**Physiol-11A14** Describe the physiological effects of general anaesthesia on temperature regulation.

**Background**

Core body temperature is tightly regulated within the interthreshold range:

- **Sensors** = thermal receptors in skin and viscera
- **Central regulator** = pre-optic nuclei in anterior hypothalamus
- **Response to cold** = vasoconstriction, piloerection, shivering, non-shivering thermogenesis, behaviour, ↑SNS
- **Response to hot** = vasodilatation, sweating, behaviour, ↓SNS and ↑PSNS

General anaesthesia affects both the central regulator and effectors

**General Anaesthesia – Induction and Maintenance**

General anaesthesia (GA) usu results in mild hypothermia (CBT falls by 1 ~ 3 ℃)
Degree of hypothermia depends on:
- dose of anaesthesia
- adjuvant neuraxial anaesthesia
- surgical exposure
- ambient temperature
- patient factors – e.g. obese patients less heat redistribution (phase 1), infants can utilise non-shiver thermogenesis (via brown adipose tissue)

**Core body temperature (CBT) usually falls in 3 phases**

**Phase 1** = rapid fall (1 ~ 2 ℃) within 1 hour after induction due to vasodilatation by anaesthetic agents → rapid redistribution of heat from core to peripheral tissues
GA → widened interthreshold range → delayed activation of compensatory vasoconstriction

**Phase 2** = more gradual fall (~ 1 ℃) over next 2 ~ 3 hours due to heat loss from:
- **radiation** (60%) – lose heat via emission of infrared radiation
- **convection** – air adjacent to skin carries heat away
- **evaporation** – evaporation of water consumes heat (due to $\Delta H_{\text{vap}}$)
- **conduction** – heat transfer from direct contact

which exceed heat gain from metabolism (which is also reduced by GA)

**Phase 3** = plateau phase  
heat loss matched by metabolic heat production  
when GA patient becomes sufficiently hypothermic to activate compensatory vasoconstriction

**General Anaesthesia – Recovery**

Anaesthetic agents washed out from CNS $\rightarrow$ restoration of thermoregulatory responses (i.e. interthreshold range gradually normalise $\rightarrow$ vasoconstriction)

Reversal of muscle relaxants $\rightarrow$ restoration of shivering thermogenesis

Core body temperature slowly returns to baseline (usu. takes 2~5 hours, delayed by residual anaesthetic $\rightarrow$ post-op opioids)

**Examiner’s comments** – This question was passed by 44% of candidates.

In order to pass this question, candidates were expected to discuss temperature regulation with induction, maintenance, and recovery from general anaesthesia.

An understanding of dose dependent, agent dependent, and age and sex dependent factors were required. Additional marks were awarded for describing the differences between elderly patients and neonates, for a correct description of the role of non-shivering thermogenesis, and for a description of the additional effects of neuraxial blocks in conjunction with general anaesthesia.

Many candidates were confused by the differences between the interthreshold range and the thermoneutral zone. Very few candidates mentioned temperature regulation during the recovery phase. Graphs were often incorrectly drawn, and the thermoneutral zone was frequently incorrectly defined. Some candidates gave a detailed account of the normal physiology of thermoregulation, rather than answering the question as relevant to anaesthesia. The main reason for candidates failing this question was insufficient core knowledge.