

## Chapter 6. Integration of Body Systems & Their Functional Significance

### 1 Learning Objectives

By the end of this chapter you will be able to ...

1. **Define homeostasis, allostasis and feedback loops** and explain why no single body system can preserve internal stability unaided.
2. **Describe anatomico-physiological link-points** between at least five systems central to physiotherapy.
3. **Analyse multi-system clinical scenarios** and derive safe, evidence-based intervention plans.
4. **Design integrated assessment batteries** that screen for cross-system contraindications and monitor treatment efficacy.

### 2 Concept Foundations

Concept	Concise Definition	Detailed Physiotherapy Context
<b>Homeostasis</b>	Dynamic internal equilibrium maintained within tight limits	Regulating core temperature, pH and blood glucose during a 30-min treadmill session
<b>Allostasis</b>	Changing baseline set-points to accommodate acute or chronic stress	Training-induced resting bradycardia; chronic pain raising sympathetic tone
<b>Feedback loop</b>	Sensor → Integrator → Effector circuitry; <i>negative</i> (restores balance) or <i>positive</i> (amplifies)	Baroreflex prevents orthostatic hypotension when a stroke survivor transfers supine → sit

**Key Point:** In rehabilitation we aim to **harness** adaptive feedback (e.g., Wolff's law for bone) while **avoiding maladaptation** (e.g., over-training syndrome).

### 3 High-Impact System Pairings

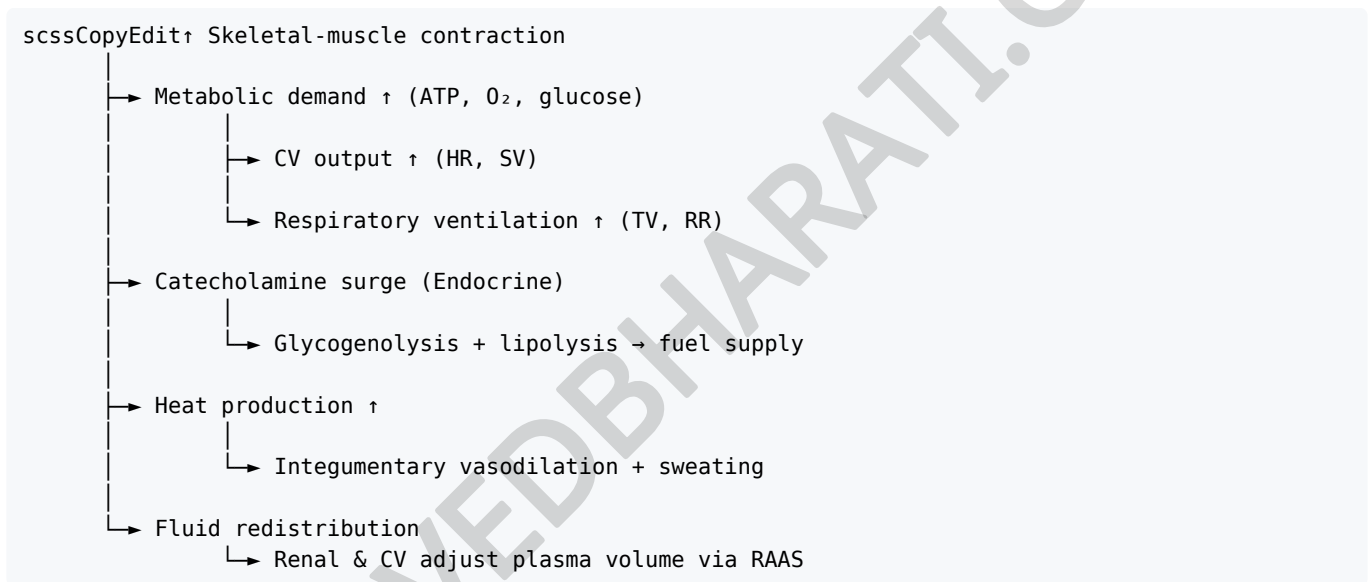
Interacting Systems	Mechanism of Coupling	Functional Significance for PT
<b>Cardiovascular ↔ Respiratory</b>	<i>Fick Principle</i> - $VO_2 = CO \times (a-v)O_2 \text{ diff}$	Prescribes aerobic intensity; guides post-operative incentive-spirometry dosage
<b>Neuromuscular ↔ Skeletal</b>	Motor-unit activation stresses bone; osteoblasts remodel under load	Progressive resistance combats sarcopenic osteoporosis
<b>Endocrine ↔ Metabolic ↔ MSK</b>	Insulin, cortisol, testosterone govern protein synthesis/glucose uptake	Scheduling exercise around insulin peaks prevents hypoglycaemia; anabolic window optimisation
<b>Renal ↔ CV</b>	RAAS alters plasma volume & BP	Haemodialysis patients: monitor pre-/post-treatment BP before gait training
<b>Immune/Lymphatic ↔ Integumentary</b>	Inflammation & lymph drainage drive tissue repair	Manual lymph drainage hastens wound closure and restores ROM post-burn

### 4 Integrated Clinical Vignettes

Case	Systems Interplay	PT Assessment & Interventions
<b>A. Post-MI + Moderate COPD</b>	CV pump reserve limited; ventilatory inefficiency ↑ work of breathing	<ul style="list-style-type: none"> <li>• Baseline vitals, 6-MWT, SpO<sub>2</sub></li> <li>• Low-load cycle-ergometry with interval pacing (RPE 11-13)</li> <li>• Diaphragmatic &amp; pursed-lip breathing to off-load accessory muscles</li> </ul>

Case	Systems Interplay	PT Assessment & Interventions
<b>B. SCI (T6) + Orthostatic Hypotension</b>	Neurogenic sympathetic loss ↓ vascular tone; CV preload falls	<ul style="list-style-type: none"> <li>• Tilt-table progression 15° → 70° over sessions</li> <li>• Compression stockings &amp; abdominal binder</li> <li>• Education on AD triggers and beta-blocker effect masking tachycardia</li> <li>• Pre-exercise capillary glucose check (avoid &lt; 100 mg/dL)</li> <li>• WBV platform + progressive resistance (8-10 RM) three times/week</li> <li>• Foot inspection &amp; footwear advice to protect integument</li> </ul>
<b>C. Elderly T2DM + Osteoporosis</b>	Endocrine dysglycaemia impairs collagen cross-linking; bone mineral density low	

**5 Systems-Integration Flow (Therapeutic Exercise Example)**



**Therapeutic Insight:** Exceeding one node’s tolerance (e.g., inadequate hydration → renal strain) cascades failure across the network, underscoring the need for graded, periodised loading.

**6 Integrated Assessment Matrix**

Parameter	Primary System	Secondary Influence	PT Tool / Frequency
HR, BP, ECG	CV	Neuro (autonomic), Endocrine	Continuous telemetry during high-risk rehab phases
SpO <sub>2</sub> , Ventilatory Pattern	Resp	CV, Neuro	Pulse-ox each session; observe paradoxical breathing
Blood Glucose (DM only)	Endocrine	CV, MSK	Pre-/post-exercise finger-stick
Girth / Bio-impedance	Lymphatic	CV, Integ	Weekly in post-mastectomy upper limb
Dermatome/Myotome	Neuro	MSK	Baseline and PRN for radiculopathy symptoms

**7 Self-Check Quiz (with Answers)**

1. **Why can beta-blockers mask autonomic dysreflexia symptoms in high-level SCI?**

**Answer:** Beta-blockers blunt sympathetic cardiac responses (tachycardia, hypertension). Autonomic dysreflexia relies on detecting these signs; suppression delays recognition and management, increasing risk of cerebrovascular events.

2. **During aquatic therapy, how do the renal and cardiovascular systems react to hydrostatic pressure?**

**Answer:** Central blood volume increases → atrial stretch → atrial natriuretic peptide release → diuresis & natriuresis (renal) while CV system adapts with ↑ stroke volume and ↓ HR (Bainbridge reflex).

3. **Match the hormone to its physiotherapy effect**

- a) **Parathyroid hormone** — stimulates osteoclasts, so excessive levels weaken bone → need low-impact loading;
- b) **Epinephrine** — raises HR & contractility, enhancing short-term exercise capacity;
- c) **Insulin-like growth factor-1** — promotes muscle protein synthesis, supporting hypertrophy training.

4. **True/False:** Lymph-oedema management is purely a local integumentary intervention.

**Answer:** *False*. It also depends on lymphatic vessel function (immune system), muscle pump (MSK), and CV venous return; systemic fluid shifts influence outcomes.

5. **Give two reasons why deconditioning after bed-rest is a multi-system issue.**

**Answer:** (i) CV deconditioning ↓ VO<sub>2</sub> max and orthostatic tolerance; (ii) MSK losses in muscle mass & bone density; additionally respiratory, endocrine (insulin resistance) and neural proprioceptive declines occur, all reducing rehab capacity.

**8 Practical / Lab Activities**

Activity	Integration Targets	Expected Competence Gain
Tilt-Table + Telemetry	CV-Neuro-Renal	Manage orthostatic hypotension protocol safely
Spiro-Cycle Test	CV-Resp-Endocrine	Interpret gas-exchange data to set HIIT zones
Systems Mapping Workshop	All	Draw 360° diagram linking pathology to PT goals

**9 Key Take-Home Messages**

1. **Systems integration underpins every rehabilitation response**—no isolated “muscle” or “lung” training truly exists.
2. **Multi-system assessment** detects red-flags early and individualises dosage.
3. Effective physiotherapists are **load managers & homeostasis guardians**, guiding the body to adapt, not fail.
4. **Communication of cross-system findings** with the healthcare team enhances safety and outcome tracking.