The Histo-Kitchen: Using Food Items to Teach Histology

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Abstract

Engaging students in active learning has proved to transform reflexive knowledge into true learning of material in medical education. Histology is one subject area that consistently presents as a challenge for medical and undergraduate students. The large amount of complex information needed to completely understand and interpret histological images is something that is many medical students do not fully grasp in the pre-clinical stages. Pedagogical studies that use physical objects and hands on learning have been shown to motivate and encourage students to self-learn such complex topics. This application of using physical objects and hands on learning, however, is not the easiest to translate to the cellular level. The Histo-Kitchen was designed to help students manage the vast amount of information and acquire knowledge in a meaningful and creative way. By incorporating food items into an active learning session, students were able to stretch their imagination and find representative items for common histological specimen representations. Based on post-session discussions, students found the activity to be beneficial to their learning and greatly enjoyed participating in the activity, often citing it as the most fun they have had learning histology. By providing students with opportunities to interact with complex material in creative and novel ways, students are able to learn in an environment that can be both engaging and enjoyable.
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Key words: food art, active learning, histology, PBL, medical education

Introduction

One of the great challenges in teaching histology is finding a way to make static, visually similar images have their own unique identities. Traditional histology didactics rely on lengthy lectures and the repetitive labelling of histological slides (Blake et al., 2003; Hightower et al., 1999). Although often presenting a concept in its entirety, these methods only provide the student with reflexive knowledge—often preventing true integration of the material into their knowledge base (Bergman et al., 2008). This problem is pervasive in medical education. In higher education, creative and simple activities from early education didactics are often overlooked in exchange for the more traditional lecture format (Balemans et al., 2016; Bloodgood, 2012; Burhanlı & Bangir-Alpan, 2021; Felszeghy et al., 2017, 2019; Johnson et al., 2015; Ness, 2011; O'Malley, 2022). This format often stifles a student's ability to truly integrate new knowledge into their own schema, overwhelming the learner with information that is not easily understood from one session.

In early education, macaroni art is often regarded as a staple educational activity. This simple craft has stood the test of time and remained an effective modality to teach spatial reasoning, creativity, and appropriate use of materials.

From a broader perspective, this activity allows learners to explore how common, single shaped items, can be used to create a beautiful piece of art. In a similar manner as macaroni, cells are simple shapes that come together to form unique and multifunctional tissues. When isolated and stained, these tissues create beautiful works of art. Through observations and direct experience with students, as well as curriculum evaluation and review, we have found that students significantly reduce the time they spend using traditional learning modalities, such as lectures and textbook reading, in lieu of resources that approach scientific topics through images, mnemonics, and other creative or art-based modalities (Burhanlı & Bangir-Alpan, 2021; El-Sayed et al., 2013; Felszeghy et al., 2019; Johnson et al., 2015; Miller et al., 2013; Walker et al., 2008).

One methodology implemented to bridge the gap between medical students' preferred modalities that also allows for appropriate coverage of the material is to integrate art into the learning sessions. Several studies have shown that using art to teach tough courses such as physiology, anatomy, or histology have increased student engagement, satisfaction, and retention of the material (Cracolici et al., 2019; Flôr et al.,

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2020; Housen, 2002; O'Malley et al., 2022). Studies have also found an improvement in students' clinical observational skills with the implementation of art into their studies (Bardes et al., 2001; Shapiro et al., 2006).

In a similar fashion to macaroni art, using food items to represent histological images is a way to integrate complex topics into a student's pre-existing schema. By expanding our concept of acceptable professional education didactic, we can greatly increase a learner's enthusiasm and understanding of complex topics. Furthermore, due to the fun and creative nature of this project, it also creates an environment in which students are actively excited to learn histology. This work complements any problem-based learning curriculum and can be used as a supplement to traditional lecture didactic.

By the end of this activity, learners will be able to:

1. Describe the epidemiology, pathology, and pathogenesis of the various types of renal cell carcinoma.
2. Describe the histological presentation and evaluation of the various types of renal cell carcinoma.
3. Apply critical thinking and problem-solving skills to the construction of a representative model.

Methods

Topic Selection

The Histo-Kitchen was initially designed for first-year medical students in the later stages of study of the renal system. Based on the current problem-based curriculum at the time of initial launch, the topic of renal cell carcinoma (RCC) histology was selected. RCC is the seventh most common type of cancer in the United States and has shown a sustained increase in its prevalence (Cairns, 2011). Considering the significant prognostic and therapeutic implications of its histological variants, understanding the microscopic appearance of RCC is of paramount importance to developing physicians. This lesson focused on the five most common subtypes of RCC: clear cell, papillary, chromophobe, oncocytic, and collecting duct carcinomas (Kay & Pedrosa, 2018).

Resource Collecting

Based on published histological reference slides of the various types of RCC, food items were selected for their ability to be modeled into shapes, represent cellular components, provide color contrast, and allow for variation across student work. Example items included: cereal, sour candy gel, pudding cups, licorice sticks, and chewing gum. Each item can be used to represent several different components. See Table 1 for a more detailed list of items and what they may symbolize. Prior to the session, large posters (24" x 36") of Figure 1 were printed for each team and partially laminated in order to create a food resistant working surface for the students. This allowed for easy clean-up and presentation of the final product. Additional office supplies such as scissors and tape may aid in the students' ability to manipulate the food objects, but are not required. Wearing gloves is advised as this can get messy!

Suggested Food Items and their Histological Representations	
Food Item	**Suggested Histology***
Sour Candy Gel	Cytoplasm, Perinuclear Halos
Licorice Sticks	Microtubules, Collagen, Basal Lamina
Chewing Gum	Fibrous Stroma, Extracellular Matrix
Miniature Marshmallows	Cuboidal Epithelial Cells, Cell Membranes
Colorful Children's Cereal	Various Organelles
Hard Candy Pieces	Nucleus
Sour Candy Strips	Elastic Fibers, Collagen Fibril
Fruit Snacks	Polygonal Cells
*Food items may represent multiple components. There is no single correct answer.	

Table 1. *Suggested food items and their histological representations.*

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Project Implementation and Facilitation

The Histo-Kitchen was implemented on the third day of a problem-based learning session which utilized a student leader to run the session (Prasad and O'Malley, 2022). During the in-class portion of the activity, groups of two worked on using the provided food items to model the requested histology images. Groups also filled out a corresponding worksheet (Figure 1) summarizing the microscopic appearance and important pathophysiology of the most common subtypes of RCC. This activity was open resource, but students were encouraged to complete the written sections by memory first, before comparing to outside resources.

Students completed the activity in 20 minutes allowing for 10 minutes of discussion and sharing. Each team of two presented on one subtype of RCC explaining what each food item represented and any relevant physiology. Facilitators of this project are required to have some baseline knowledge of RCC, however the majority of the needed information can be readily found on online clinical based resources such as Amboss and UpToDate. A completed worksheet is shown. (Figure 2).

The Histo-Kitchen	Important Subtypes Types of Renal Cell Carcinoma				
		Non-Clear Cell Renal Carcinoma			
	Clear Cell	Papillary	Chromophobe	Oncocytic	Collecting Duct
Microscopic Appearance					
Relative Frequency					
Cell of Origin					
Etiology					
Prognosis					

Figure 1. *Blank RCC Histo-Kitchen poster worksheet.*

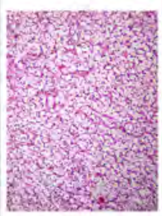
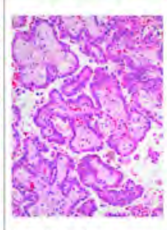
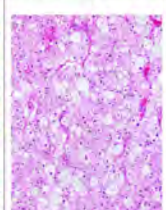
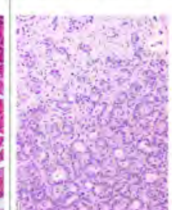
The Histo-Kitchen	Important Subtypes Types of Renal Cell Carcinoma				
		Non-Clear Cell Renal Carcinoma			
	Clear Cell	Papillary	Chromophobe	Oncocytic	Collecting Duct
Microscopic Appearance	 Clear, polygonal cells arranged as cords or tubules Clear, glycogen and/or lipid filled cytoplasm	 Cuboidal, low columnar cells growing in papillary formation	 Large polygonal cells with a prominent cell membrane Eosinophilic cytoplasm Perinuclear halo	 Similar to chromophobe RCC, but without perinuclear halo Cells occur as tumor nests	 Irregularly arranged glandular cells within a fibrous stroma
Relative Frequency	~ 70%	~ 10-15%	~ 5%	~ 1%	~ 1%
Cell of Origin	Proximal Convoluted Tubule	Proximal Convoluted Tubule	Intercalated cells of the cortical duct	Intercalated cells of the cortical duct	Medullary Collecting Duct
Etiology	Mutation of the VHL gene on chromosome 3p	Trisomy 7, Trisomy 17, or loss of Y chromosome	Hypodiploidy	Unknown	Unknown
Prognosis	Dependent on Tumor Stage	Type 1 is better than type 2 Type 2 is aggressive with a poor prognosis	Excellent Prognosis	Excellent Prognosis	Aggressive tumor with poor prognosis

Figure 2. *Filled RCC Histo-Kitchen poster worksheet; facilitator version. Pictures sourced from PathologyOutlines.com.*

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A Brief Facilitator Guide

The Histo-Kitchen active learning session can be completed within 30 minutes. The most technical aspect of this activity is the required set up and preparation. Fortunately, the creativity comes from the students and does not require too much advanced planning on the facilitator. Students will find a way to utilize any items they are given. Below is a summary of the steps taken to run this active learning session:

1. Collect food items and prepare the poster workspaces.
2. Introduce to the students the concept of using food items to mimic histological slides (in this case RCC).
3. Organize students into groups of 2-3 and give them 20 minutes to fill out the poster and create their images, they may use any study materials or references they have access to. During this step, music can be played to enrich the creative atmosphere.
4. Over the last 10 minutes, allow student groups to each present one histological image, explaining what each food item represents and how it fits into the overall histopathology. Time permitting, have other groups compare what they did differently to create their histological image.
5. Fold up the posters and dispose of them for easy clean-up. Don't forget to take pictures first!

Project Evaluation and Results

To identify how students perceived the activity, a post activity oral feedback session was held for all of the participants (n=6). Feedback questions included "what did you like about the activity?" and "how can this activity be improved for future topics?", as well as a request for any general feedback on the activity. Feedback for this educational session was overwhelmingly positive. Participants noted the importance of being able "…to use 3D models to learn histology…". They also acknowledged that constructing the image out of unique items allowed for an increase in retention of the information ("…This was a cool way to learn histo…"). Participants stated that by visualizing the histology with common food items, they thought they'd remember the histology better ("…we should do this for more histo classes…"). Additionally, they appreciated that the complex histology was easily broken down into manageable pieces through the activity. No formal assessment was done at this time.

Overall, the students presented quality work that allowed them to learn complex information and identify any corresponding gaps in knowledge. Representative student work of the microscopic appearance can be seen in figure 3.

The Histo-Kitchen	Important Subtypes Types of Renal Cell Carcinoma				
		Non-Clear Cell Renal Carcinoma			
	Clear Cell	Papillary	Chromophobe	Oncocytic	Collecting Duct
Microscopic Appearance (Student Examples)					

Figure 3. *Select student examples of RCC microscopic appearance.*

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Discussion

This single 30-minute arts-based activity offers sustained educational benefits for student participants. In this presentation, renal cell carcinoma—a cancer well known for its varying histological presentations—can be easily understood when viewed through an artistic lens. Albeit nontraditional in the medical school setting, active learning sessions utilizing food items to construct the histology of RCC is a valuable method by which to instill a sense of the importance of RCC histopathology, while maintaining a fun and positive learning environment.

This perspective is among other works which have shown that integration of visual art into the teaching of histology is beneficial to students' understanding and retention of material (Balemans et al., 2016; Cracolici et al., 2019; Osório et al., 2013; Reid et al., 2019). However, this exercise does not focus on drawing to create the art, but rather the use of food as art, which is novel for the study of histology. Similar variations of this project can be competed using non-food items as well. The true benefit results not from the use of food, but from the manipulation of 3D elements in space to recreate a complex 2D image. As such, a wide array of household items can be used.

The Histo-Kitchen adds a unique yet familiar twist to the study of histology for various levels of learning. The activity could easily be adapted to be used for an introduction to histology and tissue types for high school or undergraduate college levels. We recommend keeping students in small groups to allow for each group member to actively participate in the activity as well as the debrief where students can reflect on their process as well as their peers' process.

Overall, students were receptive to the idea of recreating any histological image. One important note about the focus of this activity is that it is not focused on accuracy, but rather the cognitive process in which students decided what items serve as symbols and how they interact within the cell. Results may greatly vary across participants. One challenge for this exercise was that participants could see what other groups had created. In some cases, they would base their ideas off each other. While this has potential to lead to more accurate final products, it more often limits diversity and detracts from an otherwise robust discussion. In general, however, participants in this activity walked away with a greater understanding and appreciation for histology, as noted through their vocal feedback regarding the activity.

About the Authors

Andrew Stewart is a third-year medical student at Nova Southeastern University Dr. Kiran C. Patel College of Allopathic Medicine (NSU MD). He has 7 years of experience developing active learning projects for a wide range of learners. His research goals aim to improve the diversity of medical school didactic and facilitate student learning in non-traditional and creative ways. He is currently interested in pursuing a career in adolescent medicine with a focus on LGBTQ+ health.

Chasity O'Malley is an associate professor of medical education and physiology at Boonshoft School of Medicine at Wright State University. Her research goals aim to improve the learning experience for students by helping them learn to study and interact with the material in meaningful ways and for faculty by helping guide them on implementing active learning into their classrooms. Her NSF funded grant revolves around helping community college faculty implement evidence based instructional practices in their classroom, while adding to the evidence through their own classroom research projects. She also is actively involved in promoting diversity through her funded research projects centered around enhancing training for medical students related to the LGBTQ population.

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