Akhil Khanal

Department of Biochemistry, University of Colorado Boulder, Boulder, CO 80309

khanala@colorado.edu

TEACHING INTERESTS

Introduction to Chemistry; General Chemistry; Organic Chemistry I**;** Biochemistry; Specialized courses in Biochemistry; Laboratory courses in Biochemistry

EDUCATION

Post-Doctoral Training, 2009-2013

University of Colorado at Boulder, Boulder, CO

Advisor: Shelley Copley

Research: The Effect of Genetic Background on the Evolvability of a Promiscuous Activity

Ph.D. in Biochemistry, July 2009

University of Delaware, Newark, DE

Advisor: Brian Bahnson

Dissertation Title: Investigations of the Putative Peroxidase Activity of Paraoxonase-1

M.S. in Biochemistry, December 2002

Temple University, Philadelphia, PA

Advisor: Charles Grubmeyer

Dissertation Title: Structure, Motion, and Co-operativity in Orotate Phosphoribosyl Transferase

B.A. in Biology, May 1999

Ithaca College, Ithaca, NY

Advisor: Vicki Cameron

Dissertation Title: Separation of Two Mutations in Cytochrome Oxidase by Genetic Recombination

TEACHING EXPERIENCE

Assistant Teaching Professor Spring 2017 - present

University of Colorado Boulder, Boulder, CO

Courses taught:

1) **Organic Chemistry I (CHEM 3311)**
   This is a course for health science majors.
   Class size = 210 students

2) **Foundations of Biochemistry (BCHM 2700)**
   This is a course for Biochemistry majors.
   Class size = 6 students

3) **Central Dogma (CHEM 4740/5740)**
   This course covers structure and function and biosynthesis of biomolecules such as RNA and RNA. Cellular signaling and gene expression is also covered in depth as well as special topics chosen by the instructor.
   Class size = 33 students

4) **General Chemistry II** (CHEM 1133)
   Second semester of college General Chemistry
   Class size = 77 students

5) **General Chemistry I Laboratory (CHEM 1114)**
   Laboratory class for General Chemistry I
   Class size approximately 800 – 900 students

6) **General Chemistry I (CHEM 1113)**
   First semester of college General Chemistry.
   Class size = 18 – 180 students

7) **General Chemistry II Laboratory (CHEM 1134)**
   Laboratory class of General Chemistry II
   Class size = 77 students

8) **Chemistry for Engineers (CHEM 1221)**
   This is an introductory laboratory course for students majoring in Engineering.
   Class size = approximately 800 – 900 students

9) **Introductory Chemistry (CHEM 1021)**
   This is a preparatory class for General Chemistry.
   Class size = 30 students

Instructor Fall 2013 – Spring 2019

Front Range Community College, Longmont, CO

Courses taught:

1) **General Chemistry I (CHE 111)**
   First semester of college General Chemistry with Laboratory.
   Class size = 15 – 25 students

2) **Introduction to Chemistry (CHE 101)**
This is a preparatory class of General Chemistry I.
Class size = 11 – 25 students

3) **Science of Biology (BIO 105)**
This is a preparatory class of General Biology I.
Class size = 18 students

Lecturer 2017 – Spring 2018

Metropolitan State University of Denver
Courses taught:

1) **Introduction to Chemistry Laboratory (CHEM 1150)**
This is a lab for non-science majors or for students in the occupational health fields. It is also recommended for students to prepare for General Chemistry.
Class size = 12 students

2) **General Chemistry II Laboratory (CHEM 1850)**
This is a laboratory of General Chemistry II.
Class size = 12 students

3) **Biochemistry Laboratory (CHEM 4350)** Spring 2017 – Fall 2017
This laboratory is designed for students majoring in Biochemistry and prepares them for a career in research or for graduate school. It focuses on modern biochemistry techniques such as UV-VIS spectroscopy, column chromatography, gel electrophoresis, and molecular cloning.
Class size = 12 students

Lecturer Spring 2014 - Fall 2015

University of Colorado Denver, Denver, CO
Courses taught:

1) **Organic Chemistry I (CHEM 3411)** Spring 2014 - Fall 2015
This is the first semester of two semester Organic Chemistry class.
Class size = 50 – 130

2) **Biochemistry Laboratory (CHEM 4828)** Spring 2014 - Fall 2015
This laboratory focuses on modern biochemistry techniques such as UV-VIS and fluorescence spectroscopy, column chromatography, gel electrophoresis, and molecular cloning.
Class size = 12 students

3) **Foundations for General Chemistry (CHEM 1000)** Spring 2014 – Fall 2014
This is a preparatory class for General Chemistry.
Class size = 40 – 60 students

Teaching Assistant Spring 2013

University of Colorado, Boulder, CO

Microbial Genetics and Physiology (CHEM 4310): Duties involved substituting for the primary instructor for teaching. Also, during each class helping students solve in-class assignments was a major part of this job function. This was a major's class for seniors and graduate students.

Teaching Assistant Spring 2014 - Fall 2014

University of Delaware, Newark, DE

1) **General Chemistry (CHEM 102)**: Duties involved teaching laboratory sessions.
2) **Protein Structure Function (CHEM 645)**: Duties involved substituting for the primary instructor. Class teaching material was selected and designed by me. This was a core class for graduate students in Biochemistry.

ACADEMIC EXPERIENCE

Post-Doctoral Research August 2009 - May 2013

University of Colorado at Boulder, Boulder, CO

Laboratory of Dr. Shelley Copley

- Investigated the effect of genetic background on the evolvability of the promiscuous activity of glutamyl phosphate from nine different bacteria.

Graduate Student February 2003 - July 2009

University of Delaware, Newark, DE

Laboratory of Dr. Brian Bahnson

- Investigated the peroxidase activity of a HDL-associated protein, paraoxonase-1
- Developed a purification scheme for paraoxonase-1 from human serum that was subsequently utilized in the biotechnology industry.
- Developed a novel purification scheme for human and rat peroxiredoxin6.

Graduate Student September 1999 - December 2002

Temple University, Philadelphia, PA

Laboratory of Charles Grubmeyer

- Conducted kinetic analysis on orotate phosphoribosyl transferase to relate enzyme structure to its motional dynamics and co-operativity.
- Designed a novel assay to separate products from an enzymatic and a non-enzymatic reaction mixture.

PUBLICATIONS

Yeung, D.T., Josse, D., Nicholson, J.D., Khanal, A., McAndrew, C.W., Bahnson, B.J., Lenz, D.E., Cerasoli, D.M., Biochimica et Biophysica Acta (2004) 1702 (1), 67-77, **Structure/Function Analyses of Human Serum Paraoxonase (HuPON1) Mutants Designed from a DFPase-like Homology Model**

Khanal, A., McLoughlin Yu, S., Kirschner, J.P., Copley, S.D., Mol. Bio. Evol. (2015), 32, (1), 100-108, **Differential effects of a mutation on the normal and promiscuous activities of orthologs: implications for natural and directed evolution.**

CONFERENCE PUBLICATIONS

"**The Effect of Genetic Background on the Level and Evolutionary Potential of a Promiscuous Enzyme Activity**", Khanal, A., McLoughlin, S.Y., and Copley, S.D. Gordon Research Conference, Enzymes, Coenzymes, and Metabolic Pathways, July 18-23, 2010 Waterville, NH

"**Paraoxonase-1: Is it a Peroxidase**?" Khanal, A., and Bahnson, B.J.
Frontiers at the Chemistry-Biology Interface, May 2, 2009, Baltimore, MD

"**Paraoxonase-1: Unraveling the Peroxidase Myth**" Khanal, A., and Bahnson, B.J.
Delaware Membrane Protein Symposium, October 8, 2008, Newark, DE

RESEARCH DESCRIPTION

Post-Doctoral Research August 2009 - May 2013

University of Colorado at Boulder, Boulder, CO

Promiscuous enzyme activities can provide the starting place for evolution of novel activities when the environment changes and a new activity becomes important for survival or fitness. Both the levels and the evolvability of promiscuous activities would be expected to depend upon the primary sequence of an enzyme, which can vary significantly between organisms. To explore this facet of molecular evolution, this study was designed to 1) determine the levels of a promiscuous N-acetylglutamyl phosphate reductase activity in glutamyl phosphate reductases from different bacteria, and 2) to explore the evolutionary trajectories by which the promiscuous activities can be improved. Our results show that the promiscuous activities of glutamyl phosphate reductases from nine different bacteria are unexpectedly similar. Furthermore, the first step in the improvement of the promiscuous activities is a mutation of a conserved glutamate in all cases.

Doctoral Research February 2003 - July 2009

University of Delaware, Newark, DE

Paraoxonase-1 (PON1) is an HDL-associated enzyme that is purported to possess a peroxidative activity. This activity has been long claimed to the reason why PON1 functions as an antioxidant providing anti-atherogenic benefits. However, there has been a paucity of evidence that describes the mechanism PON1 utilizes to conduct the peroxidative catalysis that has been ascribed to it. My thesis goals were to design and conduct kinetic assays to elucidate the mechanism of its putative peroxidation. Contrary to published literature, my results revealed that PON1 does not catalyze the peroxidation reaction. Instead, the peroxidase activity attributed to PON1 is due to an impurity, probably an enzyme, that co-purifies with PON1.

Master's Research September 1999 - December 2002

Temple University, Philadelphia, PA

Orotate phosphoribosyl transferase (OPRTase) is an enzyme in the de novo biosynthetic pathway of pyrimidine nucleotides that catalyzes the formation of the nucleotide, orotidine-5-monophosphate from orotic acid and 5-phosphoribosyl-1-pyrpphosphate (PRPP). My research focused on three aspects of OPRTase: 1) Does the enzyme accelerate the rate of catalysis through the process of substrate "activation", namely, the activation of PRPP for nucleophilic attack? I found that OPRTase does not "activate" PRPP but offers a 10-fold stabilization against its breakdown, 2) Calculated the contribution provided towards binding by the individual endocyclic and exocyclic atoms of orotic acid. I calculated the dissociation constants of more than 50 orotic acid analogs and quantified

contribution made by individual atoms. This can lead to the design of tight-binding inhibitors. 3) Analyze the co-operativity in OPRTase that was discovered and related it to enzyme motion and structure. I discovered co-operativity of binding as well as catalysis in OPRTase and identified residues that through motional dynamics are important in co-operativity.

AWARDS Nominated for 2022 Peebles Innovation in Teaching Award at CU Boulder; Nominated for Master Teacher at Front Range Community College 2018; Nominated for Master Teacher at Front Range Community College 2017.