**Hemoglobin Function and Variation in Wild Populations lab contents:**

* Activity instructions: Hb\_lab\_Activities\_Guide.docx
* Activity sheet for students to fill in: Hb\_lab\_Activity\_Sheet.docx
* Powerpoint presentation: Hb\_lab\_intro.pptx
* Group data for Hb lab Activity I: Group\_data\_for\_Activity\_I.pdf
* Prelab: Prelab\_discussion\_questions.docx
* Homework assignment: Homework\_Hb\_lab.docx
* Storz, J.F. 2007. Hemoglobin function and physiological adaptation to hypoxia in

high-altitude mammals. *Journal of Mammalogy* 88: 24-31.

* Additional optional readings listed in the References below.

**Materials required:**

Students will need internet access for some of the activities.

This activity was designed for the Plant & Animal Form & Function (BIOL 204) lab at the University of New Mexico. The suggested timeline for the activities are:

Assign Storz 2007 and the Prelab discussion questions the week before, conduct the Activities in lab, Homework assignment due next lab period

**Student learning outcomes:**

(Bloom's taxonomy terms: [Cognitive; Knowledge type])

1. Understand the basic structure of hemoglobin and how the molecular structure of hemoglobin contributes to its characteristic function.

 [Remember, Understand, Apply; Factual]

1. Recognize resources available through online databases: Genbank, Arctos and Vertnet

 [Remember, Apply; Factual]

1. Understand how hemoglobin function can be altered through amino acid substitutions and by environmental factors (allosteric affectors).

 [Apply, Analyze; Factual, Conceptual]

1. Connect chemical properties of hemoglobin to whole-organism and population biology.

 [Analyze; Conceptual]

1. Understand mechanistically how the environmental partial pressure of oxygen (PO2) can result in natural selection among populations at different elevations.

 [Analyze, Evaluate; Conceptual]

1. Identify methods and experimental design elements to test for natural selection across elevation.

 [Apply; Create; Procedural, Conceptual]

**Key Concepts:**

Structure and function of the hemoglobin molecule

Consequences of molecule modification

Natural selection

Scale: population to organism to chemical properties to DNA sequence

Scope: variation across space

**Skills:**

Accessing on-line databases

Forming and testing hypotheses
Experimental design

Reading & interpreting graphs

**References:**

Storz, J.F. 2007. Hemoglobin function and physiological adaptation to hypoxia in high-altitude mammals. *Journal of Mammalogy* 88: 24-31.

Storz, J.F., S.J. Sabatino, F.G. Hoffmann, E.J. Gering, H. Moriyama, N. Ferrand, B.

Monteiro, and M.W. Nachman. 2007. The molecular basis of high-altitude adaptation in deer mice. *PLOS Genetics* 3:e45.

Storz, J.F., A.M. Runck, S.J. Sabatino, J.K. Kelly, N. Ferrand, H. Moriyama, R.E. Weber,

and A. Fago. 2009. Evolutionary and functional insights into the mechanism underlying high-altitude adaptation of deer mouse hemoglobin. *PNAS* 106:14450-14455.

Storz, J.F., G.R. Scott, and Z.A. Cheviron. 2010. Phenotypic plasticity and genetic

adaptation to high-altitude hypoxia in vertebrates. *Journal of Experimental Biology* 213: 4125-4136.

Storz, J.F., C. Natarajan, Z.A. Cheviron, F.G. Hoffmann and J.K. Kelly. 2012. Altitudinal variation at duplicated β-globin genes in deer mice: Effects of selection, recombination and gene conversion. *Genetics*. 190: 203-216.

Natarajan, C., F.G. Hoffmann, H.C. Lanier, C.J. Wolf, Z.A. Cheviron, M.L. Spangler, R.E. Weber, A. Fago, and J.F. Storz. 2015. Intraspecific polymorphism, interspecific divergence, and the origins of function-altering mutations in deer mouse hemoglobin. *Molecular Biology and Evolution* 32: 978-997.