TRANSFORMING A TRADITIONAL BIOCHEMISTRY COURSE INTO AN APPLIED BIOLOGICAL CHEMISTRY EXPERIENCE: A SUCCESS STORY

K.M.G. Mallela*, D.L. Bain, J.F. Carpenter, K.S. Fritz, and K.L. Franson

Skaggs School of Pharmacy and Pharmaceutical Sciences

University of Colorado Anschutz Medical Campus

Aurora, CO 80045.

*E-mail: krishna.mallela@ucdenver.edu

Biochemistry grade is a major predictor of students' performance in PharmD

P1 GPA:

	Unstandardized Coefficients	P value
Cumulative GPA	0.288	P<0.001
PCAT composite	0.005	P<0.001
Biochemistry grade	0.164	P<0.001
Colorado resident	-0.118	P=0.001
Summer English Program	0.159	P=0.02

David Thompson, CU

Biochemistry grade is a major predictor of students' performance in PharmD

P2 GPA:

	Unstandardized Coefficients	P value
Cumulative GPA	0.334	P<0.001
PCAT composite	0.006	P<0.001
Biochemistry grade	0.127	P<0.001

Overall GPA:

	Unstandardized Coefficients	P value
Biochemistry grade	0.208	P<0.001

David Thompson, CU

Independently verified by Temple University, Touro University & Association of Biochemistry Educators

Applied Biological Chemistry (ABC)

- Accreditation Council of Pharmacy Education (ACPE) new guidelines require increased active-learning strategies incorporated into the PharmD curriculum.
- We changed from old curriculum to new curriculum in 2012 as part of our accreditation process.
- We developed a new Biochemistry course named Applied Biological Chemistry (ABC) with increased active-learning strategies, increased focus on the applications rather than teaching from the textbook. Now, more than half of the course materials comes from outside the textbook.

ABC (Introduced in 2012)

(1) **Pretests:** The questions come from Lehninger and Stryer Biochemistry textbooks. Results help us tailor our lectures to review some fundamentals first before launching into applications.

(2) **Reading exercises before lectures:** Chapters from Lehninger Biochemistry depending on the lecture, and a pretest before coming to the lecture.

(3) **Research paper discussions:** Randomly created student groups review recently published new and novel scientific papers, make PowerPoint presentations, and present in the class.

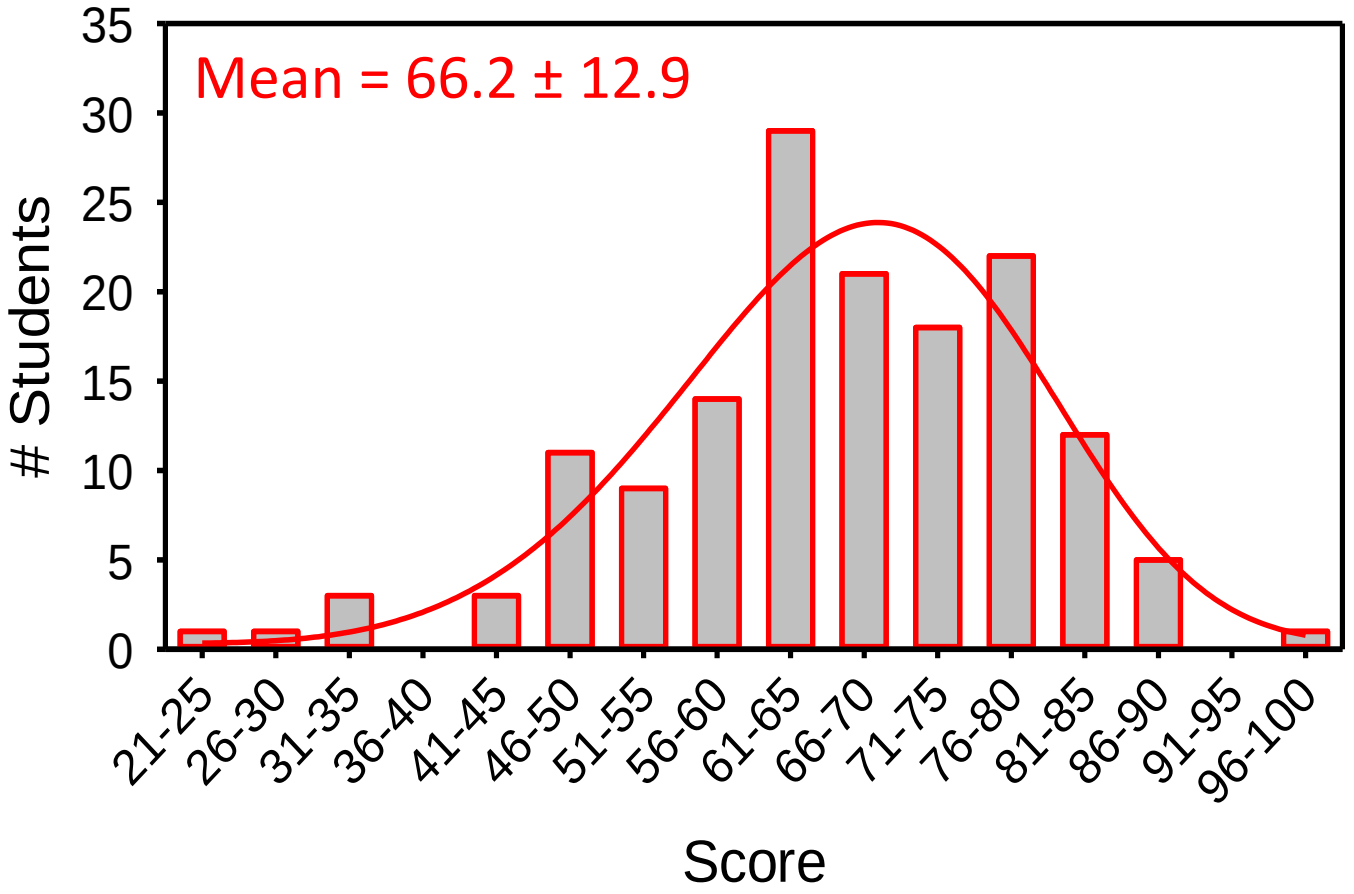
(4) **Patient case studies:** Basic biochemistry to diagnose diseases and drug recommendations.

(5) **Small group discussions:** e.g., Current issues with repurposing drugs (Lucentis vs Avastin for treating AMD); Issues with compounding pharmacies; Biosimilars.

(6) **Exam review:** Students form small groups to discuss the correct answers (TurningPoint/ResponseWare).

(7) **Percentile scores after exams:** These scores make students compete for better grades in successive exams.

Pretest Results



- ~60% of the class got grade D or below (<70% score).
- An important factor: Students had very different biochemistry courses (e.g., at different universities and colleges and at different times).

Kari Franson

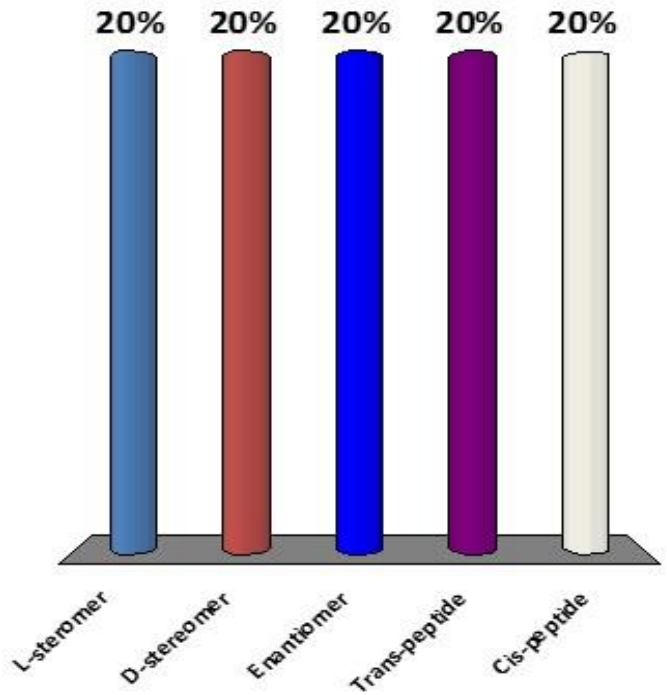
Reading assignments before lecture

	DATE	TIME	LOCATION	READ THESE CHAPTERS FROM LEHNINGER BIOCHEMISTRY, 7TH EDITION BEFORE CLASS & TAKE PRE-TESTS	TOPIC (INSTRUCTOR)
Lecture 0	Monday Aug 21	2:30 pm to 3:50 pm	Ed2N Rm 1303		Introduction (Mallela)
Lecture 1	Friday Aug 25	11:00 am to 12:20 pm	Ed2N Rm 1303	Chapters 1-2	Protein structure (Mallela)
2	Monday Aug 28	2:30 pm to 3:50 pm	Ed2N Rm 1303	Chapters 3, 4 & 5	Protein function (Mallela)
3	Friday Sept 1	11:00 am to 12:20 pm	Ed2N Rm 1303	Chapters 3, 4 & 5	Diseases with loss of protein stability and function (Mallela)

Exam Review

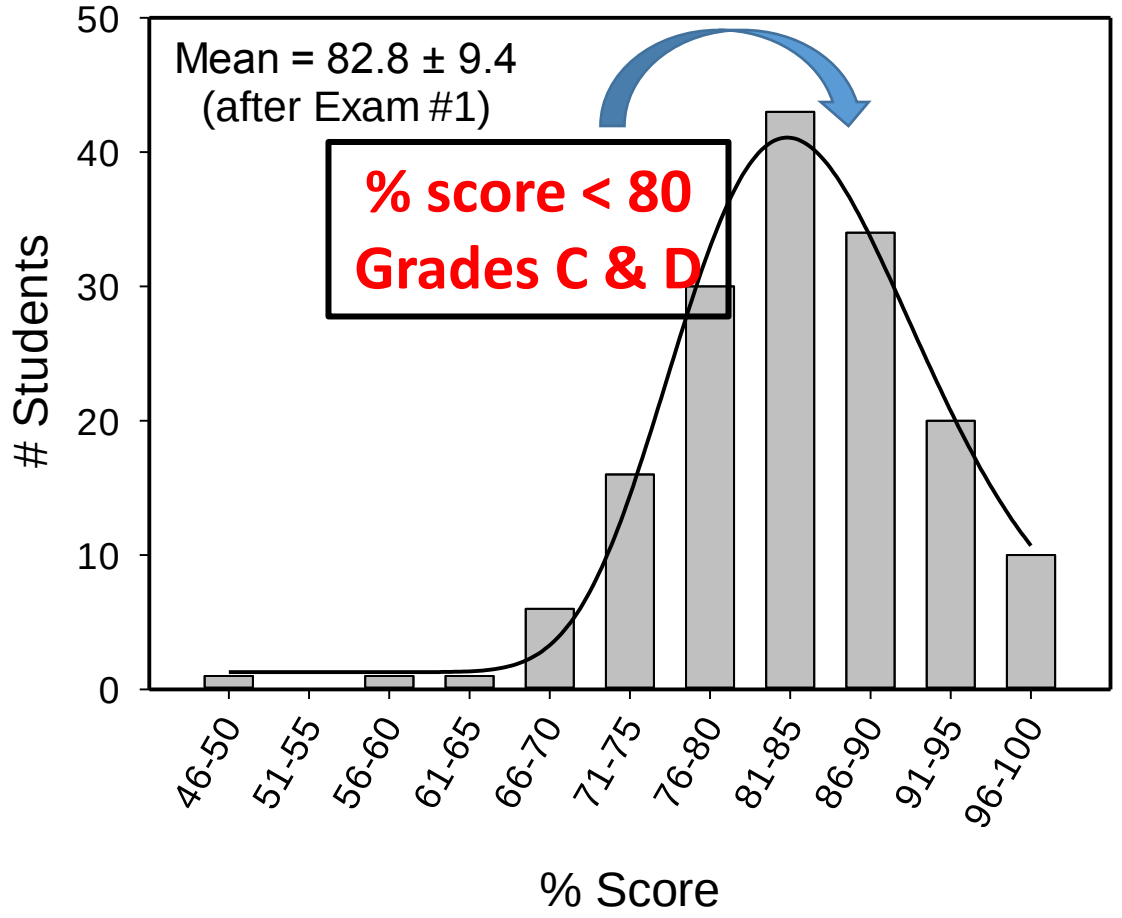
1. Antibiotic Penicillin interferes with the synthesis of peptidoglycan, the major component of rigid cell wall that protects bacteria from osmotic lysis. Penicillin is an irreversible inhibitor of transpeptidase by attacking a key Ser residue in the active site generating a covalent adduct which is very stable. Transpeptidase catalyzes the proteolysis of a peptide bond between two D-alanines. Penicillin is made up of thiazolidine, β-lactum, and a phenylalanine (or its derivatives). What should be the chirality of this phenylalanine?

A. L-steromer
B. D-stereomer
C. Enantiomer
D. Trans-peptide
E. Cis-peptide



Lisha Bustos

Percentile Scores after every Exam



If your score is less than 80%, you need to work hard to get into the mainstream. You don't want to get grade C or below, otherwise you will not be considered for any future grants, scholarships, or research honors. If you get two Ds in two different courses, you have to retake the entire semester.

Research Paper Discussions

- Case studies of how the basic knowledge of biochemistry helps in understanding the disease mechanisms and drug actions.

- Students will be randomly divided into individual groups, and will be assigned broad research topics with published review articles at least one week prior to the scheduled date.

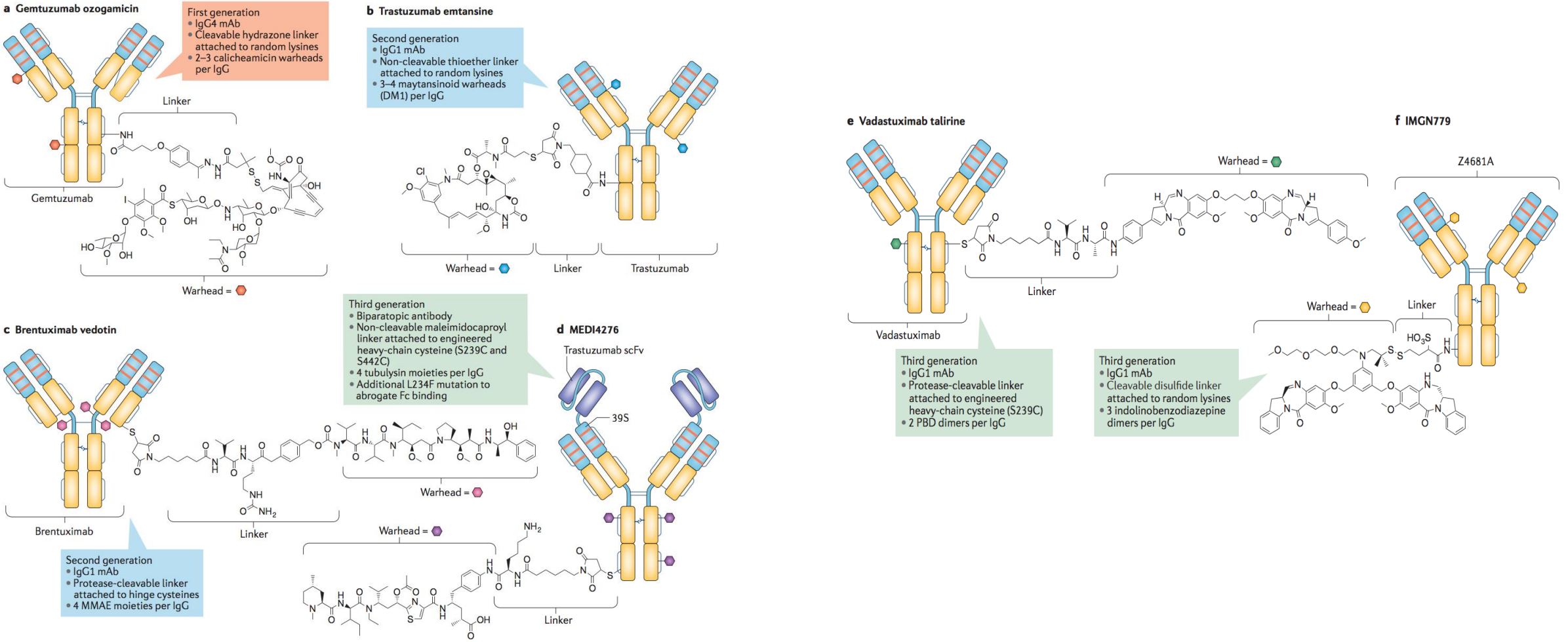
- Each group is expected to read, analyze, and research the assigned topic based on the knowledge gained from pre-requisite biochemistry courses and from in-class lectures, and submit PowerPoint presentations on Canvas.

- On the scheduled date, groups will be randomly selected from the class to present and discuss research findings from their assigned papers.

- Wide topics include: peptide and protein drugs, antibody-based drugs, vaccines, repurposing drugs, biosimilars, nutrition and diet, gene therapy, protein and genetic engineering, CRISPR/Cas9 gene editing, stem cells, personalized medicine, …

Research Paper Discussions

First, Second and Third Generation Antibody-Drug Conjugates



Research Paper Discussions

MYTHBUSTERS

Eggs Edition: Healthy or Unhealthy?

Group 20: Marilyn Banh, Erlynn Frankson, Melissa Gamble, Sherry Marks, Kate Mercer, Megan Wary

"Yolks are bad, so I should only eat egg whites…"

- A large egg contains ~186 mg of cholesterol
  - The entirety is found in the yolk
  - Egg whites contain only protein and water
- This does not, however, mean that the yolks are bad for you.
  - Although they contain more than the 300 mg of cholesterol recommended per day by the American Heart Association, research shows that the amount of cholesterol in your blood is not greatly affected by what you eat (given that you do not have a rare genetic disorder or diabetes).

Egg Yolk: A Nutritional Powerhouse

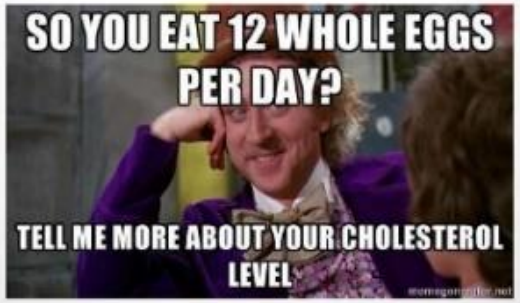
- Major egg yolk constituents:
  - Proteins
  - Lipids
- Two major portions
  - Granular fraction
    - High-density lipoproteins
    - Phosvitin
    - Low-density lipoproteins
  - Plasma fraction
    - Low-density lipoproteins
    - Livetins (including immunoglobulin Y)
- Minerals
- Carbohydrates - oligosaccharides bound to proteins

Biological Activities of Egg Yolks

component	biological activity
egg yolk	antiadhesive
immunoglobulin Y	antimicrobial activity
phosvitin	antibacterial activity
	antioxidant activity
	enhancement of calcium solubility
sialyloligosaccharides and sialylglycopeptides	antiadhesive properties
yolk lipids	antioxidant activity
lipoproteins	antibacterial activity
fatty acids	antibacterial activity
phospholipids	role in brain development and function
	reduction of cholesterol levels
cholesterol	component of cell membranes

http://pubs.acs.org/doi/full/10.1021/1050964f

RESULTS: <u>No significant difference</u> was observed between those individuals who consumed more than 6 eggs/ week compared to those who consumed none or <1 egg per week.

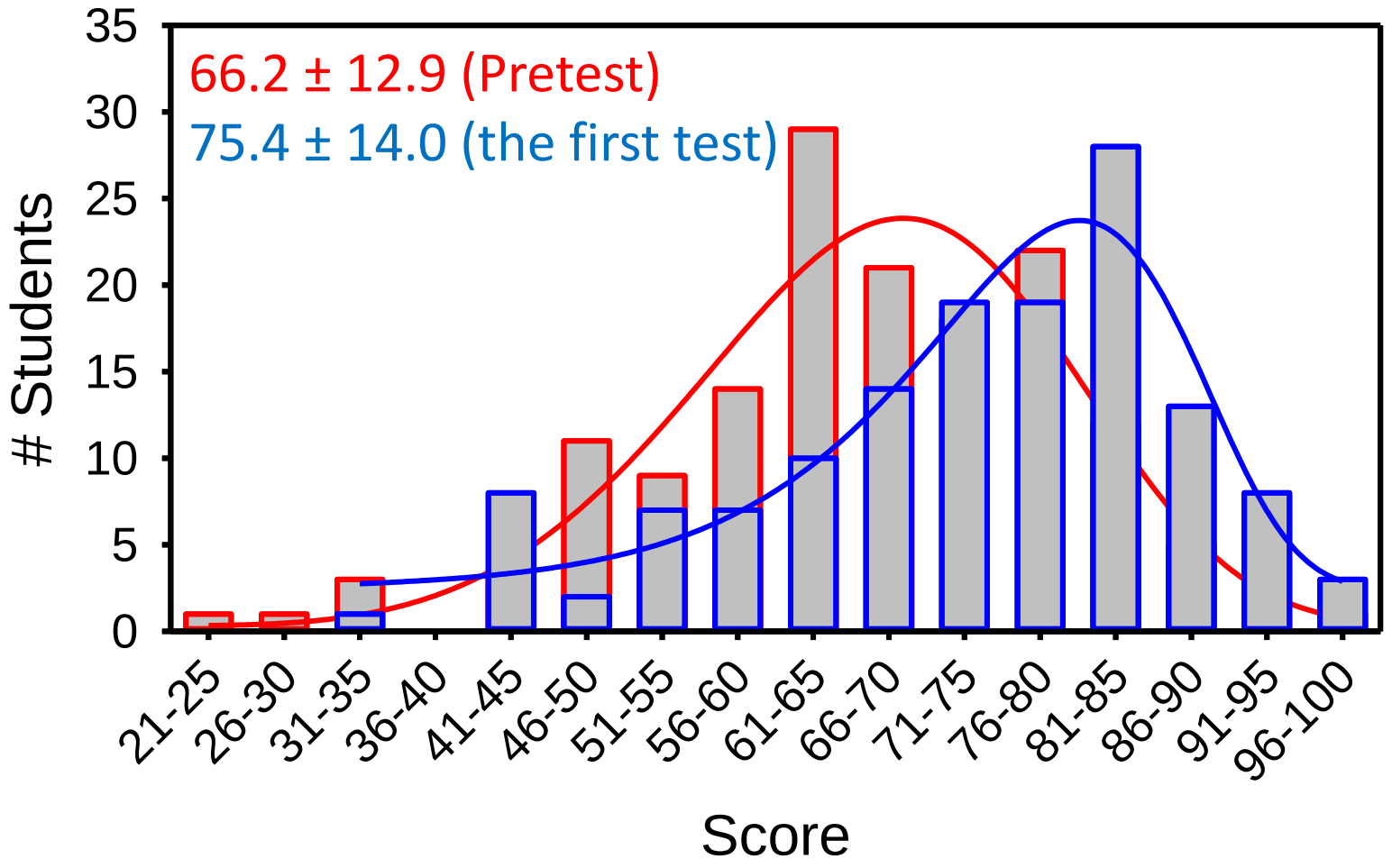


Patient Case Studies

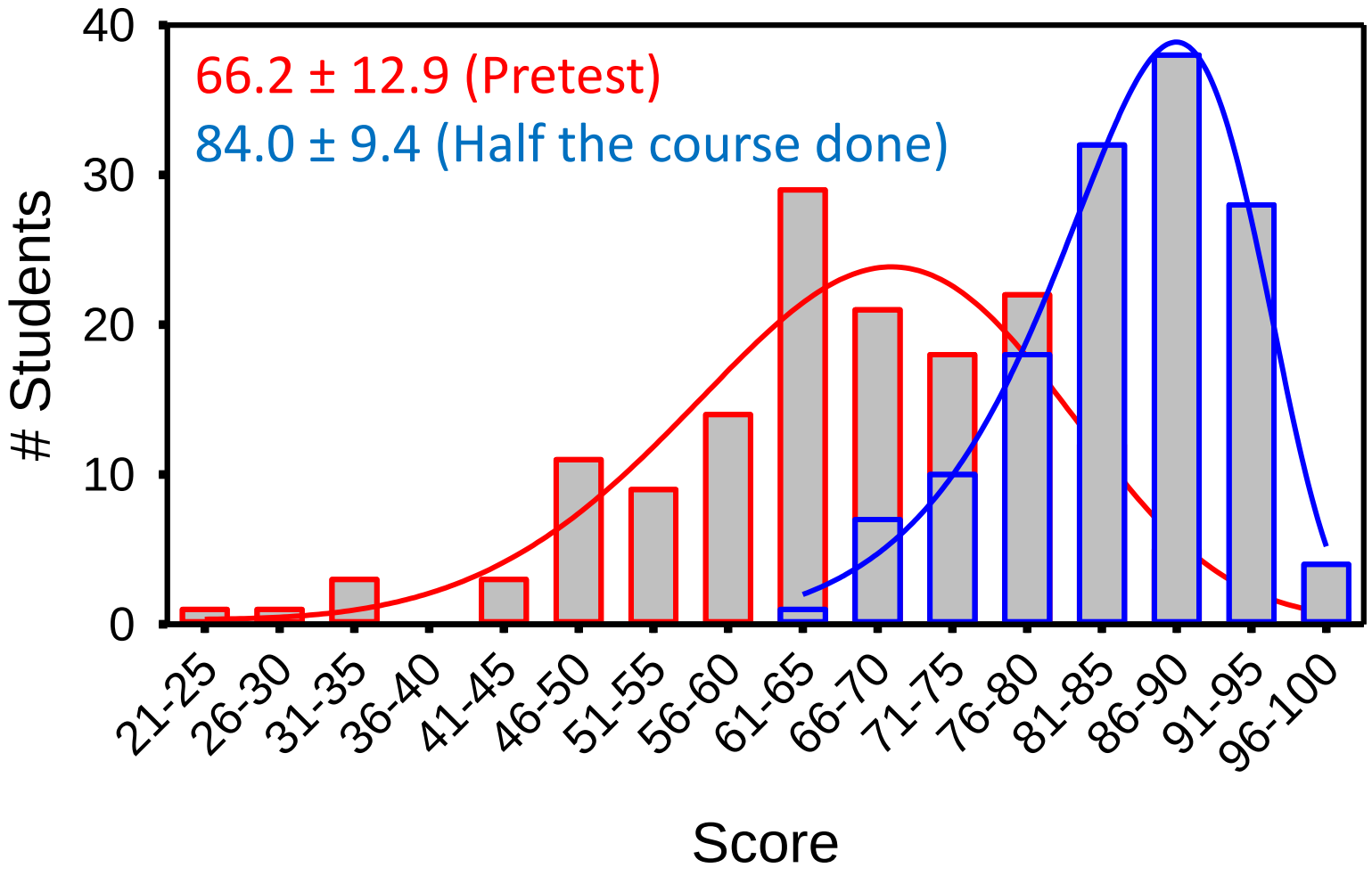
A 13-year-old girl from Nigeria visited her family physician for liver dysfunction, recurrent acute bone pains and breathing trouble.
Laboratory tests revealed the following:
Patient (Normal)
Hemoglobin: 6.9 g/dL (12.3 to 15.3 g/dL)
Hematocrit: 22.1% (36 to 45%)
Mean corpuscular Volume (MCV): 85.7 fL/red cell (80-96 fL/red cell)
Leukocytes: 8.4 x $10^3/mm^3$ (4.4 to 11.3 x $10^3/mm^3$)
Differential Count: Normal
Bilirubin (total): 45 mg/dL (0.3-1 mg/dL)
Serum iron: Normal
Serum albumin: Normal

Blood film identified many abnormal half-moon shaped reticulocytes. Which is most likely to be the diagnosis based on these results?

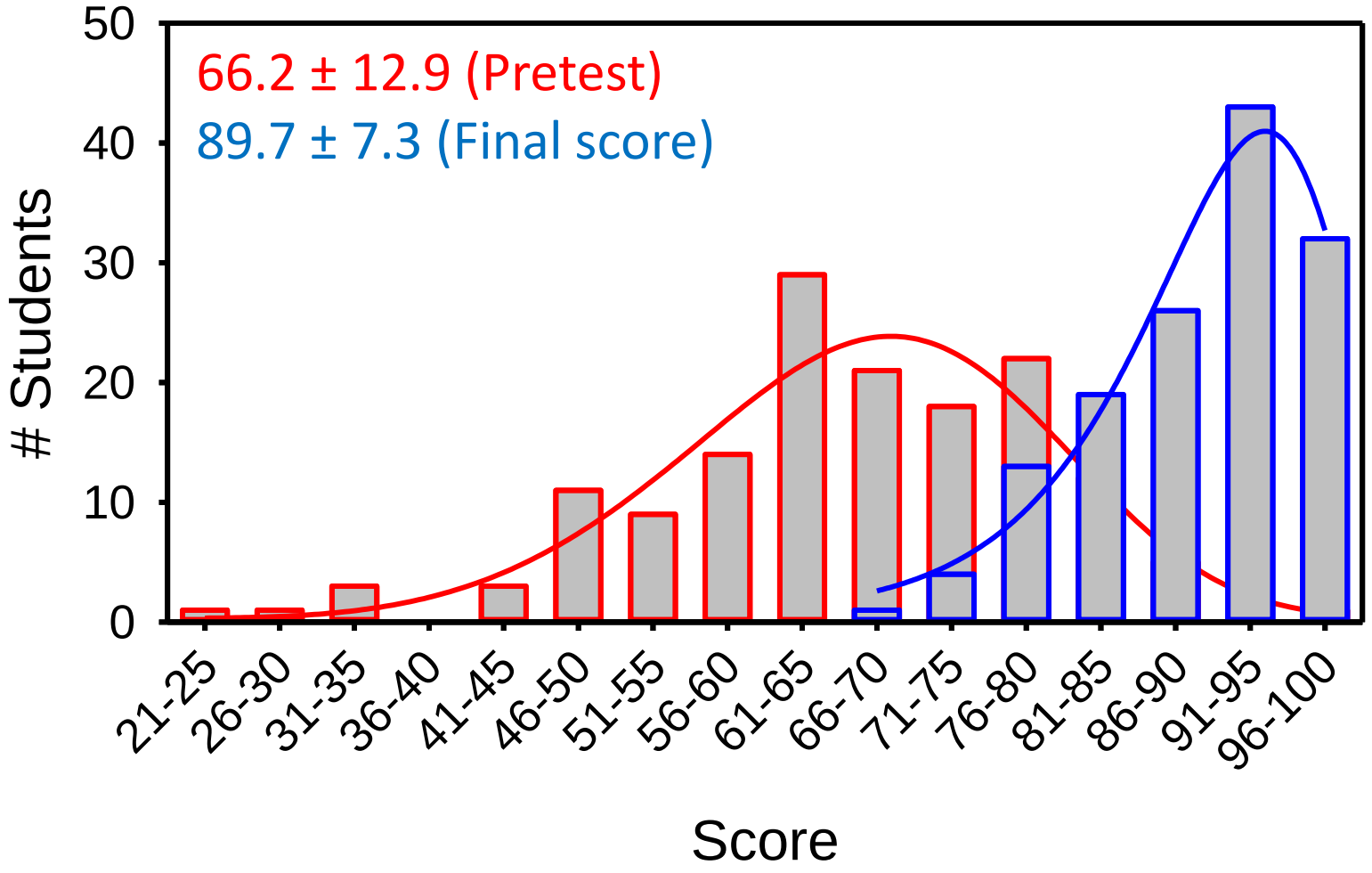
Students' grades improve as the course progresses



Students' grades improve as the course progresses

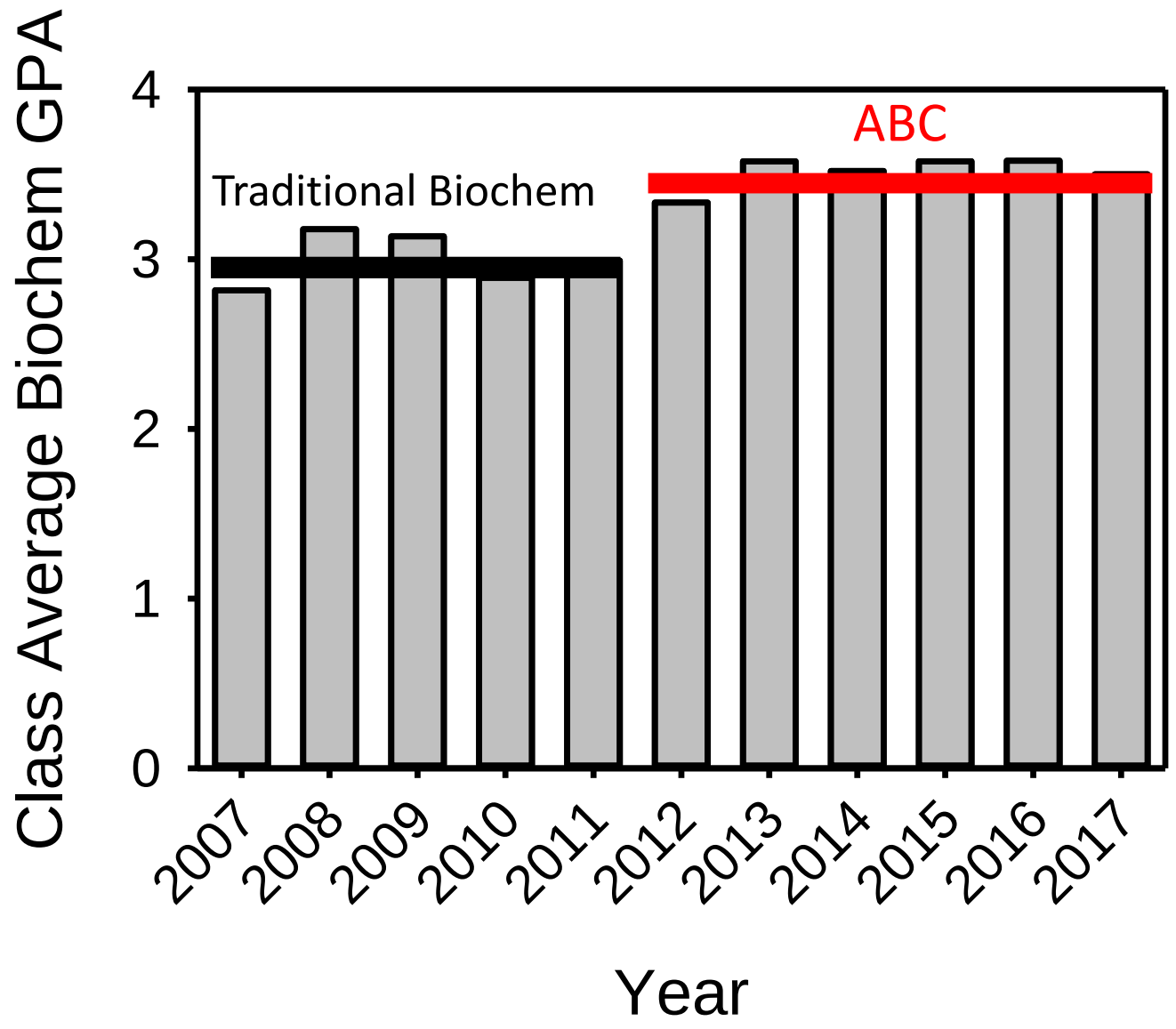


Students' grades improve as the course progresses



Kris Fritz

Class GPA improved after increased active-learning



Susan Kepner

Results

- It worked and Students like it!! Course evaluations by students: 4.6 – 4.8 out of 5 (from 4.2 for previous traditional Biochemistry). Evaluations for individual instructors in the same range. One of the highly rated courses in our PharmD program, Accreditation Council of Pharmacy Education (ACPE), and Association of Biochemistry Educators (ABE) (now featured at EAFP).

- Increased student attendance (>98% of 165 students). Overall class GPA increased from 3.0 to 3.5.

- Biochemistry grade remains as the major predictor of a student's performance in PharmD.

"Biochemistry is tough, but should be fun and enjoyable"

Course Selected as One of the Best in the Nation

BY DANA BRANDORFF

Five faculty members – Drs. Krishna Mallela, David Bain, John Carpenter, Kris Fritz and Kari Franson -- collaborated to transform the Applied Biological Chemistry course and recently received national recognition for their efforts. Incorporating active learning strategies, the course resulted in students learning the material better while improving class participation and performance.

The course was recognized as one of the best in the nation (along with Vanderbilt, Baylor, Texas A&M, and University of Florida) among all schools of Dentistry, Medicine, and Pharmacy during the 2017 Association of Biochemistry Educators (ABE) Conference.

"As a former Biochemistry major, I felt that this course added valuable information to my biochemistry knowledge. The integration of active learning strategies allowed students to engage in a deeper level and the application to disease states allowed students to understand relevance to pharmacy practice. Additionally, the student presentations provided valuable practice in professional communication to a large audience," says third-year pharmacy student Wendy Serrano.

Drs. Mallela, Fritz, Franson and Bain

Association of Biochemistry Educators (ABE) featured our course as one of the five best in the Nation (along with Vanderbilt, Baylor, Texas A&M, and University of Florida) during its 2017 annual conference among all schools of Dentistry, Medicine, and Pharmacy.

Acknowledgements

Kris Fritz

Kari Franson

David Bain

John Carpenter

David Ross

Ralph Altiere

2012-17 PharmD students