

Index

Abbreviations: HAN = high-altitude native(s), LAN = low-altitude native(s)

abortion and miscarriage rates, in HAN: Andes, 90, 91, 324, 326, 327-8; Ethiopia, 91-2, 104, 327; Nepal, 327; Tajikistan, 91; Tien Shan and Pamirs, 311

acclimatization, to altitude, 179-83

ACTH: change of altitude and production of, 76; responses of HAN and LAN to injection of, 76

aerobic capacity (ability to deliver oxygen to working muscles), 174-9; age and activity effects on, 10; as integrated measure of oxygen intake, transport, and utilization, 183; physiological factors related to, 183-5; upward migration and, 10, 179-83

age: and aerobic capacity, 10, 175, 177; increased blood pressure with, less marked in HAN, 7, 304; at migration to high altitude, and aerobic capacity, 180, 181; vital capacity and residual volume of lung decrease with, in HAN, 302

agriculture: in Andes, 117, 118, 219; in Ethiopia; 26-7, 138; in Himalaya, 35-6, 39, 147; vertical zonation of (Andes), 33-4

air: insulating properties of, increase with decrease of density, 262

alcohol: consumption of, and skin temperature of foot exposed to cold, 285, 291

alkalosis, respiratory, at high altitude or in hypoxia, 86; in foetus, 94, 95; and sex ratio in mice, 103; on transfer to high altitude, 208, 209

'Altiplanides', 190, 199-200; irreversible specialization of? 212

altiplano, Andes, 20, 31, 34; ice-free by time of arrival of man, 49, 67

alveolar ventilation, altitude and, 300, 301 Amhara people, NW Ethiopia, 4, 7, 22, 26, 138, 195

cAMP: lower level of, in HAN? 76

anaemia: haematological findings may be affected by presence of, 196, 200; raised blood methaemoglobin in, 201; sickle-cell, 55, 58, 350

Andean region, 18; agriculture and stock-raising in, 33–4, 117, 118, 219; date of arrival of man in, 49, 67, 96; genetic distances between HAN of, and neighbouring LAN, 53–4; genetic drift in, 57, 60; genetic polymorphisms in, 49–50; geology of, 20; history of, 28–31; inbreeding in, 61; migration in, 58, 60; population of, 31–2, (above 2,500 m), 318 'Andides', 190, 200–2

anti-erythropoietin, inhibits polycythaemic response to hypoxia in mice, 193

Argentina: estimated population of, above 2,500 m, 318

arm tissues, Andean HAN; area of, 121-2; development of bone, marrow, muscle, and fat in, 122 ascorbic acid: intake of, by Andean HAN, 239, 241 athletics, HAN in, 179

Aymara people, NE Chile and Bolivia, 4, 7, 57; birth rate of, 324; exogamy among, 61; genetic

distances between other tribes and, 54; maturation and body size in two groups of boys of, 135, 136; possible evidence for selection pressure in white-cell antigens of, 57; proteinogram of, HAN in situ and after downward migration, 207

babies (first year of life): body measurements, bone development, and psychomotor development of, in HAN and LAN, rural and urban, Mestizo and Indian, Andes, 104-5

Baltis people, Karakoram, 60

basal metabolic rate: altitude and, 229-30, 279, 280-1, 291; in LAN upward migrants, 279-80 Bhutan, estimated population of, 319

bicarbonate of blood, altitude and, 302

birth rate: for HAN, Chile, 324; for HAN and LAN, Peru, 320

birth spacing, HAN and LAN, Peru, 326

birth weight: altitude and, 83, 92-4, 95-6, 106; altitude, and ratio of placenta weight to, 83-4, 87; of babies born at high and low altitudes to same mothers, 93, 95; in HAN and LAN, Andes, 88, 89; maternal stature 95; and neonatal mortality, 101-2; sex and, in HAN and LAN, 100; and survival, in HAN and LAN, 342, 346

blood circulation time, altitude and, 303

blood pressure, 334; altitude and, 284, 313; in HAN downward migrants, 337; increase of, with age, less marked in HAN, 7, 304, 335-6; in LAN upward migrants, 10

body measurements: of Andean HAN and LAN, rural and urban, Mestizo and Indian, (babies) 104-5, (newborn) 99-100, (2 years old upwards) 119-27; of Ethiopian HAN and LAN, 140-4; of Tien Shan HAN and Kirov LAN, 156-9

Bohr effect, of pH on affinity of haemoglobin for oxygen, 208; in Andean HAN and acclimatized Europeans, 10, 61, 185, 209–10; 2,3-diphosphoglycerate of red cells in, 201, 208–9; in HAN, 183; in LAN upward migrants, 208–9; in Sherpas and Europeans, 210–12

Bolivia, 61; estimated population of, above 2,500 m, 318

bone development: in arm, Andean HAN, 122; in metacarpal, Sherpa HAN and Tibetan children at low altitude, 152, 153

bone marrow: altitude or hypoxia, and erythropoiesis in, 123, 191-5; of arm, development of, in Andean HAN, 122-3; hypoxia and size of, 123

breast feeding: of children up to 2 or 3 years old, Andean HAN, 241; of infants in HAN and LAN, Andes, 105, 106

calcium: absorption of, 242; intake of, by Andean HAN, 239, 241-2; ratio of, to phosphate in diet, 242



Index

capillary blood vessels: in muscle of HAN, 183, 185, 304-5, 335; in placentae of HAN, 85 carbohydrates: intake of, by Andean HAN, 236; percentage of calorie intake as, 237 carbonic anhydrase, altitude and activity of, 302 cardiac cycle: during exercise and recovery, in groups from different altitudes, 308-10; in HAN

children, 312-13 cardiac defects, in HAN newborn, 103 cardiac index, altitude and, 303

cardiovascular disease, altitude and, 334-5, 344 Caucasoid ancestry: in Andes, very small, 55; in Ethiopia, 55; in Himalaya, 51, 54

cell division, hypoxia and rate of, 70, 165, 208 cereals, staple food up to 3,500 m in Andes (rice to 2,000 m, maize 2,000–3,500 m), 221, 222, 223

cestode infestation, at different altitudes in Peru, 331

chemoreceptor sensitivity to oxygen breathing, altitude and, 300, 302, 310

chenopodiums (quinoa and cañihua), in diet of Andean HAN, 221, 222, 224

chest: circumference of, Ethiopian HAN and LAN, 141, 147; circumference/height ratio, in Andean HAN at 4,000 m and above 4,500 m, 125, in Sherpa HAN and Tibetan downward migrant children, 150, 151, and in Tien Shan HAN and Kirov LAN, 158; enlargement of, genetically determined in Andean HAN, 8, 345; enlargement of, not general characteristic of Himalayan HAN, 166; width and depth of, Andean HAN, 119, and Tien Shan HAN and Kirov LAN, 157, 162, 3

Chile, 61; estimated population of, above 2,500 m, 318

cholesterol, blood content of, 334; in Andean HAN, and HAN downward migrants, 337

chorionic gonadotrophin, human, response to injection of: in HAN downward migrants, before and after return to high altitude, 75; in HAN and LAN, 76, 77

chromosome abnormalities, none found in Andean HAN, 208

climates, in high-altitude zones, 251; Andes, 33, 253-6; Ethiopia, 258; Himalaya, 34-5, 256-7

clothes at high altitudes, 262-3, 290; Andes, 263-4; Himalaya, 264-5

coca leaf chewing, by Andean HAN, 284; and response of body temperature to exposure to cold, 286-8, 291

cold stress, in Andean HAN, 232, 266-73; influence of drugs on tolerance to, 284-8; interaction of, with hypoxic stress, 281-2; interaction of, with low-humidity stress, 288-9; laboratory studies of 274-9

Colorado, population in high altitude areas of, 4 colour-blindness, rare or absent in Andean HAN, 50

congenital defects: altitude and, 103-4, 313; in Andean HAN, 342

cor pulmonale: chronic, in some HAN (Tien Shan and Pamirs), 313

cortisol: normal production of, in HAN, 78

cosmic radiation, at high altitudes, 56, 69, 101 cultures, altitudinal similarities in? 42 cytochrome, microsomal, in oxygen transport, 89-90

demographic structure of HAN: age and sex distribution, 319-22; total numbers, 317-19

dental development: in Ethiopian HAN and LAN, 145-6; in Sherpa HAN and Tibetan children at low altitude, 154-6; in Tien Shan HAN and Kirov LAN, 160-1

Diego allele: distribution of gene frequency for, in Andean HAN and neighbouring LAN, 58, 59, 60

diet: composition of, in different groups of Andean HAN, 236-44

2,3-diphosphoglycerate content of red cells: in Bohr effect, 201, 208-9; did not increase on transfer to high altitude when alkalosis was prevented, 209; in polycythaemia, 203; in Sherpas and Europeans, 211, 212

diseases, infectious: in babies, Andean HAN and LAN, 105; in Ethiopian HAN and LAN, 138, 139; and food requirements, 233, 245; mosquitoborne, HAN free of, 330, 334; often less common in HAN, 69

divorce rate, in Ethiopia, 27 dogs, hypoxia and foetal haemoglobin in, 94 ductus arteriosus, patent: in HAN, 313, 329-30

Echinococcus infestation, in Andean HAN, 332 Ecuador, 61; estimated population of, above 2,500 m, 318

m, 318 emphysema, and polycythaemia, 204 energy balance, in Andean HAN, 235 enzymes of oxidative chain, in HAN, 183, 185 eosinophilia: in Ethiopian LAN, indicating nema-

tode infestation, 197 erythropoiesis: in bone marrow, altitude and, 123, 305; in mice, hypoxia and, 191-5

erythropoietic islands: hypoxia and numbers of, in bone marrow and spleen of mice, 191, 193

erythropoietin: increased secretion of, at high altitude, 191-4, 201, 305; in LAN upward migrants,

Ethiopia, 18; economic and political structure of, 26–7; estimated population of, 319; ethnic and linguistic diversity of population of, 25–6; exogamy in, 61; genetic distances between HAN and neighbouring LAN in, 55; genetic polymorphisms in, 51–2; geology of, 20–1; migrants between altitudes in, 11, 58; occupied by man longer than other highlands, 51

exogamy, 61

fat: of animals, in diet of Andean HAN, 221, 222, 226; of arm, development of, in Andean HAN, 122; of body, rural-urban differences in, 135; intake of, by Andean HAN, 236, 237-8, (apparent absorption of) 235, (percentage of calorie intake as) 237

fertility, 5; altitude and, 322-8; differential, apparently less important than differential mortality in selection pressure estimate, 56-7; possible

Index

fertility (cont.)

effects on, at high altitude, of increased loss of early embryos by resorption or abortion, 90, 92, 103-4; of Spaniards first coming to high altitudes in Andes, 67, 322; see also offspring, number of fibrinolytic activity, altitude and, 205, 305

foeto-placental unit, 87-90

food(s): altitude and requirements for, 226-33; factors other than altitude affecting requirement for, 233-4; habits in consumption of, Andes, 223-6; varieties and amounts of, utilized in three neighbouring towns at same altitude, Andes, 220, 222; and in four towns at different altitudes, Andes, 220-2

footwear: scarcely used in Andes, 263, or by Sherpas, 264

gametogenesis, change of altitude and, 70-3 gene flow, 56; see also migration

genetic distances, between HAN and neighbouring LAN, 53-4

genetic drift, random: estimates of, for two populations in Andes, 57, 60

genetic polymorphisms, 47-9; in Andes, 49-50, and nearby LAN, 52-4; in Ethiopian highlands, 51-2, and nearby LAN, 55; in Himalaya, 51, and nearby LAN, 54; possibility of estimating selection pressure from distribution of, 57-8

genetics, 6; limitations of studies of, 47

γ-globulin, in blood of HAN and HAN downward migrants, 207-8

glucose: altitude, and content of, in blood of newborn, 90, 312; blood content of, in HAN and HAN downward migrants, 206

glucose 6-phosphate dehydrogenase: no abnormal types of, in HAN, 55

glycogen content, in liver of newborn animals: hypoxia of mother and, 102

goats: anaerobic metabolism of foetus during acute hypoxia of mother, 95

growth: altitude and rate of, 5, 8, 117, 312; and development at high altitudes, 117, 163-6, (Andes) 117-34, (Ethiopia) 138-47, (Himalaya) 147-55, (Tien Shan) 156-63; dietary factors in, 245; in first year of life, 104-6; of foetus, 92, 94, 95, 106, (sheep) 81, 92; genetic origin of rate of, in HAN downward migrants, 10; hypoxia and, in animals, 165

guinea pigs: hypoxia, and length of gestation and birth weight in, 92; hypoxia, and vascular changes in placenta in, 82

haematocrit measurements (red cell volumes): at and after birth, 94, 97-8; change in, with age, in HAN, 98-9, 200; in HAN, 184, 191, 305, 306, 312; in HAN, and HAN downward migrants, Andes, 206; in HAN and LAN, Ethiopia, 195, 196; in HAN and LAN, and LAN upward migrants, Himalaya, 198-9; in HAN and LAN, US, 203; in hypoxic mice, 192

haematology: adaptive and inherited factors in, 345; factors other than altitude affecting, 204-12; of HAN, less affected by change of altitude than that of LAN, 8, 10; studies of, in HAN, Andes,

199-202, Ethiopia, 195-7, Himalaya, 197-9, and US, 203-4

haematopoiesis, see erythropoiesis

haematopoietic stem cells: hypoxia and numbers of, in bone marrow of mice, 191, 192, 194 haemoglobin

Bohr effect in, see Bohr effect

concentration of, in blood: of HAN, and HAN downward migrants, Andes, 206; of HAN and LAN, 184, 243, (Ethiopia) 195, 196, (US) 203; of HAN and LAN, and LAN upward migrants, Himalaya, 198; of Sherpas and Britons, 197, 198

dissociation curve of: in HAN, and LAN upward migrants, Andes, 202, 210; in polycythaemic HAN, US, 204; temperature and, 291

foetal, increased in hypoxia in some species, 94 sickle-cell: high altitude effect on, 330; lacking in HAN, 55; natural selection and, 58

total circulating amount of, altitude and, 306 hamster: anoestrus caused by cold in, 73; hypoxia, and congenital defects in, 103

health: of LAN upward migrants, 328; and work performance, of LAN, and LAN and HAN migrants, 332-3

heart: altitude, and rate of growth of, 138; increased size of right ventricle of, in HAN, 183, 184, 303-4, (children) 313; increased myocardial contractility of, in HAN, 304

heart rate: altitude and, 284, 303, (children) 312; exercise and, in groups from different altitudes, 306

heat: atmospheric humidity and loss of, 288; estimated production of, by sedentary and active LAN and active HAN, 229; extra loss of, in respiration at high altitude, 227-9

height: of Andean HAN and LAN, (Indian) 119, 123, 126, (Mestizo) 126–7; of Ethiopian HAN and LAN, 140–3; parent-offspring correlations in, Quechua, 136–8; rate of growth in, Andean HAN and US standard, 120; of Sherpa HAN and Tibetan children at low altitude, 148–50, 151, 155; of Tien Shan HAN and Kirov LAN, 156, 157

high altitude: defined as above 2,500 m, 17-18, 317; definitions of natives of, 189-90; estimated population living at, 319; rough terrain of, and calorie requirements of HAN, 232-3; simpler, less stable ecosystems at, 69; temperatures at, 68-9; variations in conditions at, 189

Himalaya region, 34-5; agriculture of, 35-6; as genetic cross-roads, 51; genetic distances between HAN of, and neighbouring LAN, 54; genetic polymorphisms in, 51; geology of, 21-2; migration in, 39, 60; population of, 35; see also Nepal

houses: Andes, 259-60; Ethiopia, 261; Himalaya, 261

humidity of air, and heat loss, 288

hydroxysteroid dehydrogenase, of cultured placenta: effect of hypoxia on activity of, 88

hyperventilation: in newcomers to high altitude, 174, 183; in pregnant women at high altitude, 89 hypoxia: interaction of cold stress and, in HAN, 281-2; of normal foetus, 88



Index

inbreeding, in HAN, 60-1

Incas, in Andes, 28, 30-1, 60, 67; inbreeding in dynasty of, 61

Indian Government: Border Roads Organization of, in Himalaya, 36

insulation, unit of (for clothing), 262

iodine, in diet of HAN, 244

iron: blood content of, in HAN and HAN downward migrants, Andes, 206; intake of, by Andean HAN, 239, 243; intestinal absorption of, promoted by increase in erythropoiesis, 201 irrigation, in Himalaya, 35, 38, 40

Karakorum ranges, Pakistan, 51, 54, 60 Kashmir province, estimated population of, 319 Kirghizia, 77–8

lactic acid, produced in foetus in acute hypoxia of mother, 95

Ladakh province, estimated population of, 319 leprosy, in Nepal, 333

leucocytes, in HAN children, 312

livestock: exposure of HAN to climatic stress in herding of, 265-6; introduced by Spaniards, at first failed to reproduce at high altitudes, 68; lodged on ground floor of Himalayan houses, 261; raising of, in Andes, 34, 117-18, 219, in Ethiopia, 26-7, 138, and in Himalaya, 36, 38-9, 40-1

llama: altitude, and size of placenta in, 83

lung capacity, 163-4, 165-6; effect on, of age at acclimatization to high altitude, 133, 134; residual volume as percentage of, higher in HAN, 302

lung forced vital capacity, in Andean HAN and LAN: chest circumference and, 132-3; compared with US standard, 130-1; and forced expiratory volume, 131-2

lung vital capacity: not affected by altitude, 302; and tidal volume and respiratory volume, in Tien Shan HAN and Kirov LAN, 161, 162, 163

lung oedema, lung ventilation, see pulmonary oedema, pulmonary ventilation

luteinizing hormone: altitude, and production of, 76, 130

lymphocytosis, in HAN, 197, 305

magnesium, in red cells of HAN, 207

malaria: agent of natural selection on sickle-cell haemoglobin, 58; at different altitudes in Peru, 330; eradication of, in Nepal, 39; in Ethiopian HAN and LAN, 138

measles: child mortality from, Bolivian HAN, 343 meat and other animal products, in diet of Andean HAN, 221, 222, 223, 224, 225-6, 244

menarche, altitude and age of, 77–8, 311; in Andes, 128–9; in Himalaya, 154; in Tien Shan HAN and Kirov LAN, 159–60

menstrual cycle, change of altitude and, 73

Mestizos, Peru, 32, 99-100, 118; growth of children of, HAN and LAN, 126-7

methaemoglobin: in normal, anaemic, and polycythaemic HAN, 201

mice: alkalosis in, and sex ratio, 103; effects of

hypoxia in, on congenital defects, 103, on erythropoiesis, 191-4, on foetal haemoglobin, 94, on gametogenesis, 71, 72, on mating behaviour, 74, and on survival and abnormalities of ova, 79–80, 90, 92

migration (gene flow): in Andes, 58, 60, 321, 345-6; in Ethiopia, 11, 58; in Himalaya, 39, 60 mining, in Andes, 220

mitochondria: numbers of, in skeletal muscle of HAN, 183, 185

Mongoloid ancestry, in Himalaya, 51, 54 monogamy, serial, in Andes, 91

morbidity at high altitudes: infant and neonatal, 340-2; childhood, 342-3; adult, 343-5

mortality: death rates, Andes, (by age) 338, (ageand sex-specific) 339, (children) 342-3; differential, apparently more important than differential fertility in selection pressure estimate, 56-7

mortality, infant: birth weight and, HAN and LAN, 341, 342; of first generation Spaniards at Potosi (4,000 m), 67; in HAN and LAN, Andes, 56, 106, 340–1; hypoxia and, in animals, 102; increased in HAN, 101, 106, 244, 399–40; sex and, HAN and LAN, 100–1, 321–2

mountain climbing: oxygen utilization during, by HAN and LAN, 178

mountain sickness, altitude-specific disease, 329 muscle: of arm, development of, in Andean HAN, 122, 124; capillarity of, in HAN, 183, 185, 304-5, 335; number of mitochondria in skeletal, of HAN, 183, 185

mutations: cosmic radiation and, 56, 69; not detected in HAN populations, 56

natural selection, possibility of estimating intensity of: from differential survival and fertility rates, 56-7; from distribution of genetic polymorphisms, 57-8

nematode infestation: at different altitudes, Peru, 331; in LAN, Ethiopia, 197

Nepal, 19, 37; agriculture and stock-raising in, 38-9, 40-1; estimated population of, 319; population distribution in, 37; vegetational zones of, 37, 38

neutrophils: excess segmentation of, at high altitudes, 305; numbers of, in HAN children, 312

newborn: measurements of, in HAN downward migrants, 10, and in HAN and LAN, Andes, 99-100; sex differences in measurements of, 100; weight of, see birth weight

niacin: intake of, by Andean HAN, 239, 240 night vision, altitude and, 18

nitrogen balance, in Andean HAN, 235

Nuñoa district, S. Peru, 31-2, 118; population structure in, 120

nutrition, 5, 163; and growth, Andes, 134-5; of infants, HAN and LAN, 104-5; of Sherpa HAN, and Tibetan children at low altitude, 147, 155

oestrogens: altitude, and concentrations of, in blood of mother and of newborn, 87-8, 102; produced by placenta, 86-7

offspring, numbers of; in Andean HAN and LAN, 90-1, 323-6, 345; in Ethiopian HAN, 327; in



Index

offspring (cont.)

Nepal, 327; in Tien Shan, 311; percentage surviving to adult age, Andes, 345

oogenesis, change of altitude and, 71

ova: hypoxia, and survival and abnormalities of, in mice, 79-80, 90, 92

oxygen: altitude and consumption of, 300; cost in, per unit of work, in groups from different altitudes, 308; exercise ventilation and uptake of, in HAN, and in LAN upward migrants, 182-3; in foetal blood, 94; hyperventilatory response to breathing of, altitude and, 300, 302, 310; partial pressure of, at different altitudes, 225-7; transport of, across placenta, 88-90; utilization of, in mountain climbing, by HAN and LAN, 178

oxygen-carrying capacity of blood: effect of hypoxia on, in HAN, and in LAN upward migrants, 184

Pamir Mountains: meteorological data for different altitudes in, 299; peoples of, 4, 51

Pan-American Health Organization, and highaltitude project, 3

parasites, intestinal: in Andes, in HAN, 234, and in populations at different altitudes, 331, 332; in Ethiopian LAN, 146, 163

Peru, estimated percentage of population of, above 2,500 m, 317-19

phosphogluconate dehydrogenase, in HAN and LAN, Ethiopia, 55

phosphorus: blood content of, HAN and HAN downward migrants, Andes, 206; intake of, by Andean HAN, 239, 242-3; ratio of calcium to, in diet of Andean HAN, 242

physical activity, habitual: and aerobic capacity, 175, 177; and hypoxic ventilatory drive, 182; and oxygen utilization in mountain climbing, 178; and ventilatory exchange ratio, 182

placenta: altitude, and infarcts in, (guinea pigs) 82, (humans) 85-6; altitude, and ratio of weight of, to birth weight, humans, 10, 83-4, 87; altitude, and size and function of, (animals) 80-3, (humans) 83, 84, 85, 87; oxygen transport across, 88-90; perfusion of, with various concentrations of oxygen, 84-5; production of hormones by, 86-8 placenta praevia: altitude, and frequency of, 86, 97 plasma proteins, polymorphisms of, 48

plasma volume, in LAN upward migrants, 202 platelets, in HAN, 205, 305

polyandry, in Nepal, 327

polycythaemia: in HAN, 184-5, 190-1, 194-5, 203-4; in hypoxic mice, 191-4; only apparent in Andean HAN in pathological conditions, 199 population, of high-altitude areas of world, 317-19 population genetics, 47

population structure, HAN of Peru compared with total population, 126

potassium: blood content of, in HAN downward migrants and LAN upward migrants, 206-7

potatoes (fresh or dehydrated): in diet of Andean HAN, 221, 223-4; as source of ascorbic acid, 241 Potosi city, Bolivia (4,000 m): first generation Spanish children in, all died at birth or soon after,

precipitation: Andes, monthly averages, 253; Ethiopia, of monsoon pattern, 258; Himalaya, 35, 40, (monthly averages) 257

pregnancy, altitude and duration of: in guinea pig, 92; in human, 93

pregnanediol: excretion of, by HAN and LAN women, 77

progesterone, 77; produced by placenta, 86

protein: altitude and requirement for, 234; hypoxia or altitude, and specific dynamic action of, 230; intake of, by Andean HAN, 236, (as percentage of calorie intake), 237

proteinograms: for blood of two ethnic groups of HAN, before and after downward migration, 207-8

protozoan infestations, at different altitudes in Peru, 331

psychomotor development of babies, Andean HAN and LAN, 105, 106

puberty, altitude and age of, 77–8, 312; in Andean HAN and LAN, 129–30; in Ethiopian HAN and LAN, 146; in Tien Shan HAN and Kirov LAN, 159–60; genetic origin of late, in HAN downward migrants, 10

pulmonary oedema, altitude-specific disease, 328-9 pulmonary ventilation: altitude and, 300, 301; exercise and, in groups from different altitudes, 307

Quechua people, Bolivia and S. Peru, 4, 10, 57, 182-3, 207; genetic distances between other tribes and, 54; large chests of, genetically determined, 8; migration of, in 15th century, 59-60

rabbits: hypoxia and foetal haemoglobin in, 94 rats, hypoxia in: and embryonic deaths, 79; and gametogenesis, 71; and litter size and birth weight, 92; and lung development, 133-4; and placenta, 82

red cell antigens, polymorphisms of: in Andes, 48, 49-50; in Ethiopia, 48, 52; in Himalaya, 48, 51; see also Diego allele, Rhesus system

red cell proteins, polymorphisms of: in Andes, 48, 49; in Ethiopia, 48, 52; in Himalaya, 48; see also glucose 6-phosphate dehydrogenase, haemoglobin

red cells: altitude, and numbers of, 303, 305, 306, 312; numbers of, HAN and LAN, Ethiopia, 105, HAN, LAN, and LAN upward migrants, Himalaya, 198, and LAN upward migrants, Andes, 202; size of, in HAN, 305, 312; volumes of, see haematocrit measurements

respiration: altitude, and loss of heat in, 227-9; percentage loss in, of heat produced by LAN (sedentary and active), and HAN (active), 229 respiratory centre, sensitivity threshold to hypoxia of: in HAN, and in LAN acclimatizing to high altitude, 300, 302; in HAN returned to high altitude after period at low altitude, 310

respiratory rate, altitude and, 300, 301

respiratory disease: in HAN, 332, 333, 334; in HAN downward migrants, 344

reticulocytes: altitude, and numbers of, 305, 306, 312; altitude, and maturation rate of, 305, 306



Index

Rhesus system: distribution of frequency of segments of, from north to south along Andes, 49-50, 58, 59, 60; in Himalaya, 54; as indicator of genetic drift in Andes, 60; possible action of natural selection through variation in resistance of haplotypes of, to salmonella infections, 57-8

riboflavin: intake of, by Andean HAN, 239, 240 rural-urban differences, Andes: in body fat, 135; in skinfold thickness and muscle development, 124; in stature and weight, 123

salmonella infections, variation in resistance of Rhesus haplotypes to, 58

Sardinia, sickle-cell haemoglobin in HAN and LAN in, 58

serum proteins: in Andes, 48, 50; in Ethiopia, 48, 52; in Himalaya, 48

sex: and birth weight in HAN and LAN, Andes, 100; and body measurements of babies, HAN and LAN, 106; and development of arm tissues, Andean HAN and US, 122; and neonatal mortality, HAN and LAN, 100-1; and response to cold stress, 278-9

sex hormones, altitude and, 73-8

sex ratio of births; in HAN and LAN, 103, 321; in mice, alkalosis and, 103

sheep, at high altitude: foetal growth rate in, 92; foetal haemoglobin in, 94; metabolism of foetus in, 95; placenta in, 81, 82, 85

Sherpa people, Nepal, 4, 7; aerobic capacity of, 178, 179; growth and development of, compared with Tibetans at low altitude, 147–55; population structure of, 321, 322

Sikkim, estimated population of, 319 silicosis, and polycythaemia, 204

HAN, 127-8; in Ethiopian HAN and LAN, 144-5; in Sherpa HAN and Tibetan children at low altitude, 153-4, 155

skin colour, of HAN and LAN in same area, 289-90 skinfold thickness: in Andean HAN, 120-1, (rural and urban) 124; in Ethiopian HAN and LAN, 143-4; in Sherpa HAN and Tibetan children at low altitude, 151, 153, 155, 164; in Tien Shan HAN and Kirov LAN, 157, 159, 162

smoking, haematological effects of, 204

socio-economic factors, 66; may obscure effects of altitude, 164-5; may be related to altitude, 69-70 sodium: blood content of, in HAN, HAN downward migrants, and LAN upward migrants, 207

soil erosion, in Nepal, 40 solar radiation, altitude and, 252-3, 289 spermatogenesis, change of altitude and, 70-1, 72-3 survivorship curves, for US, Peru, and Peruvian HAN, 338

Tajikistan, 78, 91

temperature of body: in cold stress, remains higher in extremities of HAN than of LAN, but rectal temperature decreases more in HAN, 274-5, 291; on different parts of skin of HAN, 271-2; of HAN during sleep in different conditions, 266-9, and during normal activities, 269-70; of hands and feet exposed to cold, in HAN and LAN, 272-3, 277-8; relation of body weight to, 272; sex differences in, 278-9

temperature of surroundings: altitude and, 252; diurnal variation in, increases with altitude; seasonal variation diminishes, 251-2; maximum, at three altitudes, Ethiopia, 258; mean annual, over 40 years, Andes, 256; mean monthly, in Andes at three altitudes, 254, 255-6; in Ethiopia at three altitudes, 258, and in Himalaya, 256-7; within houses, Andes, 259-60

testosterone: altitude, and production and excretion of, 74-6, 130

thalassemia, lacking in HAN, 55

thiamin: intake of, by Andean HAN, 239, 240 thrombo-cythaemia, in LAN upward migrants, 205 thrombo-embolic accidents: rare in HAN, frequent in LAN upward migrants, 205, 329

thyroid, in increased basal metabolic rate of HAN?, 280

Tibet, plateau of, 18-19, 22; estimated population of, 319

Tibetan migrants, Nepal, 4, 10; growth and development of children of, compared with Sherpa HAN, 147-55

Tien Shan Mountains, 19; meteorological data for different altitudes in, 299; peoples of, 4, 51

Tigrean (Tigrinyan) people, Ethiopia, 22, 26, 195 trade, in Himalayan region, 36, 39

trematode infestation, at different altitudes in Peru, 331

tuberculosis, in HAN downward migrants, 333, 344

tubers, staple food in Andes above 3,500 m, 221, 222, 223-4

typhoid fever, variation in resistance of Rhesus haplotypes to, 58

typhus, at different altitudes in Peru, 330, 332

ultraviolet radiation, at high altitudes, 69, 289; and vitamin D requirements of HAN, 233, 245

United States: haematology of HAN and LAN in, 203-4

uric acid content of blood: in HAN and HAN downward migrants, Andes, 206

vascular resistance, altitude and, 304, 310

vasodilation: alcohol and, 285; in extremities of HAN during cold stress? 278; in placenta in hypoxia, 89; in uterus in hypoxia, 86

ventilatory drive, hypoxic; habitual physical activity and, 181, 182

ventilatory exchange ratios, habitual physical activity and, 182

vitamin A: intake of, by Andean HAN, 228, 229, 230, 245

vitamin D: and calcium absorption, 242; ultraviolet radiation at high altitudes, and requirement of, 233, 245

water: effect of lowered boiling point of, at high altitudes, on cooked foods, 226, 240, 245; extra loss of, in respiration at high altitudes, 227-8 weight: of Andean HAN, rural and urban, 123; of



Index

weight (cont.)

Ethiopian HAN and LAN, 140-3; of Sherpa HAN and Tibetan children at low altitude, 148-50, 151, 155; see also birth weight

white cell antigens (HLA system), polymorphisms of: in Andes, 48, 50; estimate of selection pressure from frequency of haplotypes of, 57; in Ethiopia, 48; in Himalaya, 48, 51

white cells: temporary increase of, in LAN upward migrants, 204-5

wool textiles: resistance to heat flow of, compared with that of cotton textiles, 262 work capacity, altitude and, 5, 166, 173-4, 307-10; in HAN after a period at low altitude, 310-11 World Health Organization, and high-altitude project, 3

yellow fever, at different altitudes in Peru, 330