'Hide Labels' buttons allow for the toggling of slide annotations.
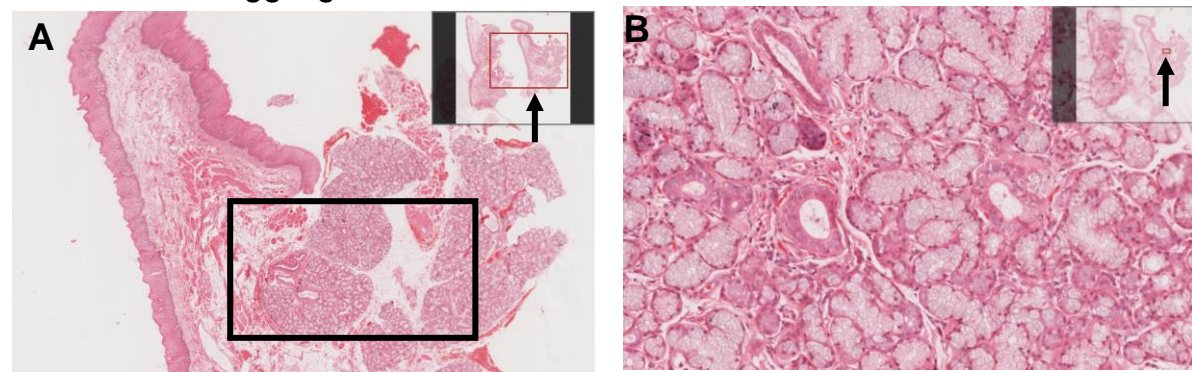
Figure 2: Application of Z-stacking to provide in-focus images in high magnification. A-B represent a section from the salivary gland gradually magnified from low (A) to high (B) magnification. Histoscope allows users to view structural details in higher magnification to mimic the experience of using a light microscope. The red box in the inset of each slide indicates the viewing area (arrow). The black box in the middle is showing the area that is being magnified (A).

Histoscope in Dental Education

Virtual microscopy has improved learners' performance in many training programs.[1,2] However, some known limitations of this existing technology are low graphics resolution and lack of z-axis information[3], which are critical for understanding cellular structures. With Histoscope, we aimed to overcome the existing shortcomings of existing virtual histology databases and create an interactive and dynamic platform to fully mimic the experience of using a traditional light microscope.

Our website incorporates a large collection of high quality and rare sections of the tooth, oral structures, and development of tooth and facial regions, which is are not readily available in any public online databases.

We believe, our website can shift the conventional teacher-focused learning to a more collaborative and student-focused learning environment.

References:
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3. Rinaldi VD, Lorr NA, Williams K. Anat Sci Educ. 2017 Jul;10(4):328-338. doi: 10.1002/ase.1667.