CCT — Correlated Color Temperature (K)

Spectral balance and non-visual biology in schools

Definition

Descriptor of spectral appearance vs. a blackbody radiator. Higher CCT = blue-rich (shorter wavelengths); lower CCT = warm (longer wavelengths).

Recommended Ranges

|  |  |
| --- | --- |
| Optimal | 4000–5000 K (general instruction), 5000–6500 K (morning alertness/exams), 3000–3500 K (late-day calming). |
| Caution | ≤2700 K (daytime sleepiness risk) or ≥6500 K (discomfort/glare if uncontrolled). |

Biological Effects

Hormones (Endocrine)

Blue-rich (~460–490 nm) → ipRGC (OPN4) activation → SCN → ↓ sympathetic tone to pineal → ↓ NE → ↓ AANAT → ↓ melatonin synthesis (day).

Morning blue-enriched light supports CRH→ACTH→cortisol diurnal peak; stabilizes HPA rhythm.

Daytime light increases serotonin turnover (raphe), supporting mood/attention; evening warm light permits melatonin rise.

Skin (Photobiology & Peripheral Clocks)

Typical classroom LEDs lack UVB → negligible vitamin D synthesis.

Skin opsins (OPN3/OPN5) can entrain local clocks via G-protein–cAMP–CREB; systemic impact modest at indoor illuminances.

Nervous System (ipRGC → SCN → CNS)

ipRGC glutamatergic input (NMDA) to SCN shifts CLOCK/BMAL1 → PER/CRY molecular clock phase.

Blue light increases retinal dopamine, aiding contrast sensitivity and attentional performance.

Biochemical Pathways (Mechanistic Detail)

ipRGC→SCN: glutamate + PACAP → NMDA-dependent Ca²⁺ influx → CREB phosphorylation → Per1/Per2 transcription → phase shifts.

SCN→PVN→IML→SCG→pineal: ↓ β-adrenergic signaling → ↓ cAMP/PKA → ↓ AANAT → melatonin↓.

Serotonin (TPH2) day turnover; night: 5-HT → melatonin via AANAT/ASMT.

Classroom Recommendations

Provide scene presets: Focus (5000–6500 K morning), General (4000–5000 K), Calm (3000–3500 K late-day).

Coordinate CCT with glare control and vertical EDI targets.

Quick Checklist

CCT scenes mapped to schedule.

Glare controlled when using higher CCT.

Teacher control available.

References

Park et al. (2015) — CCT & illuminance on performance.

Brown TM et al. (2022) — Reporting light for non-visual effects; melanopic metrics.

Mott et al. — Classroom dynamic lighting and reading fluency.