Enhancing the Microscopy Skills of Non-Science Majors and Nursing Microbiology Students: Promoting the Practice of Observing Multiple Fields of View Using Blood Smear Slides

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Abstract

One of the challenges in teaching microscopy is having students scan multiple fields of view at high power magnification. Many times, students will feel this unnecessary, especially when presented with slides that show only one structure or a monoculture of cells. This communication presents a simple microscopy activity to engage students in the importance of examining several fields of view when using the microscope. Students are challenged with determining whether an “unknown” blood smear slide is indicative of normal blood or a blood disorder. The disorders the activity examines include sickle cell anemia, leukemia, thrombocytosis and a bloodstream infection. All slides can be purchased from science education supply companies. Students must properly focus on commercially available blood slides and examine several fields of view in order to reach the most reasonable diagnosis. This lesson has been used to engage both non-science majors taking a laboratory-based science class as well as nursing/allied health microbiology students and simulates real-life scenarios in diagnosis.

INTRODUCTION

Microscopy is an integral part of the biology laboratory. It is a skill that has been identified in ASM’s Curriculum Guidelines for Undergraduate Microbiology Education (1), Microbiology in Nursing and Allied Health (MINAH) Undergraduate Curriculum Guidelines (2) and the Condensed MINAH laboratory curriculum (3). When first introducing the microscope, instructors often utilize slides that either have one structure on it or a monoculture of cells. Instructors use these types of slides to have students practice their focusing skills. We have observed that students typically focus on the first field of view only. A field of view is the area visible when looking through a microscope’s eyepiece. It doesn’t naturally occur to students to scan around and get a view of the slide as a whole instead of the one spot they focused on. It is also possible instructors forget to instruct or remind students to do so.

Students learning how to use the microscope should be taught to scan multiple fields of view (Figure 1). Students may miss different cellular structures if they only look at one field of view. To encourage students to scan multiple fields of view while using a microscope, we have developed a simple laboratory activity using prepared blood slides. This activity can be integrated into any introductory microscopy lab exercise. It is an activity that can be completed in approximately a half hour. This activity supports the Microbiology Learning Framework of Cell Structure and Function (1), especially the question of “How have the structure and function of microorganisms been revealed by the use of microscopy?” Without proper knowledge of the microscope, students cannot answer this question fully.

Blood is liquid connective tissue that the body uses for transport, immunity, salinity and temperature regulation (4). Erythrocytes (red blood cells) carry gases throughout the body using hemoglobin. Leukocytes (white blood cells) are the cellular components of the immune system. Platelets are membrane bound cellular fragments important for clotting. Blood smear slides are typically stained with either Giesma or Wright’s stain to allow for differentiation of blood features (Figure 2). This makes identifying the components of blood more straightforward.

Figure 1. Cartoon diagram showing the fields of view from a wet-mount slide of pond water. If a student focuses on just field #1, they will assume there are no organisms present. If a student focuses on just fields #2 or #3, they will assume there is only one cell type present. It is not until you examine fields #4 and #5 that you discover there are at least three different cell types present. Picture prepared by B.M. Forster.
Examination of multiple fields of view is critical to correctly diagnosing the “patient” with a disease. For example, leukemia may be missed due to the fact that leukocytes may amass in numbers in one area of the blood. Therefore, by viewing a sample of multiple, random sites on the blood slide, large groupings of leukocytes are more likely to be seen. This procedure is common practice in diagnostic laboratories and is essential for effective community healthcare. In this lesson, students assume the role of diagnosticians. Just like professional diagnostic labs, students must use multiple fields of view to determine whether a fictitious patient has a blood disorder. In the next section, we describe how the lesson can be implemented.

**PROCEDURE**

The materials required for this activity are a microscope capable of at least 400x total magnification and prepared blood smear slides. This includes normal human blood, sickle cell anemia, leukemia, thrombocytosis and bacteremia slides. These slides can be obtained from science lab supply companies including Carolina Biological, Wards Science or Flinn Scientific. Prior to giving slides to the students, instructors should rename the slides “Patient A,” “Patient B,” etc., to make it a mystery and cover up the diagnosis. A student handout instructors can distribute to students can be found in the supporting materials (Supporting File S1).

Students should know how to properly focus on a slide at both low and high power. Prior to starting this activity, instructors should review the components of blood. Instructors can use Figure 2 to aid them in introducing this topic. Instructors should also show students prior to beginning the activity what bacteria look like, focusing on spherical (coccus) and rod-shaped (bacillus) bacteria. To begin the activity, each student (or student group) receives a normal blood smear slide. Students should become proficient in recognizing normal blood parameters first. Students should begin by focusing on the slide at resolving low power and then work their way up to high power (400x or 1000x magnification).

Students should obtain a patient slide and begin focusing on the slide at low power and then move to high power. Once the slide is in focus, students record their observations for five separate fields of view. Students count the number of different cell types and platelets present in the different fields to assess their relative abundance. A sample blank data table can be found in the student handout in the supporting materials (Supporting File S1). After the students have recorded their
observations, the instructor distributes the blood reference table found in the supporting materials (Supporting File S2). Students then compare their observations to this information and then try to reach a conclusion as to what blood disorder (if any) the patient has. It is important to note that using the sickle cell blood smear will probably be the hardest to interpret. As seen in Figure 3, not all the erythrocytes on the slide will be sickled, especially if the individual is heterozygous (7).

This activity can be completed either in a lab (approximately 30–45 minutes) or as part of a take home lab (for online classes) where students are asked to purchase a microscope and prepared slides as part of a kit. Alternatively, for online labs that do not have a kit, the instructor can post images of several blood smears, asking the student to identify the structures, complete the worksheet (see Supporting File S1) and make the appropriate diagnoses. Figure 3 shows representative images of each blood disorder.

ACTIVE LEARNING AND ASSESSMENT

This activity promotes active learning as students must use the microscope (or examine micrograph images if done virtually) to identify whether a blood smear is indicative of normal blood or a blood disorder. The students have to reach their own conclusions from the microscopy observations and data they collect. Instructors can assign this activity as part of anintroductory lab activity on using the microscope. As part of a submitted lab report, students complete the student handout (see Supporting File S1), recording their observations of their assigned blood smear. Students are then asked to identify what blood disorder (if any) their assigned patient has. They must explain how they arrived at their answer, comparing the data they collected to a blood reference table (see Supporting File S2).

CONCLUSION

This activity demonstrates to students the importance of examining multiple fields of view and the importance of adequate sampling. It is not enough for us to simply teach students how to focus on a slide. We have used this activity in our non-science major lab classes and our MINAH courses. Students in these courses have reported enjoying this activity since it allows them to see a real-world medical application using microscopy. This is consistent with other reports of using disease diagnoses as a means of engaging non-science majors (15). For more advanced classes, this activity can be expanded upon in different ways; students could identify the specific type of leukocytes observed and/or measure the size of the different cells and platelets observed. Students could be given additional blood disorder slides, such as eosinophilia or iron deficiency anemia. For MINAH students, this activity encourages students to develop increased care and due diligence of their responsibility to patients to make best diagnostic opinions for best possible outcomes.

SUPPORTING MATERIALS

- S1. Enhancing Microscopy Skills – Student Handout
- S2. Enhancing Microscopy Skills – Blood Reference Table

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