

WHAT CAN LEGO TEACH US ABOUT MEDICAL EDUCATION?

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Disclosures

- Founder, ScholarRx
- Author, *First Aid for the USMLE Step 1*, McGraw-Hill Education



Cost of Medical Education



Academic Medicine Under Pressure



Global Needs



Curriculum Challenges

- Outdated curriculum with gaps
- Inconsistent pedagogy
- Lack of quality assessments
- Faculty mismatch to teaching task and value creation
- Curricular reform fatigue
- Education inequality



Curriculum Initiative



ScholarRx will be a **low-cost** comprehensive UME repository of **curricular materials** and **learning frameworks** that can be **rapidly deployed** and **customized** to suit unique curriculum needs and goals.

Curricular Repository

- Narrative **text** modules
- High-quality, labeled **images**
- Large bank of high-quality **assessment** items
- Concise, conceptual **videos**
- Virtual histology and pathology **labs**
- PowerPoint **slide decks**
- PBLs, TBLs and others **cases** for self-study

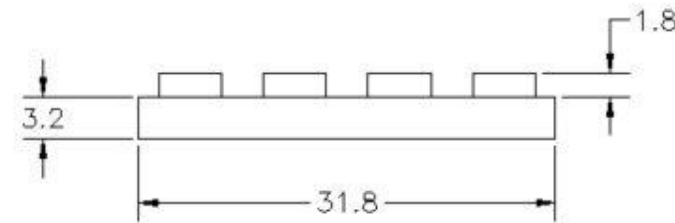
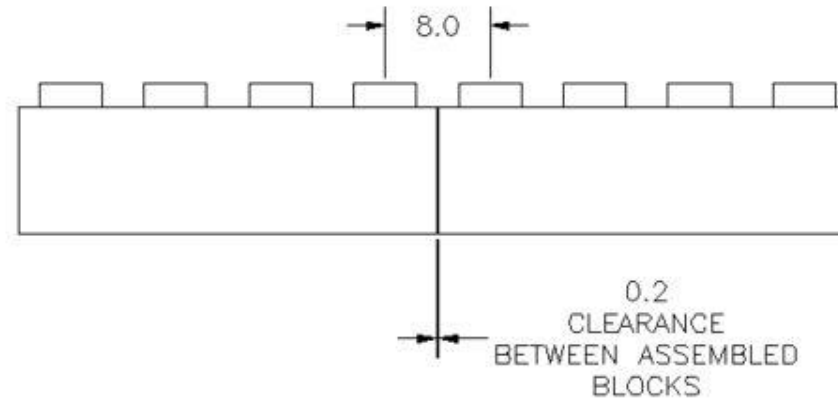
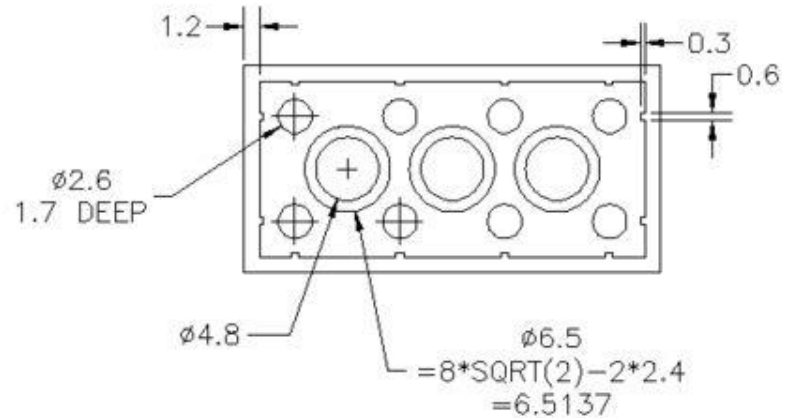
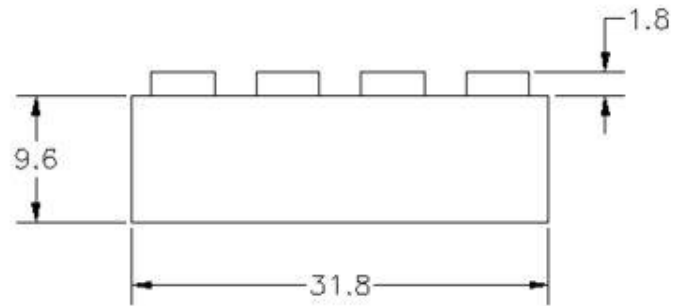
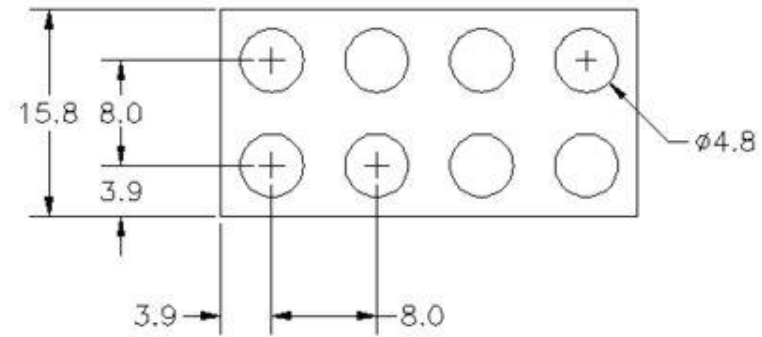


Delivery and Assessment Platform

- **Frameworks** for flipped classroom, PBL, TBL
- Course **builder** and content **authoring** tools
- **Assessment** development and management tools
- **Social** learning and community management tools
- **Dashboards** for learners, teachers, administrators

ScholarRx will be **modular, flexible**, and fully **customizable**. Content is broken down into the smallest cohesive learning units, or “**bricks**.”





SHORT BRICK
DIMENSIONS





Organized in systems-based collections

Foundations of medicine
Skin and musculoskeletal systems
Hematopoietic and immune systems
Neurologic system
Cardiovascular system
Respiratory system
Renal system
Gastrointestinal systems
Endocrine system
Reproductive system

Each collection is multidisciplinary

Anatomy
Embryology
Physiology
Biochemistry
Microbiology
Pathology
Pharmacology
Clinical medicine
Patient communications
Professionalism
Health system science

Reduce Education Costs

20-100x



Empower Educators

- Increased productivity
- Reduced work burden
- Increased focus on high-value tasks



Hematology Pilot: Everyone Included

- Team
 - Faculty curriculum designers and subject matter experts
 - Medical student authors and editors
 - Patient advocate
- Collection
 - 90+ narrative bricks
 - Hematology image bank
 - MCQ item bank



What Does a Narrative Brick Look Like?

- 10-20 minute cohesive, learning experience
- Integration of basic and clinical science concepts
- Concept prioritization over granular facts
- Minimized biomedical jargon
- High quality illustrations
- Integrated formative assessment exercises
- Some patient narrative experiences

Sickle Cell Disease

Learning Objectives

After completing this section, you will be able to:

- Define hemoglobinopathy and sickle cell disease, the most common hemoglobinopathy.
- Describe the pathogenesis of sickle cell disease.
- List and understand the characteristic CBC values in sickle cell anemia.
- Describe and identify the morphologic changes present in the blood in a patient with sickle cell anemia.
- Describe the typical clinical course and treatment of sickle cell disease.

What Is a Hemoglobinopathy?

Hemoglobinopathies are inherited diseases in which there is a mutation in one of the globin chain's genes—either alpha (α) or beta (β). Usually, the problem is a point mutation, and usually it's the beta globin gene that is affected. Sometimes the mutation is silent, meaning that it doesn't cause any noticeable change in the way hemoglobin functions. In many cases, though, the mutation results in a beta globin chain that doesn't function properly, and the patient has symptoms. Hundreds of different hemoglobinopathies have been identified, but the most common one is sickle cell disease.

What Is Sickle Cell Disease?

So what's a sickle, anyway? Turns out it's a farming tool with a C-shaped blade (Figure 1) that is used for cutting grain. It was also famously used in the Soviet Union hammer-and-sickle symbol. The cells in sickle cell disease are red blood cells (RBCs) that have been contorted into a semicircular, sickle shape.



FIGURE 1

(Left: Reproduced from https://commons.wikimedia.org/wiki/File:Sickle_without_background.png.)

Is There a Benefit to Having Sickle Cell Trait?

A clue to whether the sickle cell trait conveys any benefit can be found in the geographic distribution of SCT in Africa, which historically has correlated to that of malaria (Figure 4). Interestingly, patients with SCT have some protection against malaria. We aren't 100% sure why this happens but there are some theories. One theory is that the parasite which causes malaria will decrease oxygenation within the RBC it infects. This will cause the cell to sickle and then be cleared by the spleen, limiting the parasite's ability to infect the host.

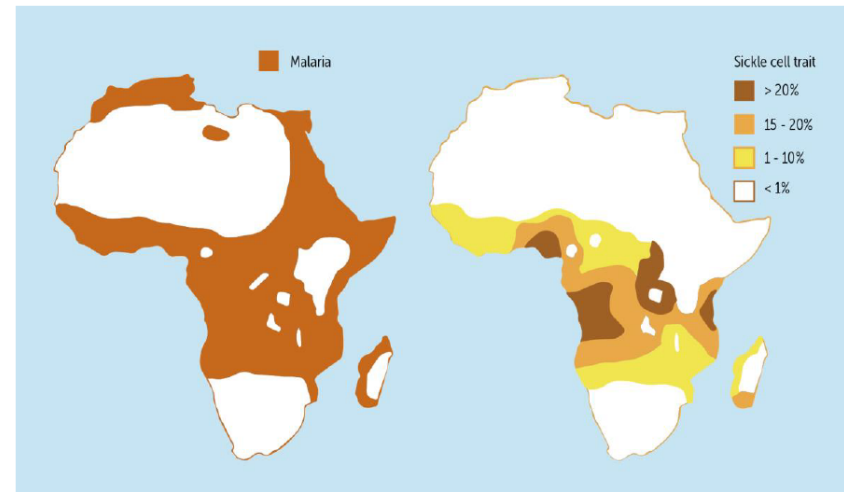


FIGURE 4

Q: What is a possible mechanism for the protective effect of SCT against malaria?

A: Parasite infection is thought to decrease oxygenation in RBCs, which promotes sickling and removal from circulation.

Why Do RBCs Sickle?

Remember that hemoglobin has two stable conformational states:

- **taut** when there is low oxygen, high CO₂, low pH, and high 2,3-BPG (or DPG); and
- **relaxed** when there is high oxygen, low CO₂, high pH, and low 2,3-BPG.

Lifestyle modifications such as avoiding dehydration, high altitude, and overly strenuous exercise can help prevent crises. Antibiotic prophylaxis and vaccines also play a major role.

Hydroxyurea is the only approved drug for the treatment of SCD. It works by increasing the amount of fetal hemoglobin (HbF). HbF is different from adult hemoglobin because it has 2 γ subunits instead of β subunits. The different structure is not subjected to the mutation and will therefore increase the number of normally shaped RBCs in circulation. Hydroxyurea has been shown to decrease the number of pain and acute chest syndrome episodes. However, it also reduces the number of leukocytes and may be carcinogenic; it is particularly associated with increased risk of leukemia.

In cases of pain crisis, the first line of treatment is hydration and analgesics. Acute chest syndrome may also require supplemental oxygen and empiric antibiotics. In severe cases, an exchange transfusion can be done to remove sickled cells and replace them with normal donor RBCs. This is particularly useful in acute chest syndrome, stroke, and priapism. Finally, bone marrow or stem cell transplants can potentially be curative but are considered only for patients with severe SCD complications.

Summary

- Hemoglobinopathies are diseases affecting the structure of the globin portion of hemoglobin. Sickle cell disease (SCD) is caused by a single amino acid mutation (glutamine to valine), which causes HbS in the taut state to polymerize into long, inflexible chains.
- SCD is diagnosed with gel electrophoresis, but sickle cells can also be seen on blood smear.
- A CBC shows decreased hemoglobin and hematocrit with an increased reticulocyte count. A peripheral smear shows sickle cells, target cells and Howell-Jolly bodies.
- Complications include asplenia, painful vaso-occlusive crisis, acute chest syndrome, infection, and avascular necrosis.
- Symptoms arise due to hypoxia, altitude, dehydration, and infection.
- Treatment includes folic acid for anemia and hydroxyurea to increase HbF concentration, because HbF is not susceptible to sickling.
- Management of pain crises includes hydration, analgesics and, potentially, exchange transfusion.

Assessment Questions

1. Which of the following mutations causes sickle cell disease?
 - A. Missense mutation
 - B. Nonsense mutation
 - C. Point mutation
 - D. Trinucleotide repeat

2. Which of the following promotes RBC sickling?
 - A. Acidosis
 - B. Alkalosis
 - C. Decreased 2,3 BPG
 - D. Fetal hemoglobin

3. A 27-year-old African American male presents to the ED with shortness of breath, fever, and chest pain which he rates as 10/10 intensity. His oxygen saturation is 88%. A review of his chart shows 1-2 admissions per year due to infection and/or bone pain. Which of the following treatments would most quickly address the issue of low oxygen saturation?
 - A. Exchange transfusion
 - B. Folate
 - C. Hydroxyurea
 - D. Ibuprofen
 - E. Pneumococcal vaccine

Answer Explanations

1. The correct answer choice is point mutation (C). SCD is caused by a point mutation in the beta globin chain gene. The mutation is not a missense mutation (A) or nonsense mutation (B). Trinucleotide repeat mutations (D) are present in several diseases, including Huntington disease and fragile X syndrome – but they are not seen in hemoglobinopathies (including sickle cell disease).
2. The correct answer choice is acidosis (A). Acidosis, increased 2,3 BPG, hyperthermia, and altitude all shift the hemoglobin dissociation curve to the right, favoring a deoxygenated state which would promote sickling in SCD. Answer choices B, C, and D, all cause a shift to the left. Increasing fetal hemoglobin is actually a target of therapy with hydroxyurea.
3. The correct answer choice is exchange transfusion (A). Based on the patient history and presenting symptoms, he most likely has SCD and is experiencing acute chest syndrome. He had a number of symptoms consistent with acute chest syndrome, including chest pain, fever, shortness of breath and hypoxemia. Management should include pain control, fluids, oxygen supplementation, and exchange transfusion. Answers (B) and (C), folate and hydroxyurea, have roles in the chronic management of SCD, but not in this setting. It is most likely that ibuprofen (D) would not be adequate to manage this patient, but not in this setting. It is most likely that opioid. The patient should be vaccinated against pneumococcal pneumonia (E), but this is not appropriate during an acute chest syndrome.

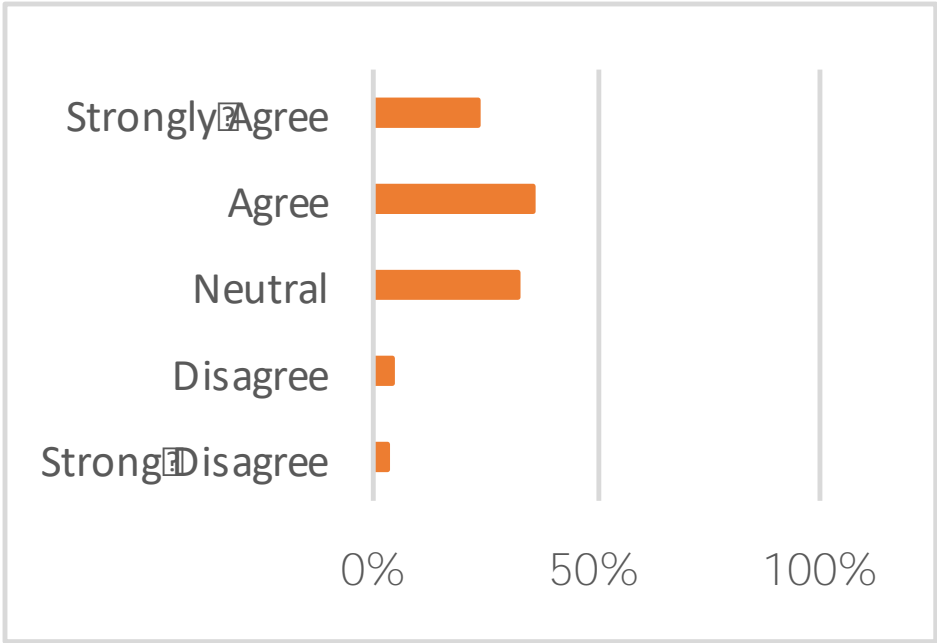
Program Evaluation

- Primarily involved narrative text bricks
- Deployed in 4 hematology courses at 3 US medical schools
 - Lecture based
 - Supplemental resource
 - First year medical students
- Kirkpatrick level 1 evaluation data
- Mixed methods approach
 - End of course surveys
 - Student focus groups
 - Faculty/dean interviews

University of Louisville #1

The ScholarRx anemia bricks were helpful as a supplemental source

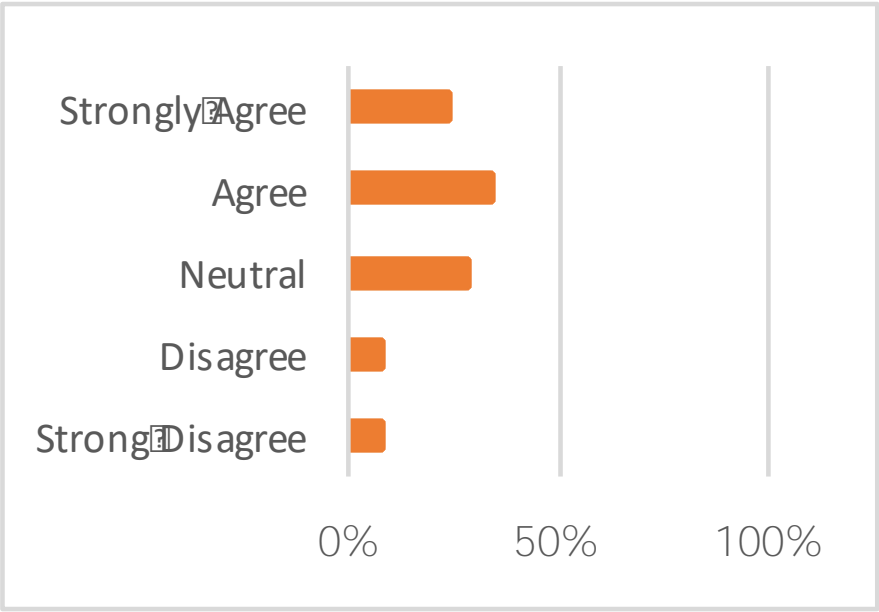
Response	Number of students	Percent of total
Strongly Disagree	4	3%
Disagree	6	5%
Neutral	42	32%
Agree	47	36%
Strongly Agree	31	24%
Total	130	



University of Louisville #2

The ScholarRx WBC disorder bricks were helpful as a supplemental source

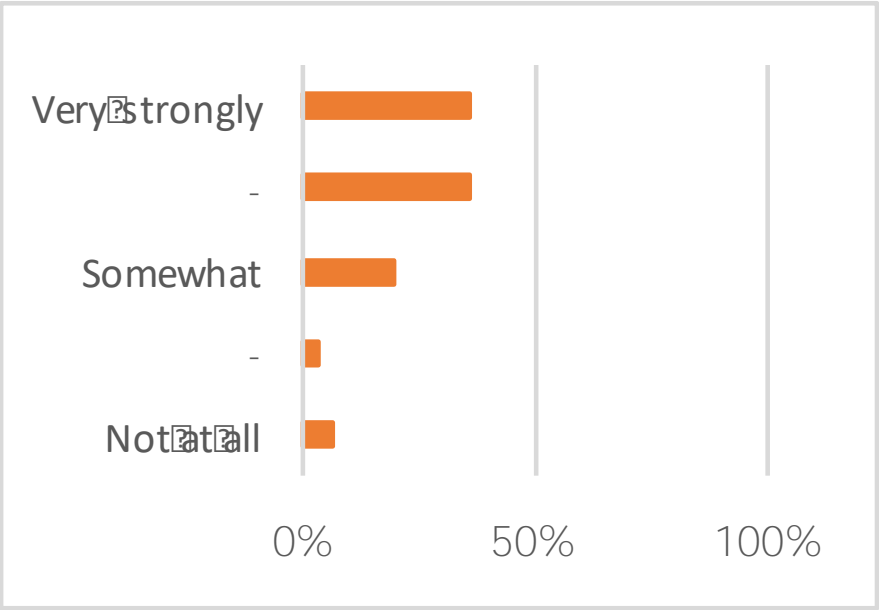
Response	Number of students	Percent of total
Strongly Disagree	11	8%
Disagree	10	7%
Neutral	38	28%
Agree	45	33%
Strongly Agree	32	24%
Total	136	



Western University of Health Sciences COMP

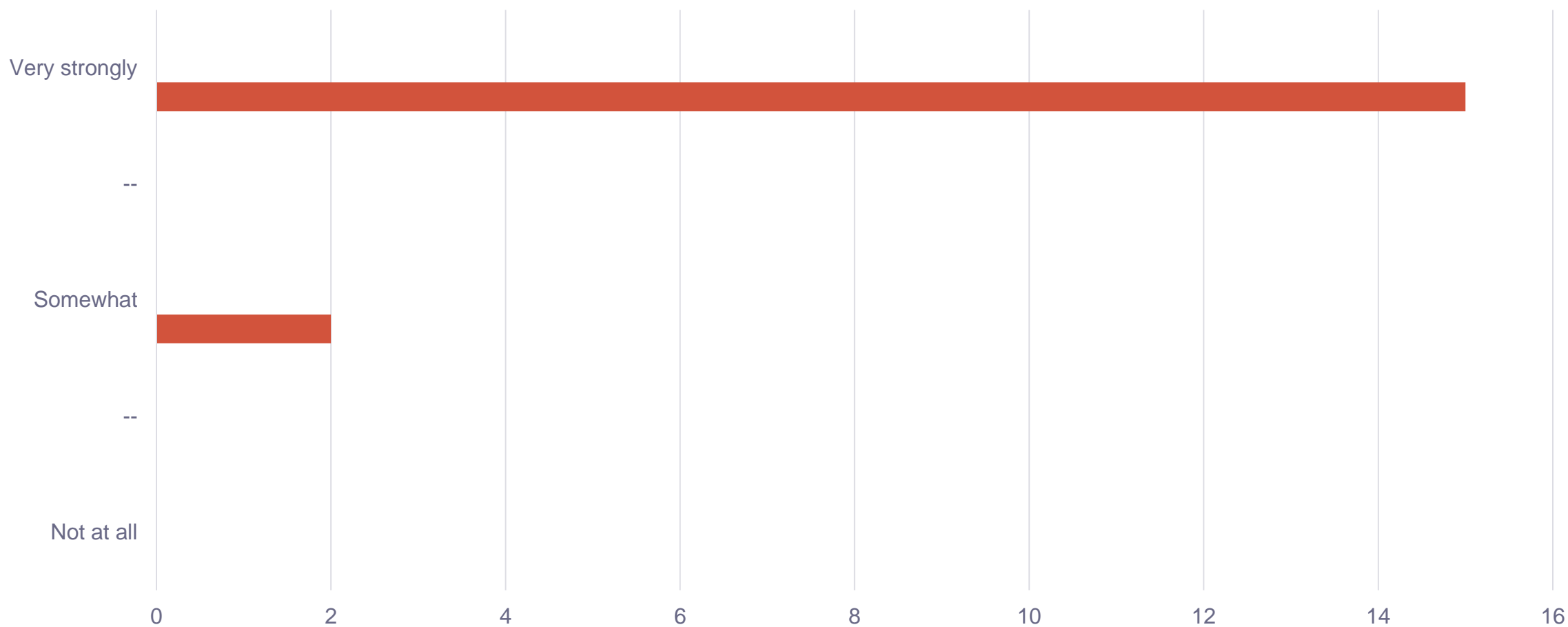
Would you recommend this resource to other students?

Response	Number of students	Percent of total
Not at all	2	6%
-	1	3%
Somewhat	6	19%
-	11	35%
Very strongly	11	35%
Total	31	



University of Minnesota (Duluth Campus)

Would you recommend this resource to other students?



UofL Student Focus Groups

- Two focus groups – 13 M1 participants
- Themes
 - Friendly and engaging
 - Very easy to read
 - Addressed “how” and “why” and not just “what”
 - Patient stories made learning relevant and meaningful
 - Large volume of material
 - More complex USMLE-style MCQs
- 12/13 agreed that bricks were useful

Faculty Individual Interviews

- Four faculty (including 2 deans)
- Themes
 - Friendly and engaging – **“No wonder the students like them. The bricks are non-threatening.”**
 - High quality
 - Good curricular coverage
 - Spontaneous student praise
 - Large volume of material
- 4/4 will use the bricks again next year

Conclusions

- ScholarRx curriculum bricks were largely well-received by students and faculty at multiple medical schools
- Potential strengths -- ease of use, high quality, good curricular coverage, patient stories
- Potential challenges -- large volume of material, need for more complex formative assessments



What's Next?

- Add mini-case scenarios
- Adding more MCQs with more complexity
- Add story arcs to improve narrative structure
- Additional pilots exploring:
 - Application in PBL
 - Application in TBL
 - Application in international medical schools
 - As primary (vs. optional) curricular experience
 - As a component of self-directed learning experiences

ScholarRx Medical Education Research and Innovation Challenge (MERIC)

- Promotes and disseminates education research and innovations with ScholarRx
- \$250K over 5 years
- Fall 2017 launch
- More details to come



Acknowledgments

- University of Louisville
 - Steve Ellis, PhD
 - Amy Holthouser, MD
 - Ann Shaw, MD, MA
- Western University of Health Sciences COMP
 - Gerald Thrush, PhD
 - Scott Helf, DO, MSIT
- Georgetown University
 - Carrie Chen, MD, PhD
- In-Training.org
 - Ajay Major, MD, MBA
 - Aleena Paul, MD, MBA
- ScholarRx faculty, med students, staff



Making Everyone an Education Super Hero

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Prototype Feedback

“The attached content on Sickle Cell is a **masterpiece** – very clear, good content, and nicely presented. The images and interspersed practice questions are helpful.”

– *Block Director, University of Arizona College of Medicine-Phoenix*

“These resources are **amazing**... Thank you.”

– *Medical Student, Western University*

“I think the bricks are **great**! They highlight the need-to-know info, fill in the blanks for understanding, and provide a solid framework for the student to build on at a higher level. **Love it.**”

– *Medical Student, American University of the Caribbean*

Prototype Feedback

“I think that this reads like a textbook that students can **actually learn** from!! :) The conversational tone is easy to follow. Also, I feel like I can read it without having a lot of background and begin to understand the topic.”

– *Medical Student, Geisinger Commonwealth School of Medicine*

“The content is absolutely **brilliant**.”

– *Medical Student, Royal College of Surgeons in Ireland*

“I really like the way it's written. It's easy to follow and understand and flows in a logical manner. I agree I think it is **friendly** and **engaging**. I especially like the fact that you've incorporated the basic physiology and review to help with the contextual information.”

– *Medical Student, Texas Tech University*