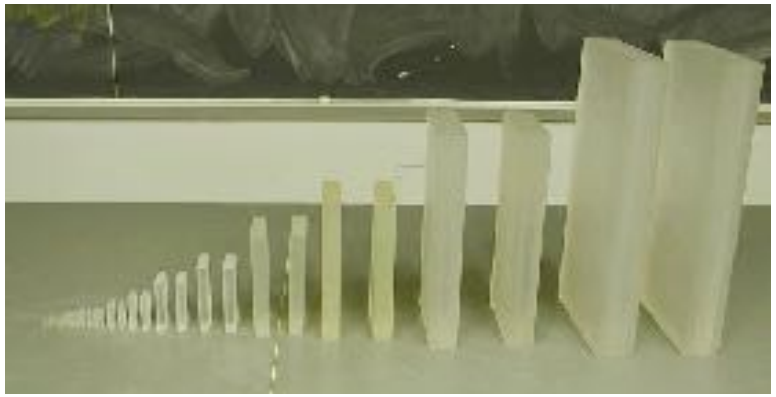
Hormones and behavior

Hormones and behavior

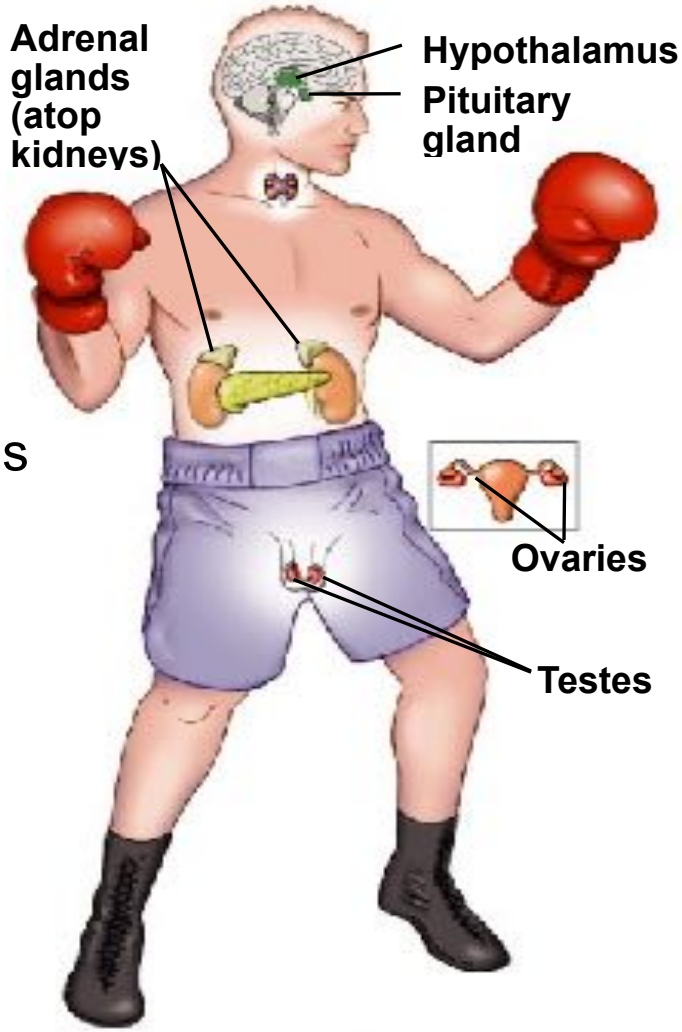
- All behavior is chemically mediated by neurotransmitters and hormones

- What is a hormone?
  - Secretions of endocrine glands
    - Usually a long distance messengers released into bloodstream (&lymph) that move from source to target
  - Effects on target cells (remember: steroids generally act as transcription factors)
  - Cascade of effects



Important hormonal players

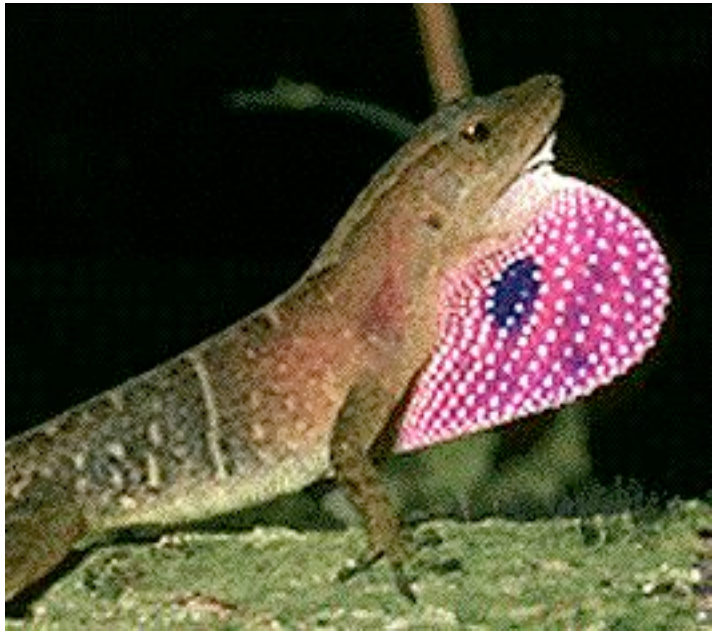
- Hypothalamus
  - Main processing center
  - GnRH is synthesized and released from neurons within
- Anterior pituitary
  - Stimulated by GnRH
  - Makes FSH and LH, which regulate gonads
- Posterior pituitary
  - Storage/secretion of hypothalamus hormones
  - Makes oxytocin, which induces uterine contraction, milk production
- Testes, ovaries, adrenals, and brain
  - Produce steroid hormones such as corticosterone and sex steroids such as testosterone and estrogen



Organizational vs. Activational

- Organizational effects

- Activational effects

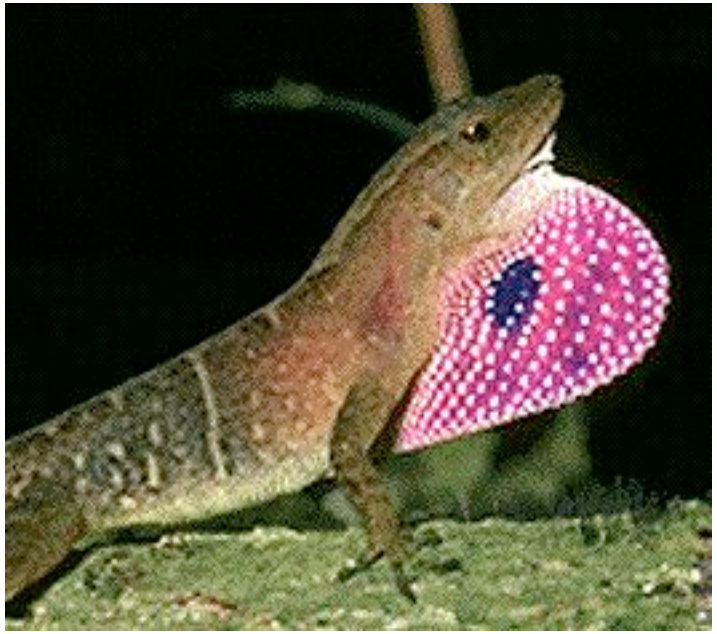


Organizational vs. Activational

- Organizational effects
  - Long term, generally permanent developmental effects
  - Define critical periods
  - Sex determination, secondary sexual characteristics

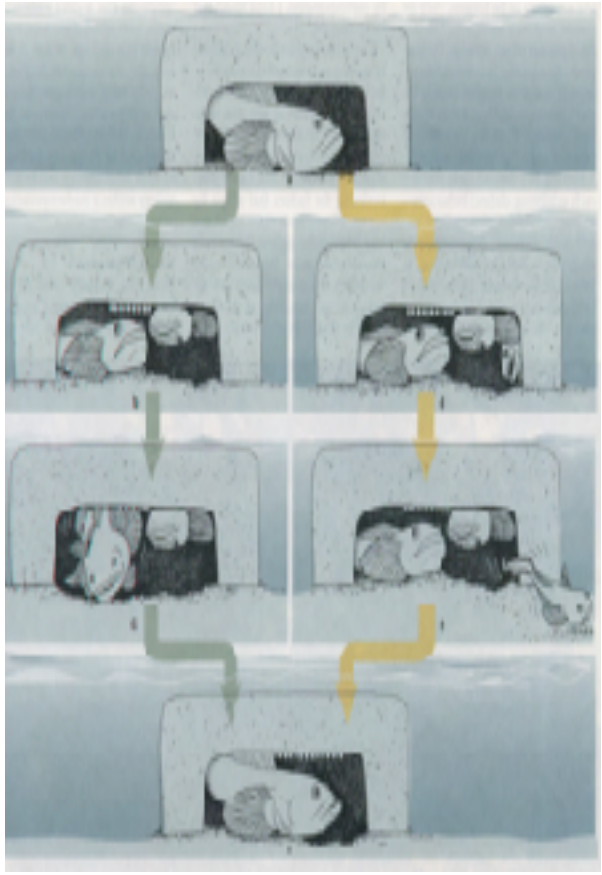
- Activational effects
  - Triggering, short term

    fast, reversible
  - Seasonal sexual behavior



Organizational effect: Midshipman fish

- Alternative male reproductive tactics
  - Type I males = “normal”
    - Large
    - Singers with strong vocal muscles
    - Large neurons to match vocal ability
    - Defend nests & care for eggs
  - Type II males = sneakers
    - Small, female-like
    - Can’t sing: undeveloped vocal muscles
    - Small vocal neurons, like females
    - No nest defense; dash & fertilize

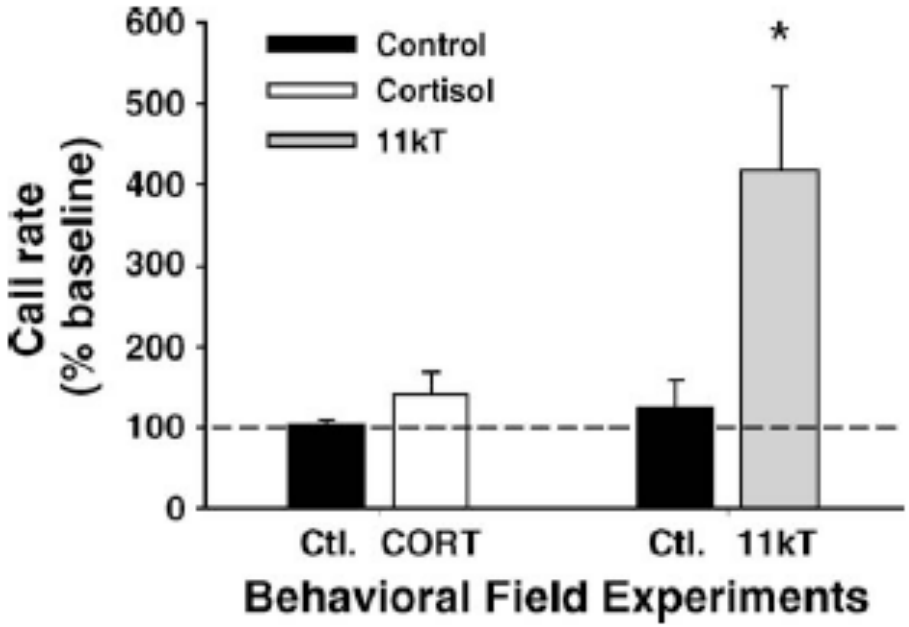


Organizational effect: Midshipman fish

- Organizational hormone cascade
  - GnRH from hypothalamus --> Ant pituitary releases gonadotropins --> gonads release steroid hormones --> steroid hormones organize sexual morph
- What triggers type I vs. type II during male development?
  - Body size differences when cascade is initiated

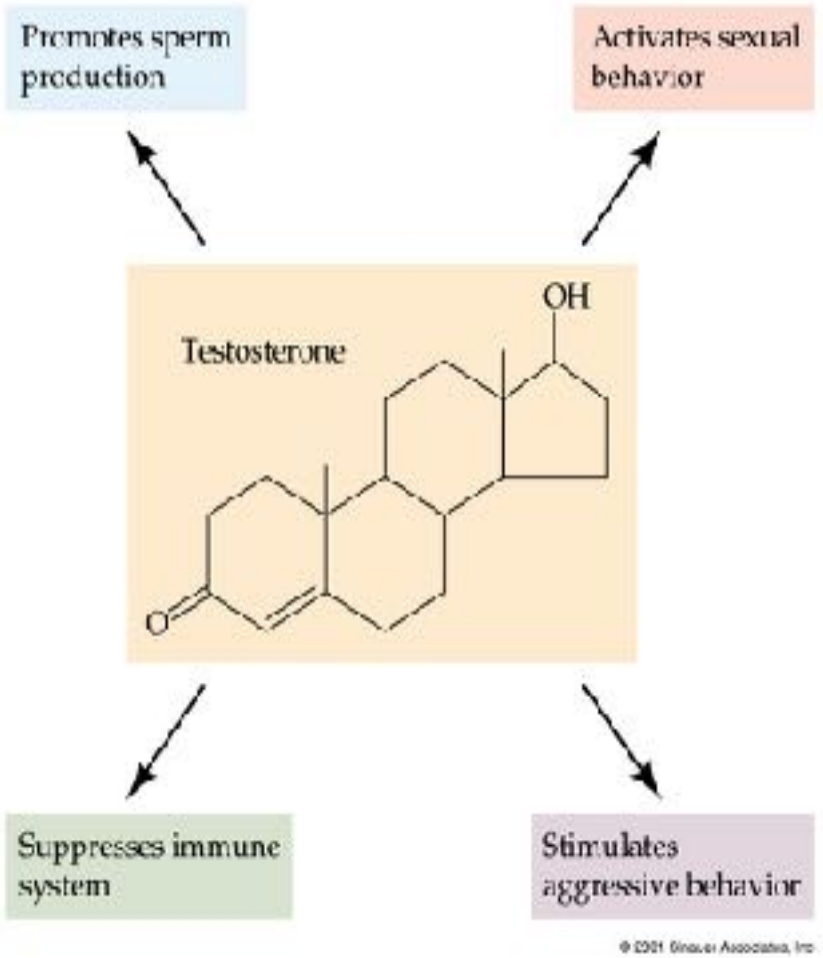
Activational effects

- As with all animals, midshipman rely on activational hormones as well
  - Administered 11kT stimulates more antagonistic calling in type I's



Testosterone: A steroid hormone

- Action of hormones
  - Organizational
    - critical periods, long-term effects
  - Activational
    - triggering, fast-acting, short-term
- Why do we care about T?
    - Regulates mating behavior, attractiveness, aggressive behavior, competition



Organizational effects of sex steroids

- Organizational
  - Sexual differentiation
  - Development of secondary sex characteristics

	Mammals
Reduction of sex steroids	Female
Sex steroid administration	Male
Organizing gonad	Testis
Homogametic sex	Female (XX)

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	Mammals	**Birds**
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Organizing gonad	Testis	Ovary
Homogametic sex	Female (XX)	Male (ZZ)

Research strategy for studying hormonal influences

- 1) Identify correlation between a hormone and a behavior

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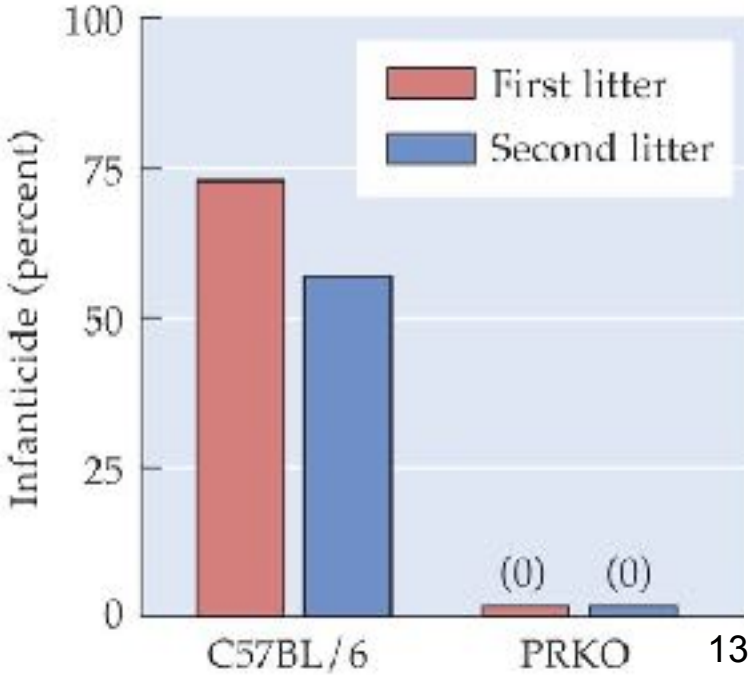
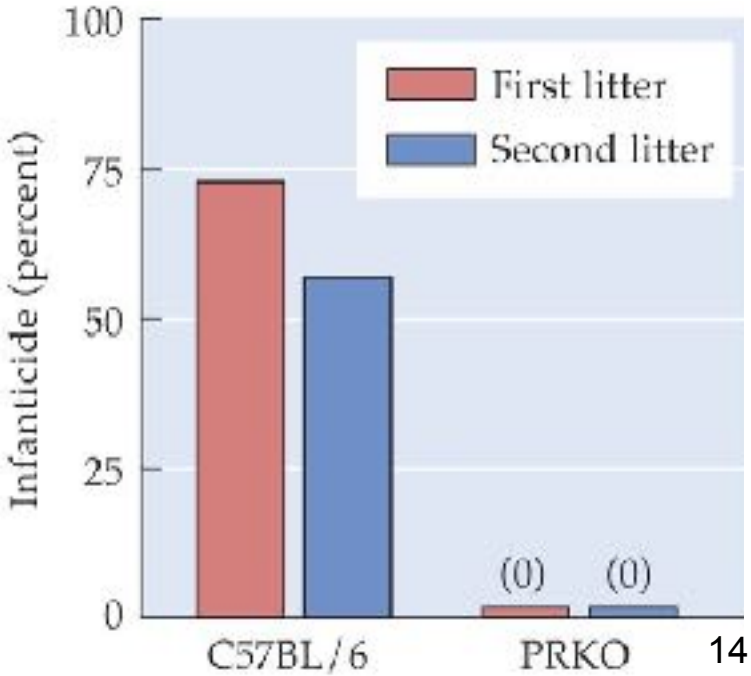
- 2) Remove hormone ⇒ see if behavior changes (or stops)
  - Excise organ that produces hormone
  - Use drug that blocks hormone production or reception
  - Knockout the receptor-making gene
    - progesterone knockout in mice



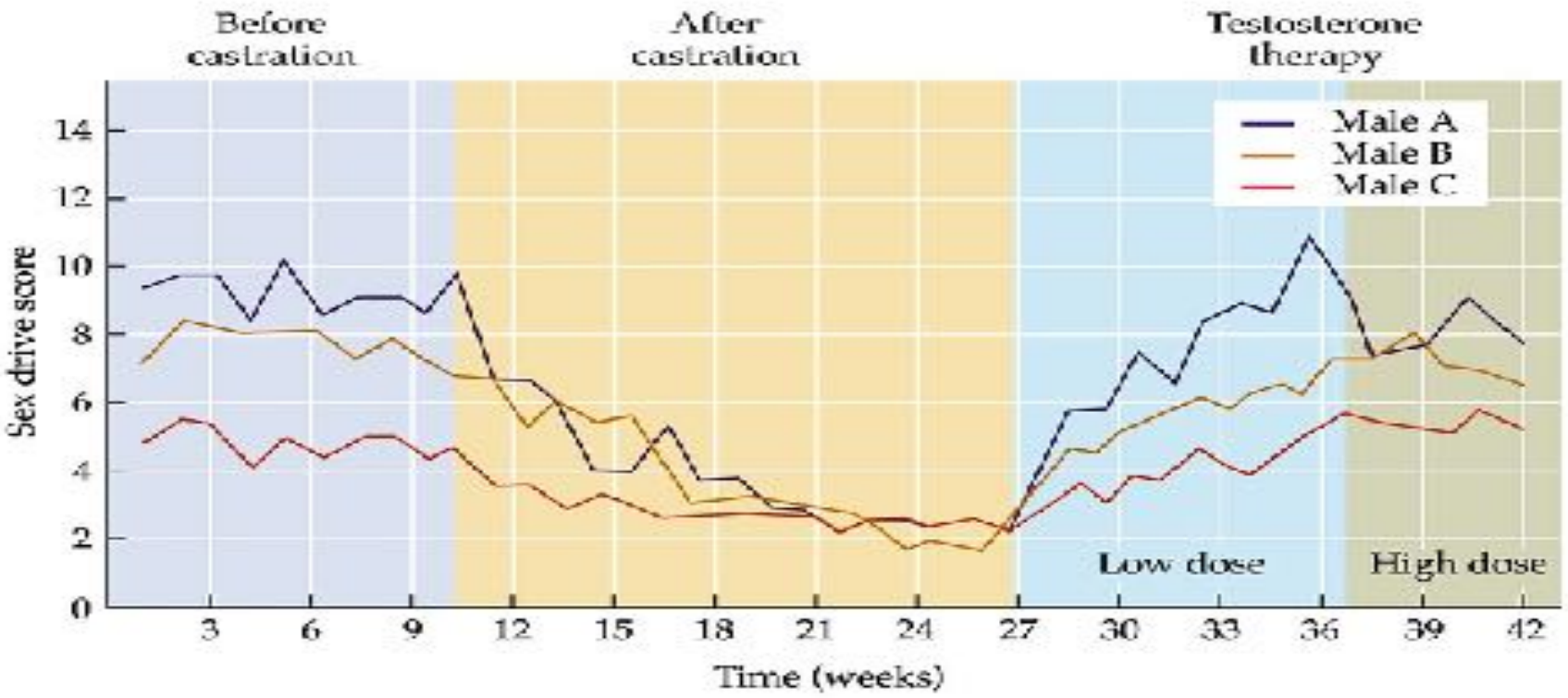
Research strategy for studying hormonal influences

- 1) Identify correlation between a hormone and a behavior
- 2) Remove hormone ⇒ see if behavior changes (or stops)
  - Excise organ that produces hormone
  - Use drug that blocks hormone production, conversion, reception
  - Knockout the receptor-making gene
    - progesterone knockout in mice
- 3) Add hormone ⇒ see if behavior returns to normal



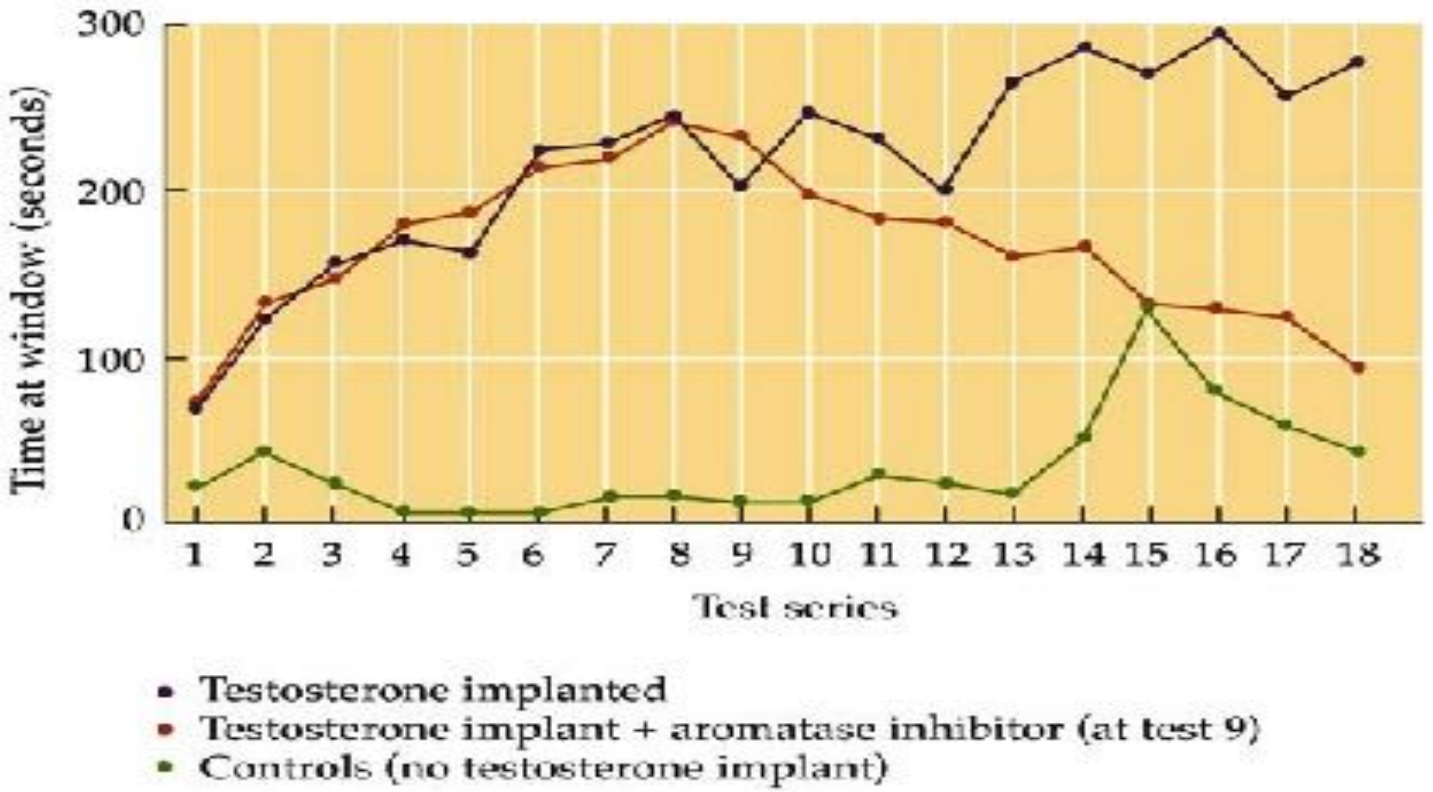
Activational effects of testosterone

- Activational
  - Guinea pigs
    - Male sex drive can recover after castration with testosterone implants



Activational effects of testosterone

- Change in behavior directly linked with hormonal activity
  - Japanese Quail
    - Male behavior (staring-at-female) stops with castration, but returns with T implant



Costs of testosterone: tradeoffs

- Benefits of T:
  - Increased attractiveness
  - Increased territory size
  - Increased sperm production
  - Increase number of EP offspring (EPCs)
- Costs of T:
  - Increased metabolism (energetic cost)
  - Reduced survival (future RS)
    - Risk of injury and/or predation with courtship & fights
  - Suppression of immune system
  - Reduced parental care

Costs of testosterone

- T has high costs
  - Otherwise, animals would always have high T, but they don't

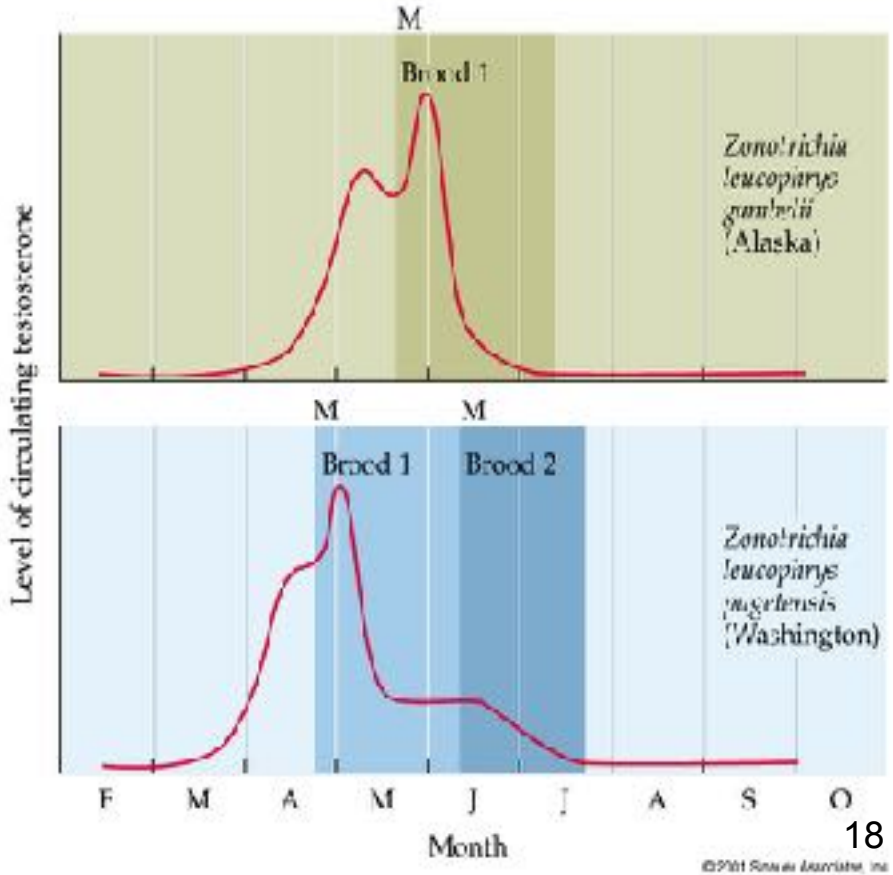
White-crowned Sparrows:

In Alaska,

- only 1 brood, with associated T

In Washington:

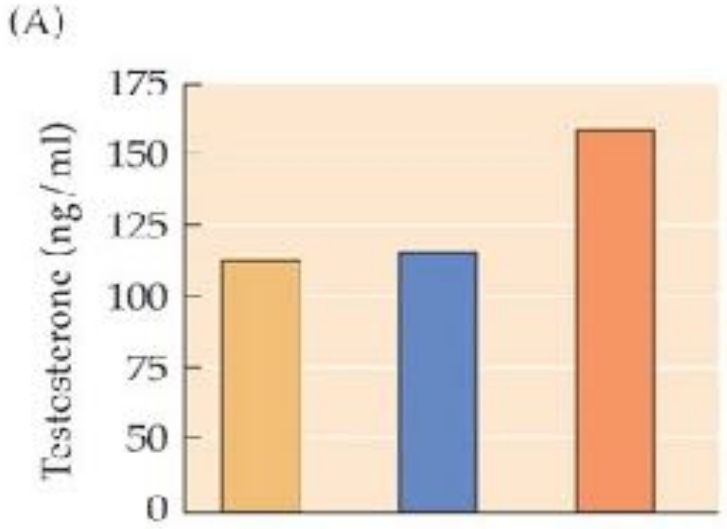
- "normal" T peak before 1st brood
- no T peak before 2nd brood

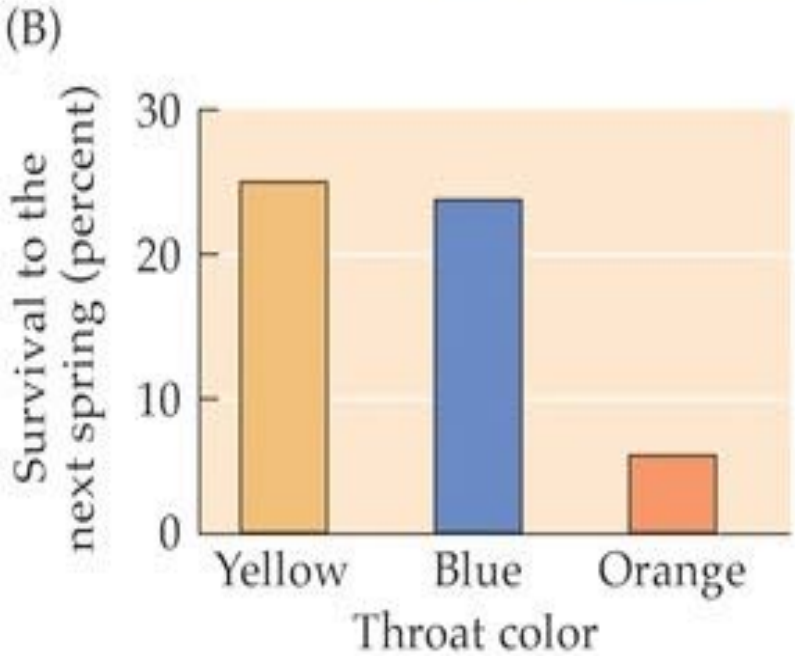


Costs of testosterone

- Survival cost
  - 3 morphs of lizard
    - The morph with the highest T also has the highest mortality!

Side-blotched lizard

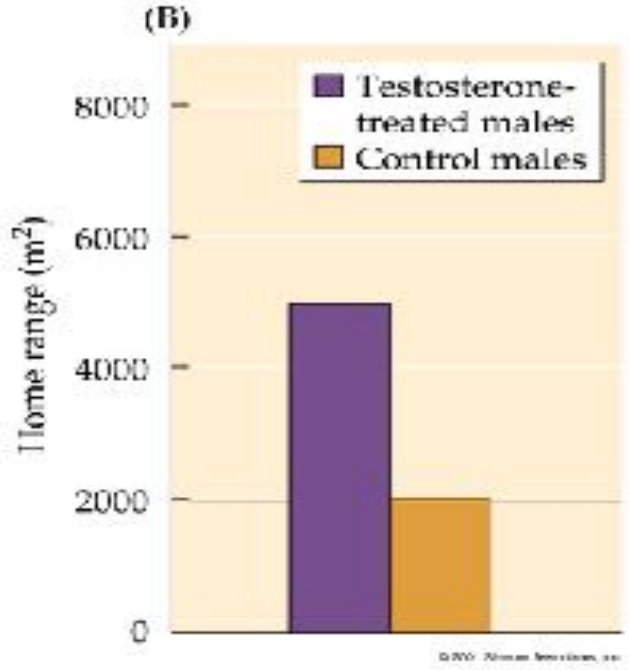


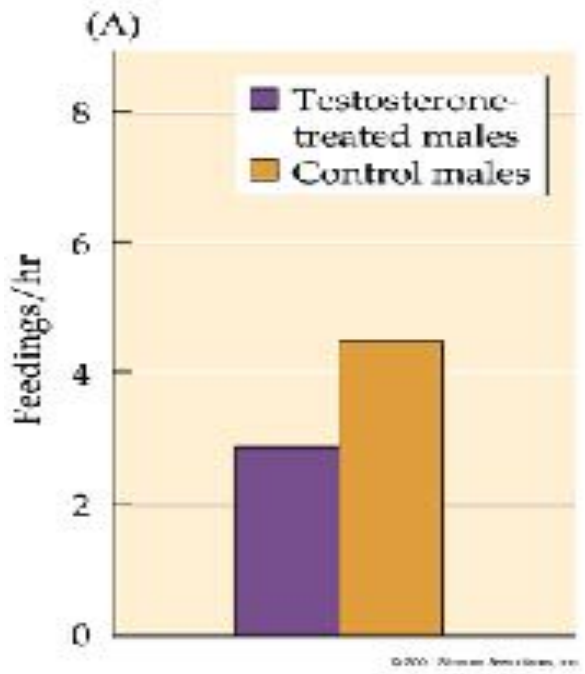


Costs of testosterone

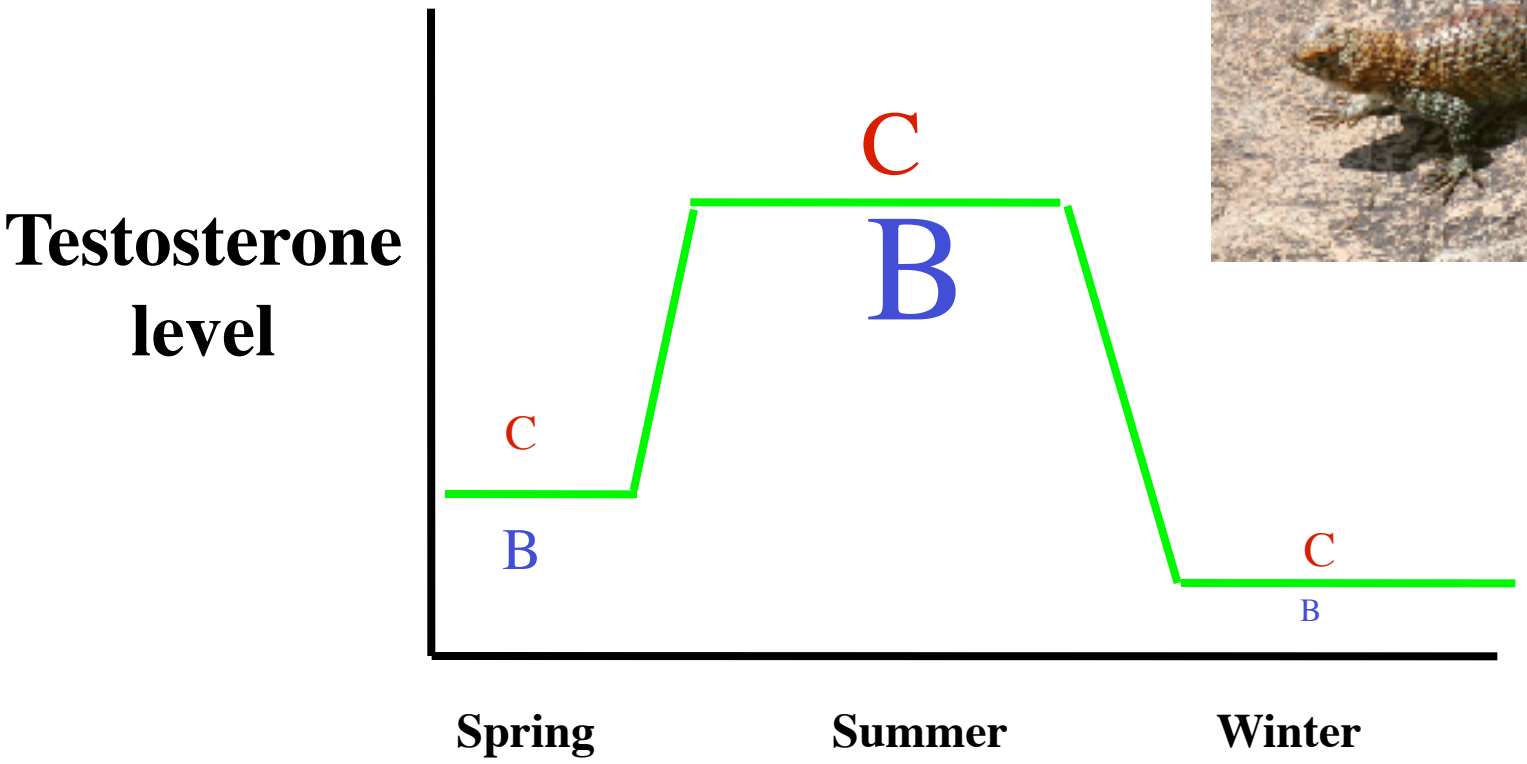
- Distractions caused by testosterone
  - Although males with T implants carve out larger home range
    - Spend less time gathering food for young

Dark-eyed Junco





Cost/benefits of seasonal T



Neural mechanisms

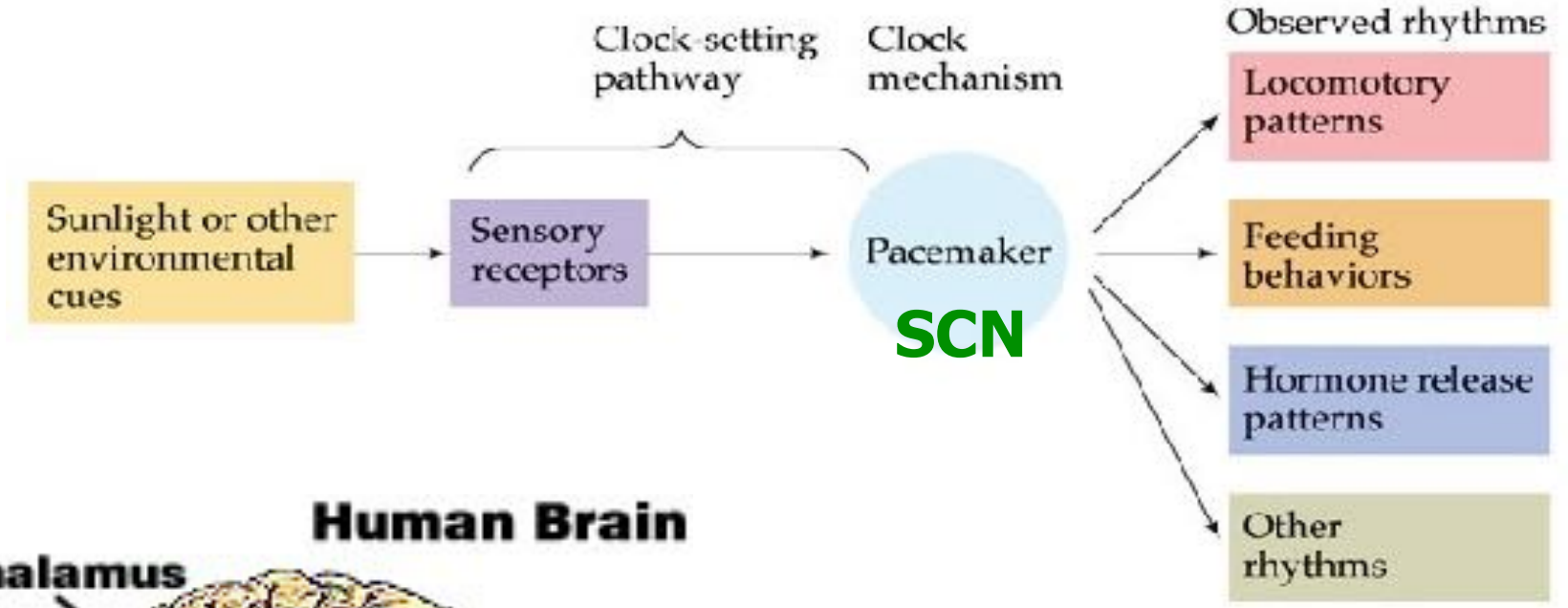
and

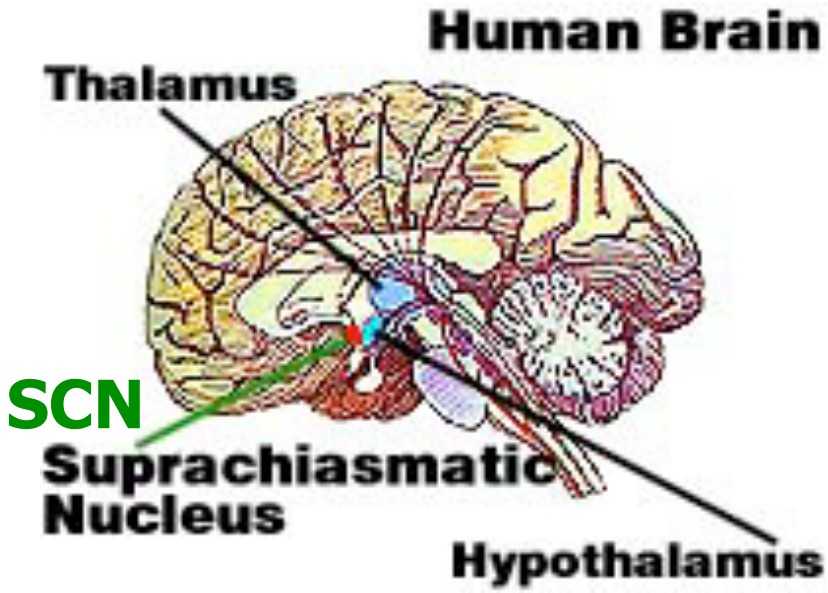
Hormonal mechanisms

Cycles and internal clocks

- How does the neural system organize cycles of behavior?
  - Environment can change over daily, seasonal, annual cycles
  - Many behaviors are matched to cycles
  - What mechanisms regulate changes in behavior over time
  - Biological clocks
    - Internal, cyclical rhythms that can persist (to some degree) in the absence of external stimuli. External stimuli will 'entrain' clock
  - Types of Rhythms
    - Circadian (24 hour solar cycle)
    - Circatidal (12-24 hour tide cycle)
    - Circannual (seasonal)
    - Circaluna (moon cycle, ~28 days)

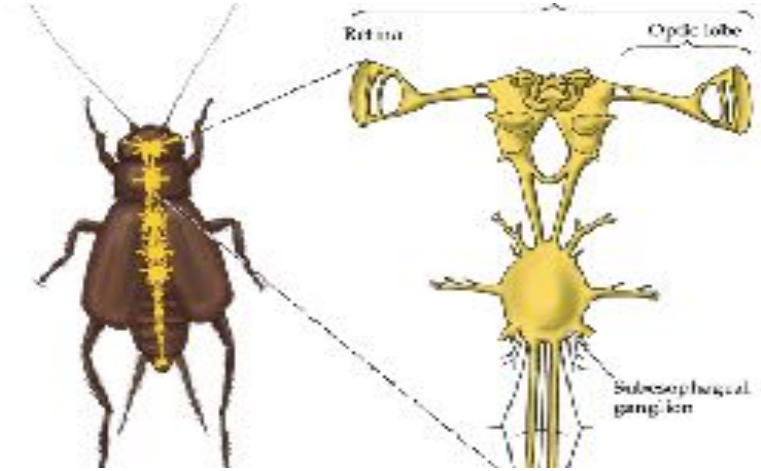
Pathways for setting the clock

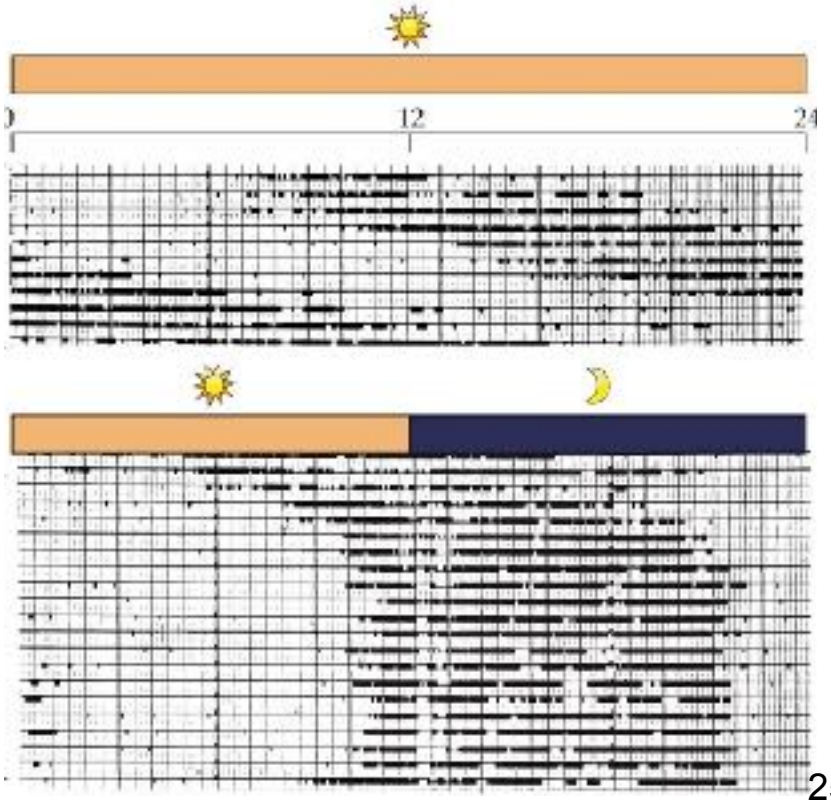


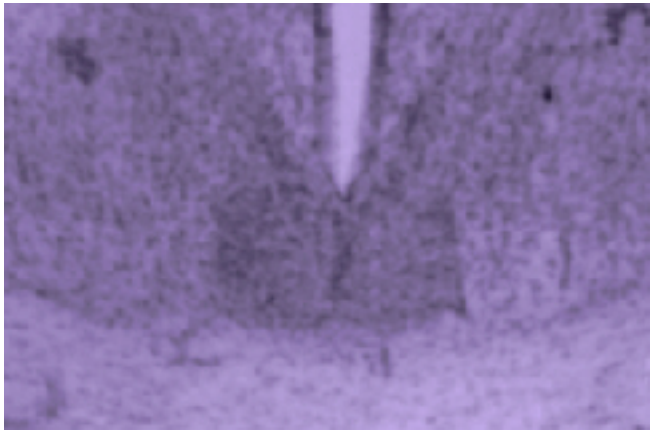


Circadian rhythms: The sun

- Male crickets call at same time every day
  - Is the rhythm completely independent from environ? **No**!
    - Under normal 12L:12D cycle, call at about same time
    - Under 24-hr light, call at 25-26 hrs
  - Internal clock entrained daily
    - How? Info from optic lobe
      - If optic nerve severed (even under 12L:12D), get free-running cycle







- How do command centers like SCN and hypothalamus communicate with other systems to organize behavior appropriately?

HORMONES

Setting the clock

- Photosensitivity in the white-crowned sparrow
  - Cyclical changes in light sensitivity
    - Summer photoperiod sets off cascade of hormonal changes that lead to reproductive behavior

  - Clock starts at first light, then insensitive for ~17 hrs, then bird takes reading of dark/light
    - If day length short, no testes growth (i.e., in winter)
    - If experimental day light matches sensitive phase, testes grow!