Origin and Creation of Life

Basics of Life Science
Thursdays 9-10:30
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What is Life?
Organic (life) compounds of carbon was first synthesized in urea.

\[
\text{NH}_3 + \text{HNCO} \rightarrow \left[ \text{NH}_2\text{NCO} \right] \rightarrow \text{NH}_2\text{CONH}_2
\]

cyanic acid \quad \text{ammonium cyanate} \quad \text{urea}

Miller and Urey made complex organic compounds by simulating early earth.

- Water heated vaporized into an “atmosphere.”
- Hydrogen gas (H₂), methane (CH₄), ammonia (NH₃), water exposed to “lightning” sparks.
- Condenser cools vapor into “rain,” flow to “sea.”
- Made formaldehyde, HCN, amino acids, hydrocarbons.
Review: Origin of Life.

• What was the first organic molecule to be synthesized in the laboratory?
  – A) ammonium cyanate
  – B) hydrogen cyanide
  – C) urea
  – D) acetic acid
  – E) methane

• Which of the following molecules were NOT found by Miller and Urey during their experiment simulating early earth?
  – A) 9 of 20 amino acids
  – B) formaldehyde
  – C) racemic (left and right handed) forms of amino acids
  – D) RNA and DNA
  – E) hydrogen cyanide

What is Life?
Asexual reproduction relies on mitosis only, produces more individuals.

Genetic recombination only occurs through meiosis, not mitosis.
Forms of asexual reproduction: fragmentation to regeneration.

- Budding – part of oneself grows into another.
- Fission – divide oneself into two.
- Parthenogenesis – unfertilized egg develops into adult, e.g. haploid honeybee drones.
- Advantageous when environment is stable, adaptation not necessary, mutations low.
- Asexual when environment is favorable, sexual when stressed, e.g. water flea.

Example of asexual reproduction: budding.
Parthenogenetic “sex”: estradiol -> female role; progesterone -> male.

Kinky stuff: variations in sexual behavior in animals.

- Hermaphroditites – both male and female reproductive organs, produce eggs and sperm, arise from limited availability of mates.
- Sexual reversals – largest female in a group becomes the next single male.
- External fertilization – eggs released into environment, where males can fertilize, season-dependent spawning in frogs.
- Monogamy is rare – male making females less receptive after mating.
Female flies: sperm in spermathecae until conditions are favorable.

Human males: sperm first made in seminiferous tubules, then cooled by scrotum.
Human males: 3 weeks sperm mature in epididymis, ejaculated vas deferens.

Human males: sperm from testes mixed with fluids from three glands.

- Seminal vesicles – produce alkaline mucus, fructose, coagulant, prostaglandins -> semen.
- Prostate gland – produce citrate, cancer risk.
- Bulbourethral glands – neutralize urine in the urethra, some sperm before ejaculation.
- Penis – blood flow seals off veins during erection, Viagra (nitric oxide enabled relaxation).
Human females: ovaries contain oocyte egg, joined to uterus by oviduct.

Human females: vagina opens to outside at vulva, protected by labia.
Human females: vestibular glands secrete mucus for lubrication.

- Endometrium – lining of uterus, blood filled, nourishes egg following ovulation (delivery of oocyte via fallopian tubes), opens at cervix.
- Clitoris – sensitive, aroused during sex.
- Hymen – thin tissue ruptured upon first intercourse.
- Mammary glands – produces milk in females.

Spermatogenesis: spermatocyte (2n) move from outer to inner tubules.
Spermatogenesis: spermatid (n) gains acrosome head for digestion, flagella.

The humble lives of human sperm.
Oogenesis: all eggs women have are present at birth in follicle form.

 Primordial germ cell 

 Mitotic divisions 

 $2n$ Oogonium 

 Mitotic divisions 

 $2n$ Primary oocyte (present at birth), arrested in prophase of meiosis I

IN EMBRYO

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Oogenesis: at puberty FSH stimulates growth of one follicle per month.

STARTING AT PUBERTY

Completion of meiosis I and onset of meiosis II

First polar body

Secondary oocyte, arrested at metaphase of meiosis II

Ovulation, sperm entry

Completion of meiosis II

Fertilized egg

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Oogenesis: unequal cell divisions generate polar bodies.

Hormonal regulation of sex, sexual characteristics, and reproduction.

- Gonadotropin-releasing hormone (GnRH) from hypothalamus directs anterior pituitary.
- Follicle-stimulating hormone (FSH) and luteinizing hormone (LH) from anterior pituitary stimulate sex hormone production.
- Androgens (testosterone) – voice, facial hair, muscles, aggressiveness, spermatogenesis.
- Estrogens (estradiol) – breasts, fat deposit.
Hormonal control of male sex system utilizes negative feedback.

Female ovarian cycle: low FSH and LH stim low estradiol -> neg feedback.
Female ovarian cycle: sharp rise of estradiol leads to stim of GnRH and LH.

Female ovarian cycle: follicle rupture and ovulation, LH -> corpus luteum.
Female ovarian cycle: progesterone and estradiol prevents another egg.

Female menstrual cycle: follicular proliferative, luteal secretory phases.

- Menstruation – flow, or shedding of endometrium from uterus.
- Endometriosis – ectopic growth of uterine tissue leads to bleeding into stomach area.
- Menopause – ovaries lose response to FSH LH.
- Other mammals have estrus cycles where uterus resorbs endometrium.
- Vasocongestion (blood fill) and myotonia (muscle tension) characterize sex response.
Review: Creating life.

Asexual reproduction results in greater reproductive success than does sexual reproduction when _______.

- A) pathogens are rapidly diversifying
- B) there is some potential for rapid overpopulation
- C) a species is expanding into diverse geographic settings
- D) a species is in stable and favorable environments

Which of the following is TRUE regarding hormonal control of the female ovarian cycle?

- A) Menstruation is triggered by negative feedback from testosterone.
- B) Anterior pituitary hormone release is negatively controlled by inhibin.
- C) Ovulation is triggered by positive feedback via LH and estradiol hormones.
- D) Progesterone levels are reduced during and after ovulation.

The miracle of birth in human beings.

Obstetric ultrasound on a 20-week human fetus.
Cleavage post conception produces blastocyst, implanted in endometrium.

First trimester: hCG, trophoblast of blastocyst + endometrium -> placenta.
First and second trimesters: organogenesis, progesterone, active.

Labor: prostaglandins and oxytocin participate in positive feedback.
Contraception: IUD and pill are most effective; for guys, abstinence.

- IUD: placed in uterus.
- The Pill: synthetic progestin - negative feedback to prevent GnRH and FSH, LH.
- Progestin: thicken cervical fluid, ovulation freq down.
- RU486: abortion pill, blocks progesterone receptors in uterus.

What is Life?