



80 Años



Leopoldina  
Nationale Akademie  
der Wissenschaften

## Workshop on Acclimatization and Adaptation to High Altitude in the Andes

Lima, May 13-15, 2019

Living at high altitude is a physiological challenge due to harsh environmental conditions. These include reduced oxygen partial pressure that leads to hypoxic conditions. The resulting hypoxemia is partially compensated for by increased erythropoiesis causing elevated hemoglobin levels. High altitude populations especially in the Andes cope well with this physiological response. However, some individuals originally well adapted to live at high altitude will suddenly develop excessive erythrocytosis resulting in a unique pathology named Chronic Mountain Sickness (CMS), first described in 1928 by the Peruvian Scientist Carlos Monge-Medrano. Despite the time gone by since its first description, little is known about the mechanisms leading to CMS. Interestingly, other ethnicities living at high altitude, such as Tibetans or Ethiopians, show only a moderate increase of erythropoiesis indicating different adaptive mechanisms in men.

At the other end of the spectrum, anemia occurring at high altitude has recently gained attention. According to the WHO, about 25% of the world population suffers from anemia, especially in developing countries. The reason for reduced erythropoiesis is not restricted to iron deficiency but includes, among other less frequent causes, inflammatory conditions. The WHO suggests correction values to adjust hemoglobin levels at high altitude and to define anemia in populations living above 1,000 m. These calculated hemoglobin values, however, result in an overestimation of the number of individuals apparently suffering from anemia. When applying these adjustment values, a very high prevalence of anemia is observed in infants and pregnant women living in the Peruvian highlands and thus, anemia is considered a severe public health problem. There is increasing scientific evidence that the cut-off levels for hemoglobin have to be redefined. Together with the impact of excessive erythropoiesis on health, cause and definition of anemia will be a main issue addressed during this international meeting.

Reduced oxygen supply not only affects red blood cell production but also has severe impacts on cellular metabolism, muscular adaptation and performance as well as on cerebral neurovascular interactions and circadian rhythm. Last but not least, oxygen's role in cancer development will also be addressed.

We welcome all participants from different parts of the world to this inspiring meeting that will open new opportunities for international cooperation ultimately leading to a better understanding of the adaptive mechanisms to high altitude/hypoxia.

To stress the importance of bilateral and multilateral follow-up activities, we have included two sessions on future research cooperation in the program. This two-days workshop is organized by the German National Academy of Sciences Leopoldina and the National Academy of Sciences of Peru (ANC) in Lima, Peru.

We hope you enjoy this workshop

Sincerely,

Prof. Dr. Max Gassmann

Prof. Dr. Gustavo Gonzales  
President, National Academy of Sciences (Peru)



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## **Organizers**

German National Academy of Sciences Leopoldina  
National Academy of Sciences (ANC, Peru)  
National Council of Science and Technology (CONCYTEC)

### **International Organizing Committee**

Dr. Gustavo F. Gonzales (ANC and Cayetano Heredia Peruvian University)  
Prof. Dr. Max Gassmann (Leopoldina and University of Zurich)  
Dr. Jan Nissen (Leopoldina)

### **Local Organizing Committee**

#### **National Academy of Sciences**

Dra. Verónica Rubin de Celis  
Dr. José Machare  
Dr. José Bauer  
Dr. Roger Guerra-García  
Dra. Carla Gonzales-Arimborgo

#### **Universidad Peruana Cayetano Heredia**

Cinthy Vázquez-Velasquez  
Diego Fano  
Dulce Esperanza Alarcón-Yaquette  
Paola Olavegoya  
Alisson Zevallos-Concha  
Vanessa Vázquez



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## Program

### Workshop on Acclimatization and Adaptation to High Altitude in the Andes

Joint Conference by the Peruvian Academy of Sciences and  
the German National Academy of Sciences Leopoldina

14-15 May 2019

**Conference Venue:** “Alberto Hurtado” Room, Universidad Peruana Cayetano, Heredia-Campus.  
Armendariz 445, Miraflores Lima, Peru

#### Conference structure:

- Presentations: 20 min, 10 min Q&A

#### Conference Day 1 | 14 May 2019

08:30 – 09:00	<b>Registration</b>
09:00 – 09:15	<b>Introductory remarks</b> Max Gassmann, German National Academy of Sciences Leopoldina, Co-organizer Gustavo F. Gonzales, President Academia Nacional de Ciencias, Co-organizer
<b>Session 1      Anemia: General Aspects</b> Chair: Hans Hoppeler, Switzerland Secretary: Cinthya Vásquez-Velásquez, Peru	
09:15 – 09:45	<b>Iron and Hypoxia</b> Martina Muckenthaler, Heidelberg, Germany
09:45 – 10:15	<b>Human Adaptation from Moderate to High Altitude</b> Max Gassmann, Zurich, Switzerland
10:15 - 10:45	<b>Coffee Break</b>
10:45 – 11:15	<b>Are We Really Fighting Against Anemia Worldwide?</b> Gustavo F. Gonzales, Lima, Peru
11:15 – 11:45	<b>Arterial Oxygen Content (CaO<sub>2</sub>) as Diagnostic Tool to Distinguish Anemia from Adaptation at High Altitude</b> Dulce Esperanza Alarcón, Lima, Peru
11:45 – 12:15	<b>Are the Food Assistance Programs in the Arequipa Region Having an Impact on the Control and Prevention of Anemia in Children?</b> Agueda Muñoz, Arequipa, Peru
12:15 – 13:30	<b>Lunch Break</b>



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<b>Session 2      Anemia and Inflammation in Children</b>	
Chair: Patricia Siques, Chile	
Secretary: Alisson Zevallos-Concha, Chile	
13:30 – 14:00	<b>Hematological Status in Newborns at Cusco (3,400 m)</b> Ramón Figueroa, Cusco, Peru
14:00 – 14:30	<b>Anemia and Iron Status in Infants of Puno (3,800 m)</b> Maritza Choque, Puno, Peru
14:30 - 15:00	<b>Anemia in Children Associated with Biomass Fuels: Is It Due to Inflammation?</b> Roberto Accinelli, Lima, Peru
15:00 – 15:30	<i>Coffee Break</i>
15:30 – 16:00	<b>Inflammatory Hypoxia – White Blood Cells at High Altitude</b> Joachim Fandrey, Essen, Germany
16:00 – 16:30	<b>Fetal and Neonatal Adaptation to Chronic Hypoxia – Impact on Health in Later Life</b> Irwin Karl Marcel Reiss, Rotterdam, The Netherlands
<u>Separate room</u> 16:45 – 17:45	<b>Discussion of Future Research Cooperation</b> Chairs: Max Gassmann / Gustavo Gonzales
19:30 – 21:30	<i>Reception at the German Ambassador's Residence</i> (by invitation only)

**Conference Day 2 | 15 May 2019**

08:30 – 09:00	<i>Registration</i>
<b>Session 3      Metabolism, Brain and Circadian Rhythm</b>	
Chair: Roberto Accinelli, Peru	
Secretary: Dulce Esperanza Alarcón-Yaquetto, Peru	
9:00 – 09:30	<b>Metabolic Changes at High Altitude and Acclimatization</b> Patricia Siques, Iquique, Chile
9:30 – 10:00	<b>The Neurovascular Interface</b> Amparo Acker-Palmer, Frankfurt, Germany
10:00-10.30	<b>Physiological Challenges in Extreme Environments</b> Hanns-Christian Gunga, Berlin, Germany
10:30 – 11:00	<i>Coffee Break</i>
11:00 – 11:30	<b>Hallmarks of Cancer: From Microenvironmental Sensing to Medical Omics</b> Till Acker, Gießen, Germany
11:30 – 12:00	<b>Weight, Length, Head Circumference, and Ponderal Index at Birth of Healthy Term Newborns from Mothers with Anemia or Erythrocytosis at 3,400m above Sea Level.</b> Wilfredo Villamonte-Calanche, Cusco, Peru



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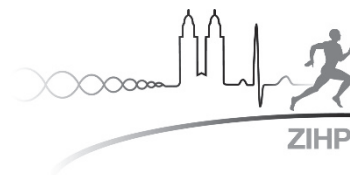
12:00 – 13:30	<i>Lunch</i>
<b>Session 4</b> <i>Chronic Hypoxia: Excessive Erythrocytosis, CMS and Exercise</i>	
Chair: Julio Brito, Chile	
Secretary: Diego Fano, Peru	
13:30 – 14:00	<b>Hypoxia, Erythropoiesis and High Altitude Evolutionary Adaptation</b> Josef Prchal, Salt Lake City, USA
14:00 – 14:30	<b>Genes Involved in Andean Aymara High Altitude Adaptation</b> Ricardo Amaru, La Paz, Bolivia
14:30 – 15:00	<b>Erythropoietic Response at the Cellular Level in Chronic Mountain Sickness</b> Francisco Villafuerte, Lima, Peru
15:00 – 15:30	<i>Coffee Break</i>
15:30 – 16:00	<b>Food Consumption and Nutritional Status of High Altitude Inhabitants, with Excessive Erythrocytosis</b> Lidia Sofía Caballero, Puno, Peru
16:00 – 16:30	<b>Effects of Exercise Training in Rats Exposed to Chronic Hypoxia. Application for Monge's Disease</b> José Luis Macarlupu, Lima, Peru
16:30 – 17:00	<b>Muscle Adaptations and Performance at Altitude</b> Hans Heinrich Hoppeler, Berne, Switzerland
17:00 – 17:15	<b>Wrap-Up</b>
<u>Separate room</u>	<b>Discussion of Future Research Cooperation</b>
17:30 – 18:30	Chairs: Gustavo Francisco Gonzales / Max Gassmann
19:30 – 21:30	<i>Conference Dinner   Four Points by Sheraton Hotel</i> (by invitation only)

As of 02 May 2019

### Partner institutions



University of  
Zurich <sup>UZH</sup>



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