Evolution 6

- send answer to iClicker Question 3A now

Natural Selection, continued:

- antibiotic resistance
- lactase persistence
- sickle-cell anemia
- Sexual Selection

- iClicker Question 3B

Due in lab next week:

⇒ pre-lab for Skulls & Evolution (lab manual p. 13 and on-line)
(meet in W-2-030 or W-2-032)

⇒ HMNH lab report (Just answer questions 1 thru 5).

- iClicker registration is now working!
- Don't forget the on-line "Tree Building Survey" - see course website for Evolution 6. (Due by midnight monday).

Evolution examples

① antibiotic resistance in bacteria

eg. methicillin (antibiotic) resistant Staph aureus (s.a. - bacterium)

long ago

- most s.a. sensitive to methicillin → die
- very rare methicillin-resistant mutants (both equally fit) → live & reproduce

treat infections with methicillin

now

many s.a now resistant to methicillin (MRSA)

how fast?

~ 1960 methicillin first made

~ 1961 first MRSA cases

1975 2.4% of hospitals had seen MRSA

1991 29% "

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now 50,000 ~ 100,000 people die each year from MRSA

⑥ lactase persistence

* lactose = sugar found in milk
* animals that eat milk (mammals) need enzyme lactase to digest lactose
* if lactose not digested, intestinal bacteria digest it ⇒ produce gas
  ⇒ gas, diarrhea, etc.
* most mammals produce lactase only until weaning
  ∴ as adults they're lactose intolerant (LI)
* mutation in some humans that leads to lactase persistence (LP)
  ⇒ can digest lactose as adults

long ago

~5000 yrs ago - cattle domesticated

∴ milk consumption as adults ↑

now

		examples: sweeden	US
· most humans LI → sick, fewer kids	· fewer LI	19%	30%
· few LP mutants → healthier, more kids; ~ equally fit	· more LP	81%	70%

* From a few mutants → 81% in 5000 yrs!
* but in China, freq of LP is 0-10% - why?

A: little milk in diet ∴ LI relatively equally fit to LP
less selection for LP ⇒ lower LP frequency

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Evolution Examples (3): Sickle-cell anemia

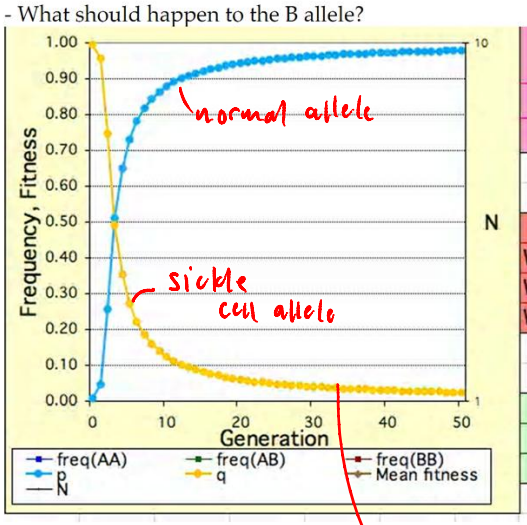
Trait controlled by one gene with two alleles:

allele	contribution to phenotype	frequency
A	normal blood (dominant)	p
B	sickle-cell anemia (recessive)	q

- BB individuals have sickle-cell anemia and greatly reduced fitness.

- What should happen to the B allele?

start majority sickle cell



Starting conditions	
p_0	0.005
q_0	0.995

Mutation	
$\mu_{A\to B}$	0.00E+00
$\mu_{B\to A}$	0.00E+00

Selection	
W_{AA}	1.000
W_{AB}	1.000
W_{BB}	0.100

sickle cell very unfit

Immigration	
M_{AA}	0
M_{AB}	0
M_{BB}	0

Plot Variables: freq(AA), freq(AB), freq(BB), p, q, Mean fitness, N

Drift		
	On	Off
N	20	

eliminated rapidly from population because of reduced fitness

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However, in areas with high incidence of Malaria (severe and often fatal parasitic infection of red blood cells), the frequency of B (q) is high (0.2) and constant (Campbell fig 23.17). In areas without Malaria, the sickle-cell allele is virtually unknown.

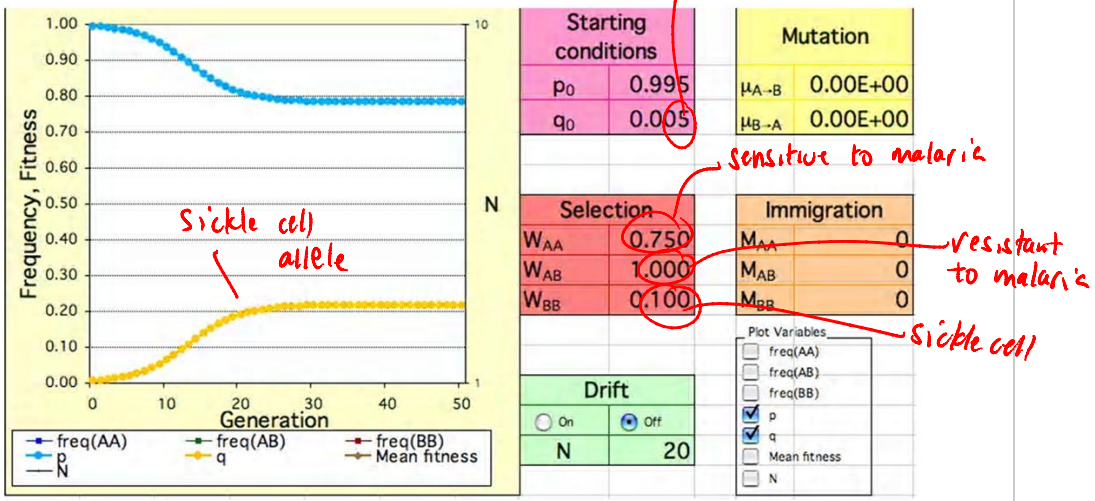
It turns out that the sickle-cell allele confers a dominant resistance to malaria:

allele	contribution to sickle-cell phenotype	contribution to malaria-resistance phenotype	frequency
A	normal (dominant)	none (recessive)	p
B	sickle-cell (recessive)	resistant (dominant)	q

therefore:

genotype	phenotype	fitness with malaria	fitness without malaria
AA	normal	low	high
AB	malaria-resistant	high	high
BB	sickle-cell (& malaria-resistant)	very low	very low

- Without malaria, the expected result is loss of the sickle-cell allele (previous page)
- With malaria, the advantage of being AB is balanced by the disadvantage of being BB.



Sickle cell very rare

sensitive to malaria

resistant to malaria

Sickle cell

Sickle cell (B) allele maintained in population even though BB very sick because AB most fit in presence of malaria

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Sexual Selection = a kind of natural selection
= natural selection based on mating success

* shows difference between "fitness" (strength) & evolutionary/reproductive fitness
reproductive success
- matters for evolution

Examples:

1) Advantages in competition with members of the same sex for mating with the opposite sex.

a) Peacock:

Males have ~170 eyespots on tail feathers

- remove 20 spots with scissors and females won't mate with them

♂'s with bigger tails
- less physically fit
more reproductively fit - more kids that look like them

b) Barn swallow:

Males have long tail feathers

- glue on longer tail feathers and females pick that male more often for mating

ditto

2) Sperm competition because females can mate with more than one male.
Garden spiders

Males lock their genitals onto the female's genitals, mate, and then die. The locked-on dead male prevents other males from mating.

♂ that lock on & die
"fitness" = 0 (dead)
fitness - higher (only they get to mate) & pass on their genes

Evolution 6 - 4

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from population genetics

moths

1848 mostly light → 1898 mostly dark

= micro evolution
Changes in one or a few genes

long ago → now cheetahs

changes in allele freqs of many genes

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slow cats

macro evolution

Species A → species B "anagenesis"

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