Adaptation Of Homo Sapiens to a Higher Altitude

Evolution is at work since the beginning of life, all of the organisms which we see around us living are the result of natural selection, environmental stress allows the survival of the fittest and causes evolution. Generally Eukaryotic organisms function physiologically on three most important key component Oxygen, water and nutrition (commonly glucose, vitamins and minerals). Homo sapiens metabolic and oxygen transport system was evolved importantly under conditions which are at sea levels. As the human population began to inhabitant higher altitude in thin low-density air, the hypobaric hypoxia starts acting as an evolutionary factor as now lesser number of oxygen molecules are present in air to inhale which causes physiological stress and natural selection came in action. Unlike cold and heat, low oxygen partial pressure at higher altitude is unavoidable and is lifelong stress. My topic's environmental stress element is limited oxygen at a high elevation which further causes physiological stress and then natural selection over long period of time results in adaptation of Homo sapiens to a higher altitude, which is the title of my topic.

Homo sapiens are only existing species of its taxon (or Genus) and are evolved from the first organism of Genus Homo, Homo habilis in the order of Homo habilis (existed 2 MYA), Homo erectus (0.8 MYA), homo heidelbergensis (250 KYA) to homo sapiens (modern human). Around 250-150 MYA global hypoxia, characterized by oxygen concentration level of 33% (340 MYA 266mmHg pO2) dropped to almost 16% (121.6 mmHg pO2) since then it rises gradually to present oxygen concentration of 20.93% (159 mmHg pO2), approximately 0.025% average increase in oxygen level in a million year. Since then, oxygen concentration levels didn't change to greater extent.

Some researchers hypothesized that human ancestors had evolved under mild hypoxic conditions. Researcher found many hominid fossils spanning over million years of period, during archaeological, vegetational and geological research analysis at sites which were below altitude of 500-600m, thus hypothesis that human ancestors hominids are evolved under oxygenic conditions at sea level and hypobaric-high altitude hypoxia acting as a physiological stress makes sense. There could be some ways in which one can think how someone can adapt to hypoxic conditions at high altitude of 5100 m above sea level, which are either by producing more RBCs (polycythemia), increasing Hemoglobin molecules in RBCs or by increasing efficiency diffusion of a number of oxygen molecules from alveoli to blood and from blood to tissues, but increased hematocrit and hemoglobin content in blood are pathological condition, causes CMS (chronic mountain sickness), raised blood pressure in the lungs can develop over time and in some cases progress to heart failure as higher number of RBCs makes blood more viscous increasing risk of embolism. At higher altitude Homo sapiens having more fitness had higher survival rate could be due to SNP (single nucleotide polymorphism), positively selection of some genes like ELGN1 gene (inhibits hemoglobin production under high oxygen concentration), EPAS1 gene and PPARA gene which can function collaboratively with HIF (hypoxia-inducible factors) and regulates the production of erythrocytes by hematopoietic stem cells in bone marrow by process of erythropoiesis in response to oxygen metabolism. Homo sapiens inhabited Tibet 3000 years ago. In 2010, the genes which result in adaptations of Homo sapiens at Tibet mountains (~4000m) were found by performing genome sequencing of 50 high lander Tibetans and their closest 40 low landers Hans Chinese neighbour.

The strongest significant difference in comparing both population genomic samples was in an EPAS1 gene encoding transcription factor involved in response to hypoxia, EPAS1 protein. this one single-nucleotide polymorphism (SNP) mutation at EPAS1 gene shows a 78% frequency difference between Tibetan and mainland Chinese samples, which is the fastest genetic change ever observed in humans causing population to evolve at fastest rate (the average life expectancy for Tibetans rose from 35.5 years in 1951 to over 67 years by the end of 2010).These genes are associated with decreased hemoglobin concentration in RBCs and in regulating energy metabolism. EPAS1 is significantly associated with increased lactic acid concentration (the product of anaerobic glycolysis), and PPARA is correlated with a decrease in the activity of fatty acid oxidation.