Adiposity rebound (AR) 193
Adolescent growth
  frontothalamic pathway
    maturation 98, 99
  genome-wide association studies 33, 34
  life history theory and pubertal
    maturation 96–98
  secular trends
    body proportions 119, 120
    causes of secular changes 120, 121
    epigenetic assimilation 123–125
    overview 115–118
    stature 118, 119
Adult stature, secular trends
  body proportions 119, 120
  causes of secular changes 120, 121
  epigenetic assimilation 123–125
  overview 115–118
  stature 118, 119
Assisted reproductive technology (ART),
  loss of imprinting 71

Beckwith-Wiedemann syndrome (BWS)
  diagnosis
    clinical 70
    molecular 70
    epimutations 68
  genotype/phenotype correlations 70
Birthweight, see Fetal growth
Breastfeeding
  insulin-like growth factor-I response
    in infants 20–23
  protective effects
    Early Protein Hypothesis
      17–19
    infection and diarrhea 14, 15
    obesity in later life 15–19
    serum amino acid response in
      infants 19–21
Childhood growth, see also Stunting
  evolutionary perspective 95
  secular trends
    body proportions 119, 120
    causes of secular changes 120, 121, 129
    epigenetic assimilation 123–125
    overview 115–118
    stature 118, 119
Coronary heart disease (CHD),
  birthweight and childhood body mass
  index correlation 192, 193
  C-reactive protein (CRP), childhood
  weight gain and programming 193

Diabetes
  birthweight, and childhood body mass
  index correlation 192–194
  obesity comorbidity in developing
  countries 150, 152
  Dutch Winter famine 79, 80
Early Protein Hypothesis, breastfeeding
  protective effects against later
  obesity 17–19, 40
Economic analysis, see Social-economic-political environment; Stunting

Epigenetics
assisted reproductive technology and loss of imprinting 71
critical development periods 60–62, 66
fetal growth modulation 66, 67
height heritability 41, 42
imprinting in disease 55
life course strategies for non-communicable disease prevention and treatment 58, 59
multilocus imprinting disorders 70, 71
RXRA promoter methylation and later obesity risks 60–62
secular change in growth patterns 123–125
syndromes with defects, see Beckwith-Wiedemann syndrome; Russell-Silver syndrome

Evolutionary perspective, growth
developmental plasticity 91, 92, 97
gestation length and environmental effects 94
glossary of terms 99, 100
humans versus other animals 208
life history theory 92–95
microevolution 90, 91
overview 90, 91, 94
phenotypic-driven evolution 93
pubertal maturation 96–98

Failure to thrive (FTT) 172, 173
Fetal growth, see also Gestation length
birthweight secular trends
Australia 106
Canada 105
China 106
fetal growth and determinants 109–111
France 105
overview 103, 104
prospects for study 111, 112
United States 104–107

Dutch Winter famine studies
energy supplementation optimization 7
epidemiological evidence of early life developmental programming 77
epigenetics studies, see Epigenetics
genetic regulators 78, 79
glucocorticoids in programming 80
growth hormone regulation 76, 77
macronutrient interventions
energy decrease 4
energy increase 2, 3
protein greater than 25% of energy 3, 4
protein less than 25% of energy 3
multiple nutrient interventions 6, 7
overview of factors affecting 1, 2
single-nutrient interventions 5, 6
FTO, genome-wide association studies of growth 30–32

Genetic Investigation of Anthropometric Traits (GIANT) 32
Genome-wide association study (GWAS), growth traits
complexity of growth genetics 34
FTO 30–32
HMGA2 31
overview 29, 30
postnatal growth studies 32, 33
prospects for study 34–37
pubertal growth studies 33, 34
sample size increase 31, 32

Gestation length
environmental effects 94
secular trends 107–109
Glucocorticoids, maternal programming of fetal growth 80
Glucokinase, mutation and fetal growth 78

Growth hormone (GH)
fetal growth regulation 76
 genetic defect investigation
algorithm 52, 53
insulin-like growth factor-I axis 44, 45
leptin modulation 81, 82
receptor mutations and phenotypes 46–48
therapy
cost 210, 212
efficacy 211, 212
ethics 210, 211
indications 209–211, 220
safety 213–215

Growth standards
historical perspective
child rearing and anthropology 162, 163
French contributions 164–166
weighing and charting 163, 164
prospects for study 189
universal, provisional standards 168, 169
variability of growth in 20th century 167, 168
World Health Organization charts 161, 162, 169, 185, 186

HMGA2, genome-wide association studies of growth 31

Hypertension
birthweight and childhood body mass index correlation 195
salt intake studies 159
obesity comorbidity in developing countries 150–152

IF1H1, genome-wide association studies of growth 35

Imprinting, see Epigenetics
Infancy-Childhood-Puberty Growth (ICP) Model 12
Infants, see Postnatal growth
Insulin-like growth factor-I (IGF-I) acid-labile subunit mutations and phenotypes 49, 50, 78
breastfeeding response in infants 20–23
fetal growth regulation 76–78
functional overview 43, 44
genetic defect investigation algorithm 52, 53
growth hormone axis 44, 45

Insulin-like growth factor-II (IGF-II), imprinting and fetal growth 67, 79, 80

Intrauterine growth retardation, see Fetal growth

Leptin, growth hormone-insulin-like growth factor modulation 81, 82

Life history theory
evolutionary perspective of growth 92–95
pubertal maturation 96, 97
LIN28B, adolescent growth genome-wide association studies 33, 34

Malnutrition, see Stunting
Mammalian target of rapamycin (mTOR), growth regulation 12, 13
Maya, social-economic-political effects on growth 122, 123
MCR4, growth regulation 34

Non-communicable disease, see specific diseases

Obesity
activity energy expenditure and population weight gain 152–154
comorbidities in developing countries 149–152
coronary heart disease, birthweight, and childhood body mass index correlation 192, 193
critical periods of development 194
energy intake and population weight gain 154, 155
infant diet
breastfeeding protective effects 15–21
energy and later obesity risk 13, 14
leptin and growth hormone-insulin-like growth factor modulation 81, 82
malnutrition and risks 135–137, 143–146
RXRA promoter methylation and later obesity risks 60–62
screening for cardiometabolic disorders 160
Omega-3 fatty acids, fetal growth intervention studies 5, 6
Osteoporosis, childhood weight gain and programming 193
Placental dysfunction, fetal programming 81
Policy, see Public policy
Postnatal growth
animal models 41
breastfeeding protective effects
  Early Protein Hypothesis 17–19
  infection and diarrhea 14, 15
  obesity in later life 15–21
clinical trials
  challenges 40
  effectiveness 39, 40
  end points 40
diet impact on later obesity risk 13, 14
epidemiological evidence of early life developmental programming 77
epigenetics studies, see Epigenetics
genome-wide association studies 32, 33
regulators 12, 13, 40
trade-offs in developed world
  full-term infants 172–174
  overview 171, 172, 186–188
  preterm infants 174–178
  prospects for study 180–182, 189
  small for gestational age
    infants 179, 180
Pregnancy, see Fetal growth; Gestation length
PTPN11, mutations and phenotypes 51
Puberty, see Adolescent growth
Public policy
  amenability to intervention 203, 204
complexity of early nutrition and later outcome relationship 201, 202
components of policy response
  knowledge base enhancement 204
  political will building 205, 206
  social strategy 205
  overview 199–201
  predictive utility and scale of impact 202
Russell-Silver syndrome (RSS)
diagnosis
  clinical 68, 69
  molecular 69
  epimutations 68
  genotype/phenotype correlations 69
RXRA, promoter methylation and later obesity risks 60–62
Secular trends, see Adolescent growth;
  Adult stature; Childhood growth; Fetal growth; Gestation length
Small for gestational age, see Fetal growth
Social-economic-political (SEP) environment
  secular changes in growth 118, 120–122
  stunting, see Stunting
STAT5B, mutations and phenotypes 48, 49, 78, 79
Stunting, see also Childhood growth; Fetal growth
  malnutrition
    income growth role in prevention 134–136
    interventions
      economic analysis 132, 133, 135
      outcome selection 137–140
    non-communicable disease risks 135–137, 143–146
    synergy between economics and nutrition 133, 134
Trends, see Secular trends
World Health Organization (WHO),
  growth charts 161, 162, 169, 185, 186