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CUET · PHYSICAL EDUCATION · CLASS XI · CODE 321

Physical and Physiological Aspects of Physical Education and Sports

By **UniDrill** · NCERT-grounded study material

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CUET unit: Physical & Physiological Aspects of Physical

📌 Snapshot

- Distinguishes growth (quantitative, biological, limited period) from development (qualitative + quantitative, lifelong) and explains the factors that drive both.
- Lists factors affecting growth and development — heredity, environment, gender, nutrition, exercise, hormones, learning & reinforcement, pollution, socio-economic status.
- Walks through three developmental stages — early childhood, middle childhood, adolescence — and the physical/physiological changes at each.
- Builds the physiological frame for sport: warm-up (general + specific), sports conditioning, and cool-down/limber down.
- Quantifies the effects of exercise on cardiovascular, respiratory, muscular and digestive systems — a heavy MCQ-yielding area for CUET.

📖 Detailed Notes

2.1 Core concepts

- **Growth vs Development (intro):** Growth is a physical change that means becoming bigger or larger; development includes physical, social and psychological changes — i.e., transformation or improvement. Growth is quantitative; development is both quantitative and qualitative (NCERT §Growth and Development, p. 32).
- **Growth defined:** Growth is a biological process through which the body increases in size and shape; it starts in the mother's womb from conception and continues till complete physical maturity. It is a tangible biological process measured in size, volume, height and weight (NCERT §Growth, pp. 32–33).
- **Development defined:** Development is a progressive series of qualitative changes; it has greater relationship with external factors than growth. It needs nutrition, activity, protection from disease and socio-cultural inputs. Growth ends at some stage; development continues till death (NCERT §Development, p. 33).
- **Table of differences (selected):** Growth is visible, quantitative, due to cell division, limited in period and scope, limits set by heredity; Development is observable through matured behaviour, qualitative + quantitative, life-long, vast in scope, more affected by environment (NCERT Table 1, p. 33).
- **Heredity:** A biological process of transmission of physical and social attributes from parents to offspring — height, weight, body structure, hair/eye colour, intelligence,

aptitudes, instincts. Hereditary traits are innate and present at birth (NCERT §Heredity, p. 34).

- **Environment:** Three types — Physical (animate/inanimate surroundings, weather, climate), Social (society, institutions, customs, culture, education) and Psychological (love, affection, emotion, friendship). Environment is divided broadly into natural and social (NCERT §Environment, pp. 34–35).
- **Role of heredity & environment:** Heredity is responsible for inborn traits, instincts, emotions and physical traits; environment is responsible for mental and social traits; the two are complementary "like seed and soil, ship and wave" (NCERT p. 35).
- **Gender:** Boys are generally taller and heavier than girls; but girls demonstrate early physical growth during adolescence. Body composition and structural growth of girls differ from boys (NCERT §Gender, p. 35).
- **Nutrition & Exercise:** Body requires adequate calories; malnutrition adversely affects structural and functional development. Exercise causes growth through use and atrophy through disuse; repeated physical activity builds muscle strength via better circulation and supply of nutrients/oxygen (NCERT §Nutrition, §Exercise, p. 35).
- **Hormones:** Chemical substances from ductless endocrine glands. Thyroid releases thyroxin → influences skeletal and muscular growth. Adrenal glands (near kidneys) secrete adrenaline → strong/rapid heartbeat, sugar release from liver, controls BP. Gonads secrete hormones affecting growth and sexual behaviour (NCERT §Hormones, p. 36).
- **Learning & Reinforcement; Pollution; Socio-economic status:** Development = maturation + learning; "learning by doing and getting results". Air pollution and lead exposure harm growth. Higher socio-economic groups show better growth due to nutrition, facilities, exercise (NCERT pp. 36–37).
- **Early childhood (birth – ~8):** Between birth and age three a child doubles in height and quadruples in weight. By age five, fine-motor control of pencils/crayons/scissors and gross motor skills like skipping and balancing on one foot appear. Physical growth slows between 5 and 8 (NCERT §Early Childhood, p. 37).
- **Middle childhood:** Slow and steady growth until onset of puberty; trend of earlier puberty over time; puberty starts earlier in females (sometimes by age 8–9) (NCERT §Middle Childhood, pp. 37–38).
- **Adolescence (12–18):** Second period of accelerated growth — gain of 15–20 cm in height and 8–10 kg in weight. Females mature earlier (around age 13); males mature around 15. Important phase for cognitive development (NCERT §Adolescence, p. 38).
- **Types of Workout:** Warm-up, Sport Conditioning, Cool-down (NCERT §Physiological Aspects of Activities, p. 38, Fig.).

- **Warm-up:** Short activity prior to intense/skilled activity — 10–40 minutes of light activity like slow jog, calisthenics, stretching. Objectives: increase heart rate, blood flow, internal muscle temperature, respiratory rate, perspiration; decrease viscosity of joint fluids. Optimum duration 15–20 minutes; gradual increase to 70 % of maximal heart rate; produces 2–3 °C rise in body temperature lasting 45 minutes (NCERT §Warm-up, pp. 38–39).
- **General Warm-up:** Rhythmic movements of large muscle groups — walking, jogging, stationary bike, skipping, easy aerobics — improves neuromuscular coordination, raises temperature, reduces viscosity in muscle fibres (NCERT §General Warm-up, pp. 39–40).
- **Specific Warm-up:** Sport-specific exercises matched to main activity — e.g. weightlifting (bar exercises), basketball (lay-up & free throws), cricket (bowling, batting, fielding), lawn tennis (wall/service practice), shot put (standing throws, gliding), hockey (dribbling, scoop), weightlifting (rowing, high pull, snatch squat) (NCERT §Specific Warm-up, p. 40).
- **Methods of warming up:** exercise, massage, hot water bath, sipping hot beverages. Massage removes lactic acid and helps recovery; hot bath raises temperature and activates muscles; hot beverage stimulates body functions. End with sprints; heart rate 120–140 beats/min during warm-up (NCERT §Methods of Warming up, pp. 41–42).
- **Sports Conditioning:** Complements current sports training; enhances strength, balance, coordination, flexibility, speed, power; reduces injury risk; should be sport-specific (NCERT §Sports Conditioning, p. 42).
- **Cool down / Limber down:** Light exercises and stretching following rigorous activity. Effects: faster removal of lactic acid from fast-twitch muscle fibres, faster removal of CO_2 from muscle tissue, reduced muscle soreness, gradual return of heart rate/breathing to resting, avoids fainting/dizziness from blood pooling in legs (NCERT §Limber down/Cool down, pp. 42–43).
- **Effects of exercise on cardiovascular system:** Heart rate at rest 60–80 bpm (normal 72); during exercise 140–180 bpm. Stroke volume at rest ~70 ml/beat (male), 50 ml/beat (female). Cardiac output = HR × SV; rest ~5 L/min, 4–5 fold rise during exercise. Cardiac hypertrophy ("athlete's heart") occurs after 7–10 years of vigorous training. Blood volume: adult body ~5–6 L (1/3 of body weight); endurance training raises resting blood volume by ~8 %, plasma volume by 12 %; hemodilution; capillarisation (NCERT §Effects of Exercise on Cardiovascular System, pp. 43–44).
- **Effects of exercise on respiratory system:** Tidal volume at rest ~500 ml; rises 5–6 × during maximal exercise. Respiratory rate at rest 12–20 / min, increases 2–3 × during exercise. Pulmonary ventilation = TV × RR; rest = 8 L/min (smaller in females). Pulmonary diffusing capacity increases. Hyperventilation = increased breathing due to increased TV or RR or both. Total lung capacity slightly decreases during exercise; vital capacity = max air forcefully expired after max inspiration (NCERT §Effects of Exercise on Respiratory System, pp. 44–45).

- **Effects of exercise on muscular system:** Muscular hypertrophy (fibres enlarge, more protein/glycogen/enzymes); aerobic changes (myoglobin ↑, more O_2 to muscles, oxidation of glycogen, more fat used); anaerobic changes (lactic acid tolerance ↑, change in blood flow, change in red/white fibres); endurance training raises capillary ratio; performance: more strength, flexibility, endurance, less anaerobic dependence (NCERT §Effects of Exercise on Muscular System, pp. 45–46).
- **Effects of exercise on digestive system:** Increased blood flow to digestive organs, speeds up metabolism (raises resting metabolic rate), prevents constipation (less time for stool to lose water in large intestine), strengthens internal organs and prevents digestive diseases (NCERT §Effects of exercise on Digestive System, pp. 46–47).

2.2 Definitions to memorise

Term	Definition	Page
Growth	Biological process of increase in body size and shape (height, weight, volume); quantitative change	32–33
Development	Progressive series of qualitative changes (and quantitative); lifelong process	33
Heredity	Biological process of transmission of physical/social attributes from parents to offspring	34
Environment	Sum total of physical/psychological stimulations received from conception; physical, social, psychological types	34
Adolescence	Period 12–18 years; second period of accelerated growth, gain of 15–20 cm height & 8–10 kg weight	38
Warm-up	Short light activity prior to intense/skilled activity to raise body temperature and prepare body	38
General Warm-up	Rhythmic movements of large muscle groups — walking, jogging, skipping, calisthenics	39
Specific Warm-up	Sport-specific exercises matched to the main activity	40
Sports Conditioning	Training to enhance strength, balance, coordination, flexibility, speed, power; complements sports training	42
Cool down / Limber down	Light exercise + stretching after rigorous activity; faster lactic acid & CO_2 removal	42–43
Heart rate	Number of beats/contractions of heart per minute (rest 60–80; normal 72)	43
Stroke volume	Amount of blood pumped out by each ventricle in each heartbeat (rest: 70 ml male, 50 ml female)	44
Cardiac output	HR × SV; ~5 L/min at rest, 4–5 fold rise on exercise	44

Term	Definition	Page
Cardiac hypertrophy	Increase in heart's volume due to enlargement of component cells ("athlete's heart"), after 7–10 yr training	44
Tidal volume	Volume of air inspired or expired per breath (~500 ml at rest)	44
Respiratory rate	Number of breaths per minute (rest 12–20)	45
Pulmonary ventilation (PV)	TV × RR; rest = 8 L/min	45
Hyperventilation	Increased breathing due to increased TV or RR or both	45
Vital capacity	Max volume of air forcefully expired after max inspiration	45
Muscular hypertrophy	Enlargement of muscle fibres (diameter, length) with training; more protein, glycogen, enzymes	46

2.3 Diagrams / processes to remember

- **Types of Workout flow** — Warm-up → Sport Conditioning → Cool-down (p. 38).
- **Types of Warm-up** — General Warm-up & Specific Warm-up (p. 38).
- **Fig. 3.1: General warm-up exercises** — lunges, stretches, squats, arm swings (p. 39).
- **Fig. 3.2: Different types of warming up drills in basketball** (p. 41).
- **Effects of a Cool down flow chart** — faster removal of lactic acid from fast-twitch fibres; faster removal of CO_2; reduction in muscle soreness (p. 43).
- **Table 1: Differences between Growth and Development** — 9 row comparison (p. 33).

2.4 Common confusions / NTA trap points

- Growth vs Development — Growth is quantitative only; Development is quantitative AND qualitative. Distractors flip this. Growth ends at a stage; development continues till death.
- Cardiac output formula — HR × SV (NOT SV ÷ HR or HR + SV); at rest = 5 L/min, NOT 8 L/min (which is pulmonary ventilation).
- Pulmonary ventilation formula — TV × RR (NOT HR × SV). The 8 L/min figure belongs here, not to cardiac output.
- Stroke volume values — 70 ml male, 50 ml female (don't swap).
- Tidal volume — 500 ml at rest (don't confuse with vital capacity or total lung capacity).
- Optimum warm-up duration — 15–20 minutes (the 10–40 figure refers to range of light activity, the 45 minutes is duration the 2–3 °C rise lasts).
- Heart rate during warm-up = 120–140 bpm; during full exercise = 140–180 bpm. Distractors swap these bands.

- Thyroxin = thyroid (skeletal/muscular growth); Adrenaline = adrenal glands near kidneys (heart rate, sugar release, BP). Frequent NCERT trap.
- Females mature at about age 13, males at about age 15 — easy to swap.
- Cardiac hypertrophy ("athlete's heart") requires 7–10 years of vigorous training — it is not the immediate effect of a single workout.
- Endurance training raises resting blood volume by ~8% and plasma volume by ~12% — students often invert the two numbers.
- Cool-down lactic acid removal targets fast-twitch fibres; slow-twitch fibres clear lactate on their own. NTA may swap fibre type.
- Methods of warming up = exercise, massage, hot water bath, hot beverage. Cryotherapy/ice bath is NOT a warm-up method (that is a recovery/post-injury tool).

2.5 Key concepts table — physiological values, hormones and workout phases

#	Variable / concept	Resting value	Exercise value / change	NCERT page
1	Heart rate (adult)	60–80 bpm (normal 72)	140–180 bpm	43
2	Stroke volume (male)	70 ml/beat	Increases with training	44
3	Stroke volume (female)	50 ml/beat	Increases with training	44
4	Cardiac output (HR × SV)	~5 L/min	4–5-fold rise	44
5	Cardiac hypertrophy	—	After 7–10 yrs vigorous training	44
6	Blood volume (adult)	5–6 L (~⅓ body weight)	+8% with endurance training	44
7	Plasma volume	—	+12% with endurance training	44
8	Tidal volume	500 ml	5–6 × rise at max	44
9	Respiratory rate	12–20/min	2–3 × rise	45
10	Pulmonary ventilation (TV × RR)	8 L/min	Several-fold increase	45
11	Vital capacity	Max forced expiry after max inspiry	Slight rise w/ training	45
12	Hyperventilation	—	↑ breathing via TV/RR or both	45
13	Muscle hypertrophy	—	Fibres enlarge w/ training	46
14	Myoglobin	—	↑ aerobic O_2 supply	46

#	Variable / concept	Resting value	Exercise value / change	NCERT page
15	Lactic acid tolerance	—	↑ with anaerobic training	46
16	Warm-up HR target	—	120–140 bpm	41
17	Warm-up duration (optimum)	—	15–20 min	39
18	Body temp rise post warm-up	—	2–3 °C (lasts ~45 min)	39
19	Hormones — Thyroxin	Thyroid gland	Skeletal/muscular growth	36
20	Hormones — Adrenaline	Adrenal gland	Heart rate, sugar release, BP	36
21	Hormones — Gonads	Testes/ovaries	Sexual behaviour + growth	36
22	Adolescence height gain	—	15–20 cm	38
23	Adolescence weight gain	—	8–10 kg	38
24	Workout phases	—	Warm-up → Conditioning → Cool-down	38
25	Methods of warm-up	—	Exercise, massage, hot bath, hot beverage	41

2.6 Extended discussion — workout architecture, hormonal control, system-by-system effects

The three-phase workout architecture — **warm-up → sports conditioning → cool-down** — is the spine of every CUET item drawn from this section. Each phase has a specific physiological signature. The warm-up raises core temperature by 2–3 °C, lowers the viscosity of synovial fluid in the joints, enlarges capillary beds via vasodilation, and primes the neuromuscular system so motor units fire more synchronously. The optimum duration is 15–20 minutes, with a target heart rate of 120–140 bpm — about 70% of maximal HR. The 2–3 °C temperature rise persists for around 45 minutes, which is why warm-up should not be done too far before the main activity.

The **general warm-up** is non-specific — slow jogging, calisthenics, stationary cycling, easy aerobics, large-muscle rhythmic movement — and its sole purpose is to raise temperature and circulation. The **specific warm-up** is sport-specific: lay-up shots before basketball, gliding throws before shot put, wall and service practice before tennis, bar exercises and rowing/high-pull/snatch squat before weightlifting, dribbling and scoop before hockey, bowling/batting/fielding rehearsal before cricket. Examiners frequently test this matching directly.

Sports conditioning is the body of the workout — sport-specific drills that build strength, balance, coordination, flexibility, speed and power. Conditioning complements sports training rather than replacing it and that it must be tailored to the sport's biomechanical demands.

The **cool-down or "limber down"** phase mirrors the warm-up in reverse: 5–10 minutes of light jogging or walking followed by static stretches. Its physiological payoff is fourfold — faster clearance of lactic acid from fast-twitch fibres, faster removal of CO_2 from muscle tissue, reduced post-exercise muscle soreness, and avoidance of fainting or dizziness from blood pooling in the legs.

Hormonal control of growth is summarised through three glands. The **thyroid** secretes thyroxin, which directly drives skeletal and muscular growth — deficiency causes cretinism in children and stunted physical development. The **adrenal glands**, perched on top of the kidneys, secrete adrenaline (epinephrine) — the "fight-or-flight" hormone that accelerates heart rate, mobilises glucose from the liver, and maintains blood pressure during exercise stress. The **gonads** (testes in males, ovaries in females) secrete sex hormones that drive both the adolescent growth spurt and the development of secondary sexual characteristics. Note that thyroxin–adrenaline mix-ups are a perennial CUET trap.

System-by-system exercise effects form the densest CUET-yielding numeric block. Cardiovascular changes include bradycardia at rest (lower resting HR in trained athletes), increased stroke volume, larger cardiac output ceiling, cardiac hypertrophy after 7–10 years of vigorous training, raised blood volume (+8%) and plasma volume (+12%), and capillarisation. Respiratory changes include rise in tidal volume, vital capacity, pulmonary diffusing capacity, and minute ventilation, with reduced respiratory rate at rest. Muscular changes include hypertrophy of fibres, increased myoglobin, glycogen, mitochondria and oxidative enzymes; greater lactic acid tolerance through anaerobic training; and improved strength, flexibility and endurance. Digestive changes include increased blood flow to digestive organs, faster metabolism, raised RMR, and reduced incidence of constipation through better intestinal motility.

🎯 Practice MCQs

📊 PYQ Alignment

> This chapter is a consistent CUET source — typical questions test (i) growth-vs-development definitions and Table 1 contrasts, (ii) numerical values from the physiological sub-sections (resting cardiac output, stroke volume, tidal volume, PV formula, heart-rate ranges), (iii) factors affecting growth (hormones — thyroxin/adrenaline mix-ups), and (iv) classification questions on warm-up types and sport-specific drills. Expect 1–2 direct-

recall numerical MCQs and at least one match-the-following on workout/sport pairings every year.