



SPUTUM CULTURES: AN INTERACTIVE ONLINE LEARNING MODULE FOR MLSP 5112

Kaylee Renstrom

Advisor: Lorna Ruskin

MLSP 6905 Capstone Project Presentation

Project Research Question

Can an online learning module for the education of sputum cultures be developed for use within the MLS program at the University of Minnesota?

Literature Review / Background

- Understanding the presentation of pathogenic bacteria is an important aspect in microbiology
- MLS educators prepare students through mock specimens
- Sputum specimens can be costly to replicate, may provide inaccurate results, and pose a health hazard
- An online learning module may improve education

Materials & Methods

- Scenario Based Learning Environment (SaBLE)
- One module with multiple levels
- Incorporation of learning theories
 - Behavioral
 - Constructive
 - Cognitive
- Acquisition of authentic sputum sample images

Results - Module Level 1

- Determination of sputum specimen acceptability
 - Greater than 25 polymorphonuclear leukocytes (PMNS) and fewer than 10 squamous epithelial cells
- Morphology and quantitation of bacterial organisms on high powered microscopic field
 - 1+, 2+, 3+, 4+
 - GNR, GNC, GPR, GPC, Yeast, No organisms seen

Sputum Specimen Acceptability

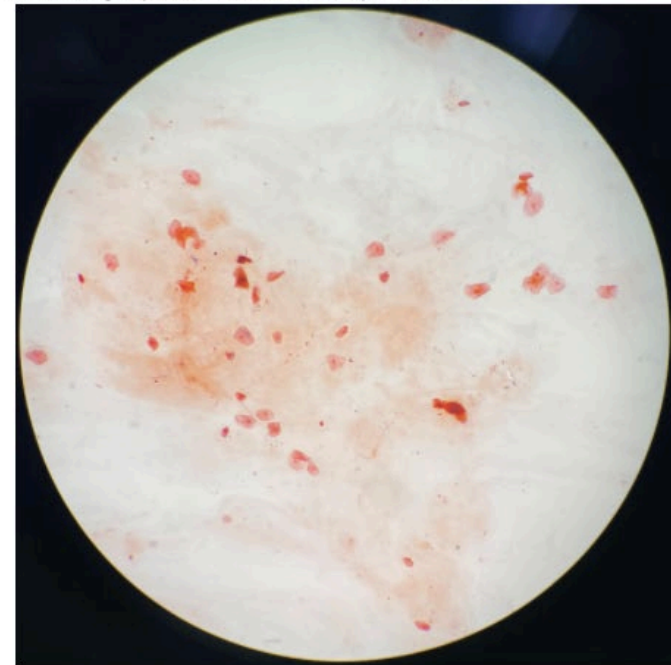
Scenario Based Learning Environment

Overview

Let's try another one! What should be reported out for this patient's specimen? Don't forget you can zoom in with your browser!

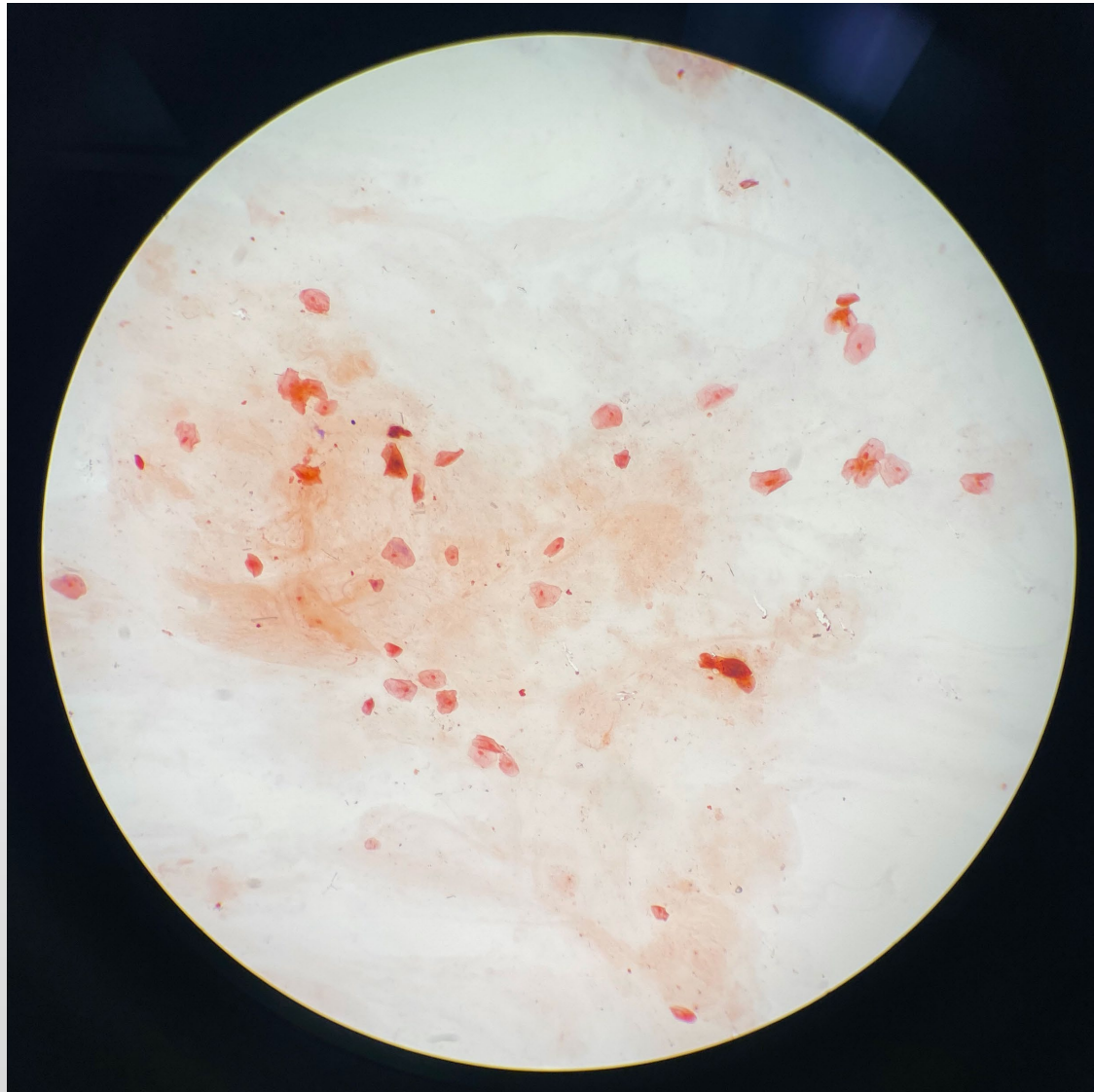
- 1. <25 PMNs, <10 Squamous Epithelial Cells
- 2. <25 PMNs, >10 Squamous Epithelial Cells
- 3. >25 PMNs, <10 Squamous Epithelial Cells
- 4. >25 PMNs, >10 Squamous Epithelial Cells

Check My Answer



Prev

Next



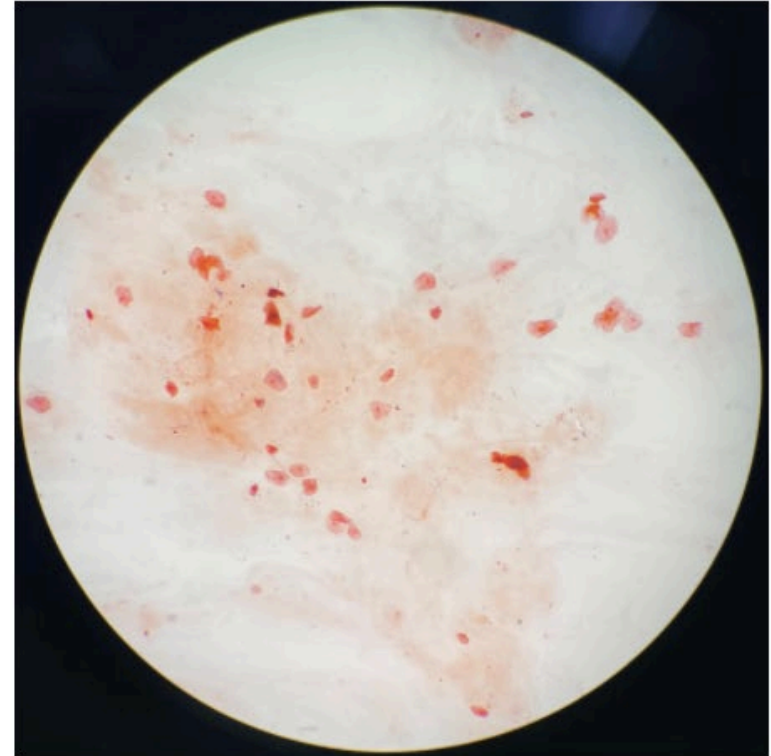
Scenario Based Learning Environment

Overview

Let's try another one! What should be reported out for this patient's specimen? Don't forget you can zoom in with your browser!

- 1. <25 PMNs, <10 Squamous Epithelial Cells
- 2. <25 PMNs, >10 Squamous Epithelial Cells
- 3. >25 PMNs, <10 Squamous Epithelial Cells
- 4. >25 PMNs, >10 Squamous Epithelial Cells

Check My Answer



Prev

Next



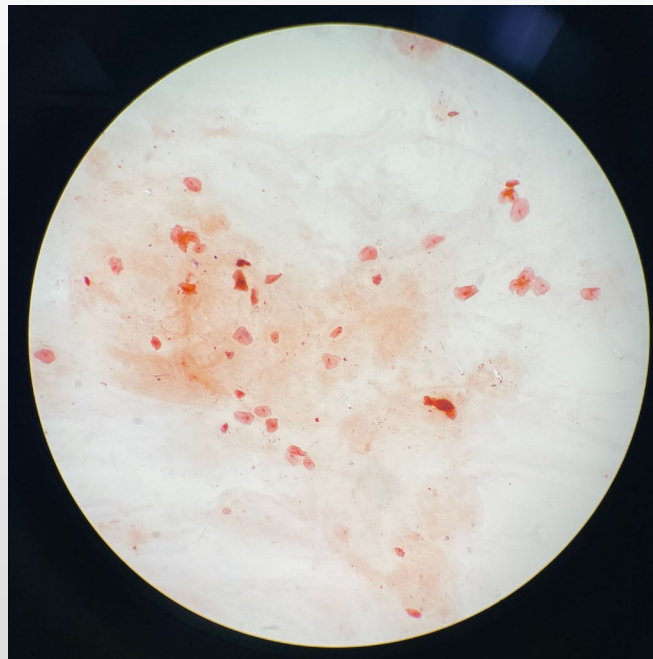
UNIVERSITY OF MINNESOTA

2021 ©Regents of the University of Minnesota. All rights reserved.

Possible Responses

Try again. Are you sure? The squamous epithelial cells are prominent in this sample

Try again. Not quite! Make sure you're not confusing artifact for PMNs.



Great job! Note the difference between this specimen and the previous sample. Squamous epithelial cells are prevalent and hardly any PMNs can be seen.

That's ok, let's break down this sample on the next page.

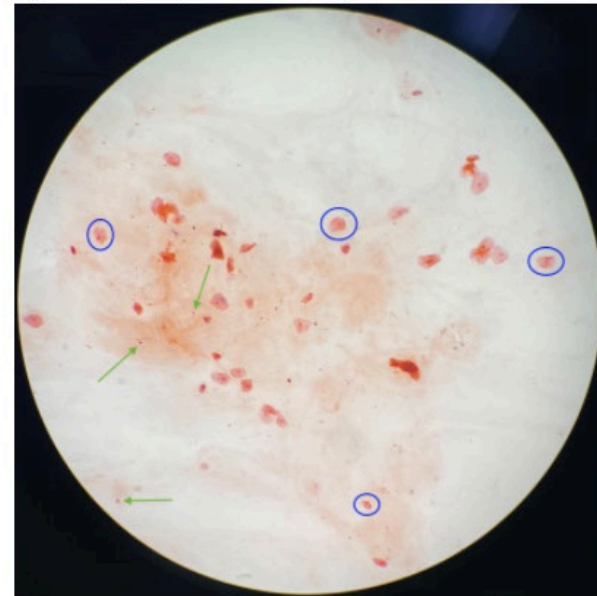
In-Depth Explanation

Scenario Based Learning Environment

Overview

A few PMNs have been pointed out by the green arrows. This time, it's a little harder to discern between polymorphonuclear leukocytes and artifact. That's ok if you called something a PMN that was debris or vice versa. Regardless, your quantification should have resulted in this sample having less than 25 PMNs/lpf.

Observe some of the squamous epithelial cells highlighted by the blue circles. Note how they can fold over on themselves or roll up. Try your best to focus on searching for large, flat cells with a small nucleus when screening for acceptability. Practice makes perfect!



Prev Next

Morphology and Quantity

Scenario Based Learning Environment

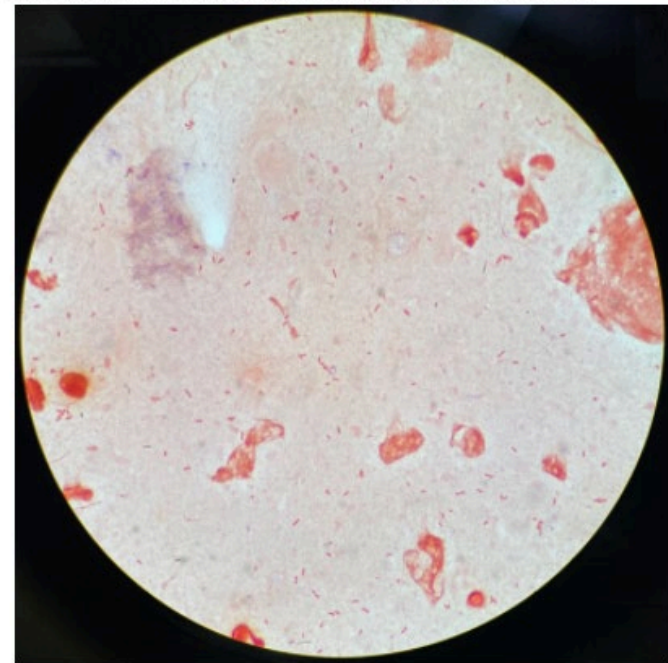
Overview

Fill in the text boxes below with the correct quantities (1+, 2+, 3+, 4+). If none are seen, a zero can be entered. All fields must be filled out.

- Gram Positive Cocci
- Gram Positive Rods
- Gram Negative Cocci
- Gram Negative Rods
- Budding Yeast

0 = None Seen
1+ = Rare
2+ = Few
3+ = Moderate
4+ = Many

Submit



Prev

Next

Results - Module Level 2

- Case study created based off patient sample
 - Quantity and morphology under microscope
 - Presumptive identification (growth challenge and colony morphology)
 - Correlation of results with possible identification

Module Slides

Scenario Based Learning Environment Overview

Enter in the boxes below what the interpretation is for the bacteria present, working in order of quantity, gram stain, morphology, and finally arrangement. Zoom in on the image using your web browser for a closer look at the field.

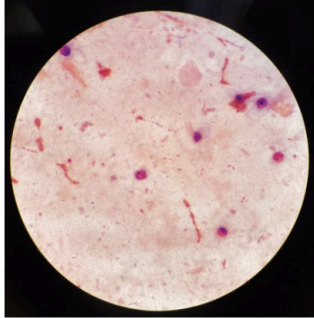
Fill in the blanks with the correct answers.

Quantity (rare, few, moderate, many):

Gram reaction (gram negative or positive):

Morphology (rod, cocci, diplococci):

Arrangement (pairs, chains, clusters, palisade, none seen):



2021 ©Regents of the University of Minnesota. All rights reserved.

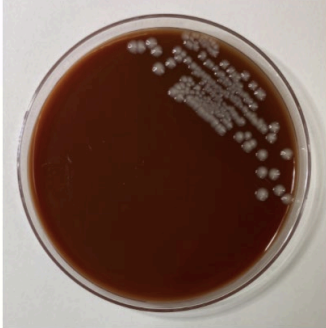
Scenario Based Learning Environment Overview

Looking once again at the chocolate agar, list below the color and size of the colonies.

Fill in the blanks with the correct answers.

Color (white or gray):

Size (pinpoint, small, medium, or large):




2021 ©Regents of the University of Minnesota. All rights reserved.

Scenario Based Learning Environment Overview

Select the correct characteristic below that describes the appearance of this organism on MacConkey agar.

- 1. Mucoïd
- 2. Swarming
- 3. Metallic
- 4. Dry



2021 ©Regents of the University of Minnesota. All rights reserved.

Possible Feedback

Scenario Based Learning Environment

Overview

Test your knowledge!

During this module, we've learned that this organism is a 1+ gram negative rod that grows as medium, gray, gamma, mucoid colonies that ferment lactose.

Which of these provided organisms matches with this description?

- 1. Streptococcus pneumoniae
- 2. Escherichia coli
- 3. Pseudomonas aeruginosa
- 4. Proteus mirabilis
- 5. Klebsiella pneumoniae

Try again. Oops, Streptococcus pneumoniae is a gram positive cocci!

Try again. Not quite! While Proteus mirabilis is a gram negative rod, it exhibits a swarming morphology. Our colonies are well isolated.

Try again. Hmm...is Pseudomonas aeruginosa a lactose fermenter?

While Escherichia coli does ferment lactose, colonies will often appear metallic on SBA. We're looking for an organism that produces mucoid colonies.

Prev

Next



Discussion / Conclusion

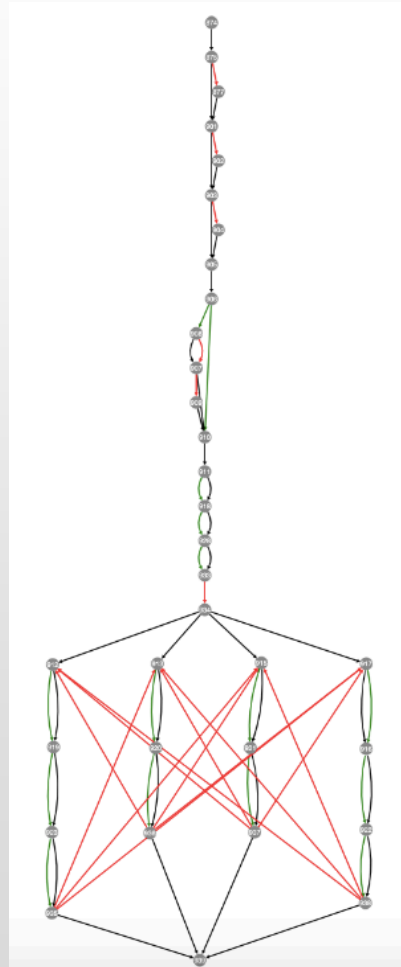
- Inclusion of learning theories
 - Cognitive: Knowledge checks, second chances when answering questions, stimulating visuals, randomized sections
 - Constructive: Highlighting the importance of learning materials, case study
 - Behavioral: Immediate feedback with praise or suggestions

Study Limitations

- Replating of samples to incorporate MacConkey agar
- Image clarity and size
- Presentation of samples
- Randomization with fill in the blank

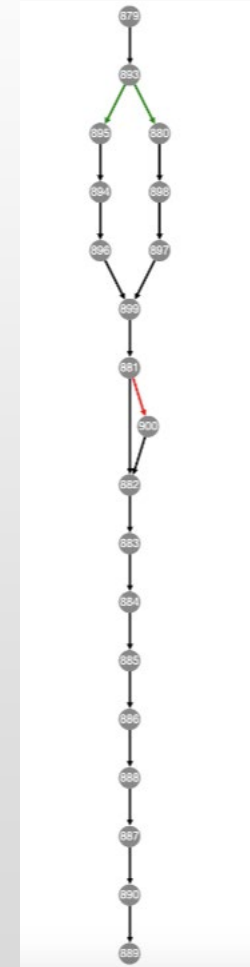
Module Node Graphs

Level 1

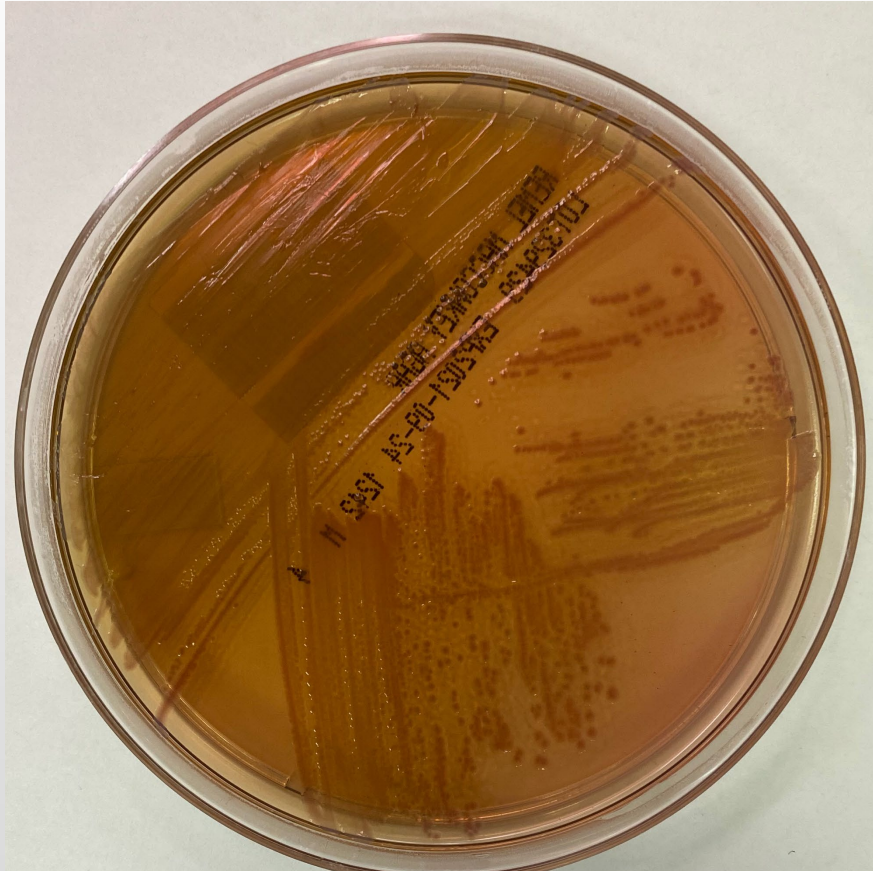


Renstrom

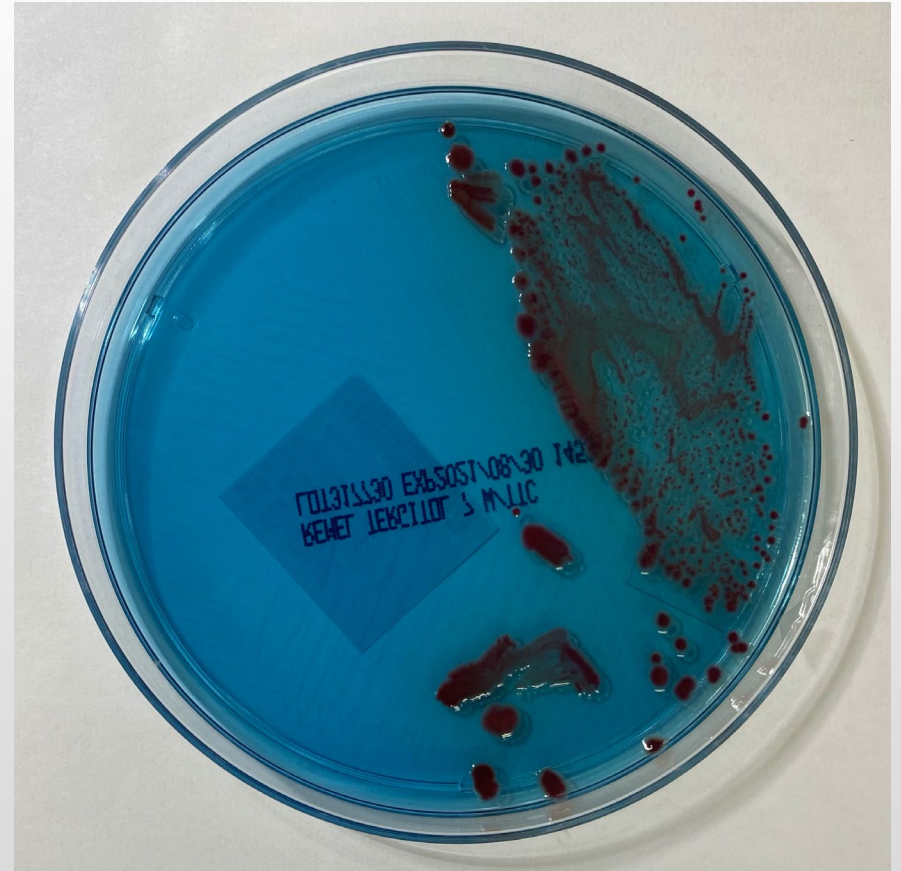
Level 2



Gram-Negative Selective Agars



MacConkey Agar



Tergitol-7 Agar

Next Steps

- Incorporation of learning module into MLSP 5112 course
- Comparison study of student performance
- Addition of new module levels
 - Matching culture images to final identification
 - Inclusion of identification test results

References

- Alomyan, H., & Green, D. (2019). Learning theories: implications for online learning design. *ICSET 2019: Proceedings of the 2019 3rd International Conference on E-Society, E-Education and E-Technology*, <https://doi.org/10.1145/3355966.3358412>
- Arghode, V., Brieger, E.W., & McLean, G.N. (2017). Adult learning theories: implications for online instruction. *European Journal of Training and Development*, 41(7), 593-609. <https://doi.org/10.1108/EJTD-02-2017-0014>
- Bailey, R., & Tille, P. (2017). "Infections of the Lower Respiratory Tract." *Bailey & Scott's Diagnostic Microbiology*. St. Louis, MI: Elsevier Inc.
- Butler, A., Karpicke, J., & Roediger, H. (2007). The effect of type and timing of feedback on learning from multiple-choice tests. *Journal of Experimental Psychology: Applied*, 13(4), 273-281. doi:10.1037/1076-898X.13.4.273. PMID: 18194050.
- Hou, J., Wu, H., Zeng, X., Rao, H., & Zhao, P. (2018). Clinical evaluation of the loop-mediated isothermal amplification assay for the detection of common lower respiratory pathogens in patients with respiratory symptoms. *Medicine (Baltimore)*, 97(51). doi:10.1097/MD.00000000000013660
- Joyce, S.M. (1986). Sputum analysis and culture. *Annals of Emergency Medicine*, 15(3), 325-328. doi:10.1016/s0196-0644(86)80576-5
- Kester, L., Corbalan, G., & Kirschner, F. (2011). Cognitive load theory and multimedia learning, task characteristics and learning engagement: the current state of the art. *Computer in Human Behavior*, 27(1), 1-4.
- Kirschner, P., & Kester, L. (2003). Taking the load off a learner's mind: instructional design for complex learning. *Educational Psychologist*, 38(1), 5-13.
- Kirschner, P., Sweller, J., & Clark, R. (2006). Why minimal guidance during instruction does not work: an analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, 41(2), 75-86. doi:10.1207/s15326985ep4102_1.
- Laurenzi, G.A., Potter, R.T., & Kass, E.H. (1961). Bacteriologic flora of the lower respiratory tract. *New England Journal of Medicine*. doi:10.1056/NEJM196112282652601
- Robinson, J. (2004). Colonization and infection of the respiratory tract: what do we know? *Paediatrics and Child Health*, 9(1), 21-24. doi:10.1093/pch/9.1.21
- Schneider, S., Beegee, M., Nebel, S., Schnaubert, L., & Rey, G. (2021). The cognitive-affective-social theory of learning in digital environments (castle). *Educational Psychology Review*. <https://doi.org/10.1007/s10648-021-09626-5>
- Wiesner, S., Walker, J., & Creeger C. (2017). Improving critical thinking using a web-based tutorial environment. *Journal of Allied Health*, 46(2), 111-116. PMID: 28561868.
- Yatera, K., Noguchi, S., & Mukae, H. (2018). The microbiome in the lower respiratory tract. *Respiratory Investigation*, 56(6), 432-439. doi:10.1016/j.resinv.2018.08.003
- Zhou, M., & Brown, D. (2017). *Educational learning theories: 2nd edition*. Education Open Textbooks. 1. <https://oer.galileo.usg.edu/education-textbooks/1>

Questions or Comments?