Bio 112 Handout for Themes 1

This handout contains:
• Today's iClicker Questions

iClicker Question #7A - <u>before</u> lecture

Which of the following statements is(are) **<u>true</u>**?

A. Animals can use CO_2 as a carbon source.
B. Both plants and animals carry out cellular respiration.
C. All cells obtain energy input directly in the form of light.
D. More than one.
E. None of the above.

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iClicker Question #7B - <u>after</u> lecture

Which of the following statements are true?

A. Both plants and animals require externally-supplied vitamins.
B. Animals can make some monomers from other monomers.
C. Essentially all of the carbon atoms in a plant came from the air.
D. none are true.
E. More than one is true.

<u>Beaming in your answers</u>

1. Figure out your answer and select the appropriate letter (A-E).
2. Turn on your iCliker by pressing the "ON/OFF" button; the blue "POWER" light should come on. If the red "LOW BATTERY" light comes on, you should replace your batteries soon.
3. Transmit your answer as follows:
    a. Press the button corresponding to the answer you've selected (A thru E).
    b. The "STATUS" light will flash green to indicate that your answer has been received. If the "STATUS" light flashed red, your answer was not received; you should re-send it until you get a green "STATUS" light.

Bio 112 Handout for Themes 2

This handout contains:

- Today's iClicker Questions
- Handouts for today's lecture
- Information for Exam I

iClicker Question #8A - before lecture

In the classic 1954 science fiction movie "Them", Los Angeles is terrorized by giant ants. These ants are roughly 1000-times larger than regular ants. Which of the following statements is correct?

A. The giant ants will weigh the same as regular ants.
B. The giant ants will weigh roughly 1,000-times more than regular ants.
C. The giant ants will weigh roughly 1,000,000-times more than regular ants.
D. The giant ants will weigh roughly 1,000,000,000-times more than regular ants.
E. None of the above.

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iClicker Question #8B - after lecture

Consider a solid sphere 2 feet in diameter. If this sphere were tripled in size to 6 foot diameter and made of the same materials, which of the following is correct:

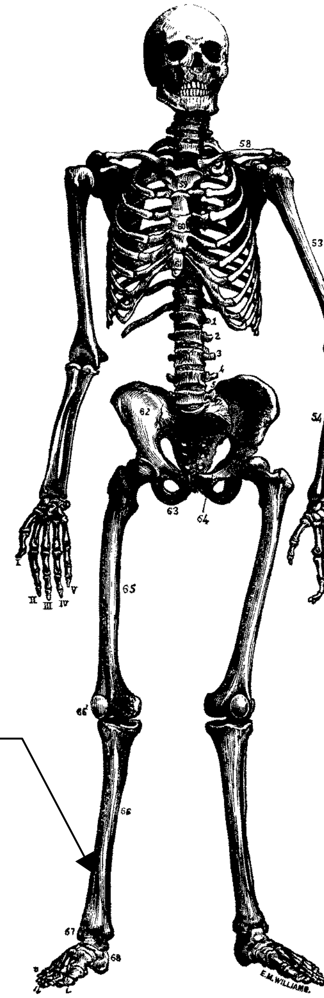
	change in surface area	change in weight
A)	increase 3x	increase 6x
B)	increase 9x	increase 27x
C)	increase 3x	increase 9x
D)	increase 100x	increase 1000x
E)	none of the above	

Beaming in your answers

1. Figure out your answer and select the appropriate letter (A-E).
2. Turn on your iCliker by pressing the "ON/OFF" button; the blue "POWER" light should come on. If the red "LOW BATTERY" light comes on, you should replace your batteries soon.
3. Transmit your answer as follows:
    a. Press the button corresponding to the answer you've selected (A thru E).
    b. The "STATUS" light will flash green to indicate that your answer has been received. If the "STATUS" light flashed red, your answer was not received; you should re-send it until you get a green "STATUS" light.

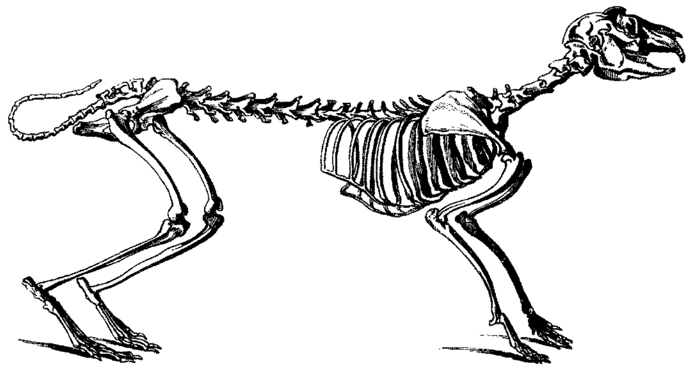
Bio 112 Size & Scale

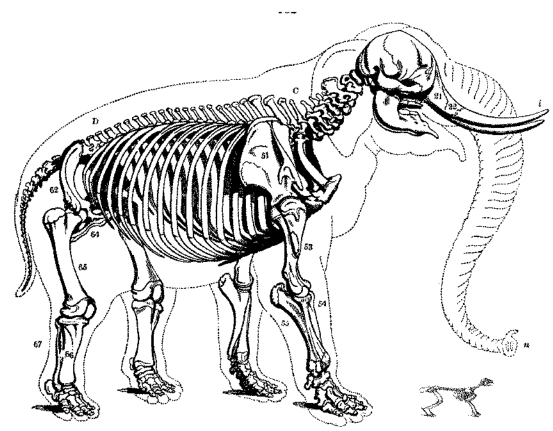
(1) Fictional Example



Tibia - the larger of the two bones in the lower leg.

(2) Real-Life examples
4-legged mammals:





Rabbit
Rabbit
enlarged to elephant size

Elephant
correct relative sizes

Notice that the elephant is not just a scaled-up rabbit; the leg bones are much thicker. Notice also that the elephant stands with knees locked & legs vertical while the rabbit's legs (which must support much less weight) can be bent at rest.

Bio 112: Information for Exam I

Basic Facts

- The exam will be held in locations TBA on the date listed on the syllabus from 12:00 to 12:50.
- The exam will cover reading, lab, and lecture from Evolution 1 through Themes 3 as described below.
- The exam will consist of approximately 4 questions. These will not be multiple choice; they will be problem-solving or short answer. The exam is likely to be similar to Exam I from Spring 2001 (see pages 6 - 12 of this handout) and Question 3 from Exam 2 from Spring 2008 (see the Animals 3 handout).
- It will likely consist of questions like:
    - Population Genetics. This will be like practice problem 1, 2, 3 or 4 (see Evolution 6 handout) or Question 4 from the Spring 2001 Exam I.
    - Evolution Scenario. A problem very much like Survey #1 (the cheetah problem), Questions 1a & 1b from the Spring 2001 Exam I, and/or Practice Prob. 5 (Evolution 6 handout).
    - A few short-answer questions about earth history, phylogeny, speciation, etc.
    - the themes I described in lecture and how to apply them to specific situations (you do not have to know all the details, just the general overview)
        - – cellular nutrition (animals, plants, bacteria from lecture)
        - – size & scale

– You need to know how to solve population genetics problems like those on the practice problems. The exam problems will likely be simpler than the hardest ones on the practice problems.

– You also need to know:
- the process of evolution
- the formation of species
- sexual selection
- "physical fitness" vs reproductive fitness
- the outline of the history of the earth that I presented in lecture
- the 5 Hardy-Weinberg assumptions and what they mean
- how to interpret phylogenies
- how to explain a graph of genotype or allele freqs as it changes over time

– You will need to be able to describe evolutionary scenarios like in Question 1a & 1b from Spring 2001 Exam I. These ask you to tell a story given certain constraints.

– You should be familiar with these terms:
- convergent evolution
- pre/post zygotic
- kingdom, phylum, etc.
- anagenesis/cladogenesis
- analgous/homologous structures

– You will need to know how to do problems like Question 3 from Exam 2 from Spring 2008 (see Animals 3) and how to apply issues of size and scale to particular scenarios.

– You **do not** need to know:
  - the specific allele or genotype frequencies of any genetic disease or trait
  - the names of the periods and eras
  - specific classification of any organism
- the cellular metabolism or scale of any particular organism

• You may bring in a single sheet of (8 1/2 x 11 inch) paper with any notes you want. You may write on either side. You should be sure that you completely understand the material on your note sheet; it cannot help you if you don't know what it means.

Tips

• The best way to learn population genetics is to work problems. You should work through all the practice problems. You should work through them and write out answers **before** looking at the answers.

• Tutoring is available (if you think you'll need tutoring you should start ASAP): go to CC-1-1200 to arrange tutoring.

• Almost all of the questions will ask you to explain your reasoning or justify your answer. In general, the majority of the points on any question will be for the explanation rather than the answer itself. As a result:

– Explain yourself carefully and thoroughly; this will increase your chances of part credit.

– Be careful not to write more than necessary; you will be penalized for extra added wrong answers.

– Be careful to make your choice of answer clear. If you write, "yes unless it is not" (for example) you will get no credit.

– Try to use the terms correctly and use standard notation; this will make it easier for the graders to read and therefore more likely to get part credit.

Bio 112 Exam #1

3/5/01

Your Name:______________________ TA's Name:___________________

Write your initials on every page in the space provided.
This exam has 7 pages including this coversheet.
Check that you have pages 1-7.

This exam has four questions.

Make your answers as clear and precise as possible.
Answer all questions in the space provided.

Question	Value	Score
1	20	______
2	21	______
3	28	______
4	31	______
TOTAL:	100	______

Themes 2 - 6

Question 1: Evolution I (20 points)

Elephants are large mammals with extremely long incisors called tusks. Ivory, a very valuable commodity is often made from these tusks. Elephants have been hunted almost to extinction primarily for their tusks – hunters never use any other parts of the elephant. Some elephants are born without tusks and their tusks never develop as adults. Over the past 100 or so years, the frequency of these 'tuskless' elephants has increased, presumably as a result of hunting.

a) Provide a plausible explanation for how the frequency of tuskless elephants could increase by a process of **natural selection**. (12 pts)

b) Provide a plausible explanation for how the frequency of tuskless elephants could increase by a process involving **small population size** that does not involve natural selection. (8 pts)

Question 2: Evolution & Population Genetics, short answer (21 points)

a) Consider a hypothetical human inherited disease that results in sterility - the complete inability to produce children. Suppose further that this disease is inherited in an autosomal dominant manner:

genotype	phenotype
DD	sterile
Dd	sterile
dd	fertile

i) Explain why you would expect the frequency of the D allele to decrease rapidly towards 0. (5 pts)

ii) Suppose that you measure the frequency of the D allele in the human population over many years and find that it remains roughly constant at a very low level. Provide a plausible explanation for this, given that the D allele results in complete sterility.
(6 pts)

b) For each of the following, circle True or False as appropriate. (5 pts each)

- if you circle "true", no explanation is required
- if you circle "false", explain why the answer is false.

i) The dominant allele is always the majority allele in a population. That is, the frequency of the dominant allele is always greater that the frequency of the recessive allele.

Explanation if **false**: True False

ii) Natural selection is the only mechanism for changing allele frequencies in nature.

Explanation if **false**: True False

Question 3: Earth History, Phylogeny, etc. (28 points)

a) Put the following 3 events in the proper order. Indicate your answer by writing the corresponding number of the event in the blanks provided. (6 pts)

#	Event
1	First bacteria
2	atmospheric oxygen levels reach 20%
3	First photosynthesis

first event #:_______ next event #:_ last event #:________

b) Put the following 3 events in the proper order. Indicate your answer by writing the corresponding number of the event in the blanks provided. (6 pts)

#	Event
1	First vertebrates in water
2	First mammals that lived exclusively in water
3	First reptiles that lived exclusively in water

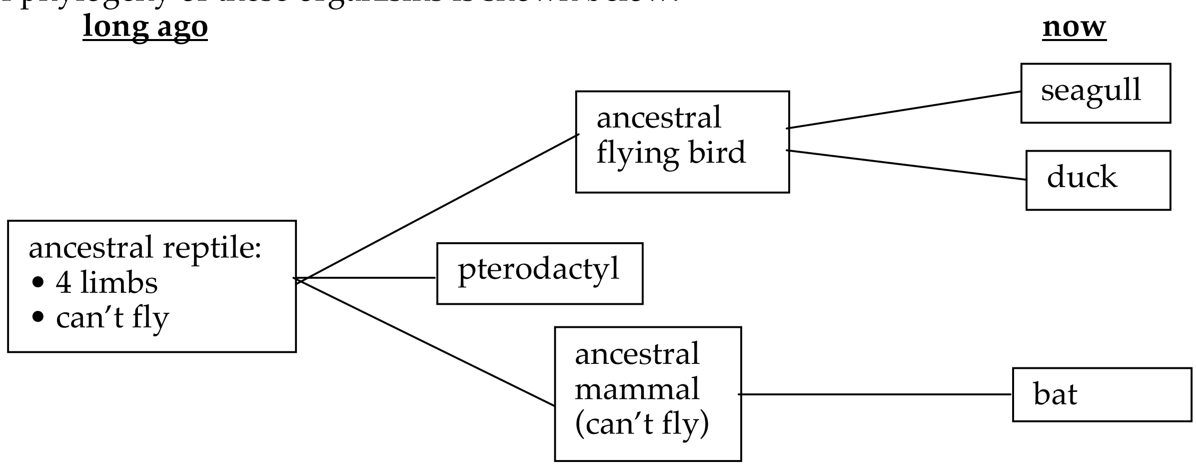
first event #:_______ next event #:_ last event #:________

Question 3, continued;

c) Consider the following four organisms:

- 2 flying birds: a seagull & a duck
- a flying mammal: a bat
- an extinct flying reptile: a pterodactyl

A phylogeny of these organisms is shown below:



Answer the following questions based on the above phylogeny. (4 pts each)

i) Seagulls evolved from pterodactyls. True False
Explanation if **false**:

ii) Bats evolved from ancient reptiles. True False
Explanation if **false**:

iii) Which of the following pairs of structures are homologous? Circle all that are.

- the wings of seagulls & ducks
- the wings of seagulls & bats
- the wings of bats & pterodactyls
- the wings of ducks & pterodactyls

iv) Which of the following pairs of structures are the result of convergent evolution? Circle all that are.

- the wings of seagulls & ducks
- the wings of seagulls & bats
- the wings of bats & pterodactyls
- the wings of ducks & pterodactyls

Question 4: Population Genetics (31 points)

Consider a population of organisms that have a gene with two alleles, B and b.

You count the individuals in the population and find:

Genotype	Number
BB	70
Bb	5
bb	25

a) What is the frequency of the B allele in the population's gene pool? Show your work. (6 pts)

b) What is the frequency of the b allele in the population's gene pool? Show your work. (4 pts)

c) Assuming that the 5 conditions for Hardy-Weinberg Equilibrium (HWE) hold for this population, what will be the frequencies of the 3 genotypes in the next generation? Show your work. (10 pts)

d) Is the population at the top of this page at Hardy-Weinberg Equilibrium? Yes no

Justify your answer. (5 pts)

Question 4, continued:

e) Using the same starting population,

Genotype	Number
BB	70
Bb	5
bb	25

answer the following question:

If half of the BB individuals are eaten by predators before they can reproduce, what will be the frequency of the **B allele** in the gene pool of the survivors? Show your work. (6 pts)

Solutions to Bio 112 Exam #1 Spring 2001 prepared by Juliette Houlne

Question 1: Evolution I

a.)There are four parts to a full-credit answer that explains the increase in frequency of tuskless elephants in the evolution of elephants.

- **Pre-existing variation.** The variation in traits already existed. In the starting population, most elephants had tusks, but some didn't.
- **Genetic variation.** Whether or not an elephant had tusks was determined genetically and passed down from generation to generation.
- **Some genotypes at an advantage.** An outside force, in this case hunters, acted against the tusked elephant phenotype. Only the tusked elephants were hunted, making it so that there were less tusked elephants to reproduce. There would be less of them to pass on the tusked allele. The tuskless allele would increase in frequency and the population would have more tuskless elephants.
- **Thus the frequency of of tuskless elephants increased over time.** There would be more and more tuskless elephants over time to reproduce, so their frequency would increase.

b.) **Your answer must have clearly stated that the population changed purely by chance, or the bottleneck effect.** For example, consider a starting population of tusked and tuskless elephants. A volcano eruption killed most of the population except for a small group of tuskless elephants that had wandered to the other side of the volcano. This non-representative group would be the new starting population. That is, this tuskless group of elephants is not representative of the starting population, but by chance they survived , becoming the new population. This is different than a non-random change, like elephants being hunted for their tusks (which is an example of being selection based on their genotype.)

Question 2: Evolution & Population Genetics, short answer

a.)

i.) **Any individual with a D allele (DD and Dd) would not be able to reproduce.** Therefore, the D allele wouldn't be able to be passed on and would quickly disappear from the population.

ii.) **Mutation in a d allele, changing it to a D allele, is a possible way for the D allele to continue.** Consider the possibilities. We know that any one with the D allele is sterile, therefore they can not pass on the D allele in offspring because there won't be any. So how could the D allele keep showing up? One way is mutation in the allele. This happens often in real life. Mutation is always occurring, and it can create new alleles and change existing ones.

b.)

i.) **False.** There are many alleles that are dominant but very rare- including the D for dwarfism. As described in lecture, the D for dwarfism is dominant but most people are dd.

ii.) **False.** There are four other ways for allele frequencies to change, including small population size, migration, non-random mating, and mutation.

<u>Question 3: Earth History, Phylogeny, etc.</u>

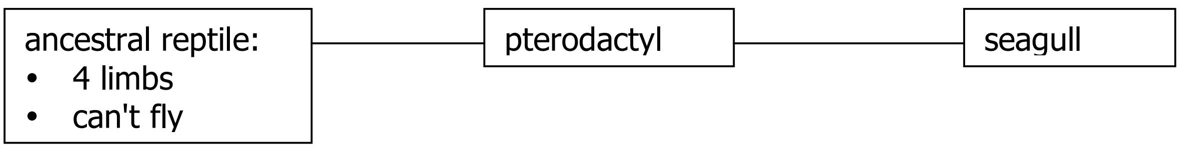
a.) **The order is 1,3,2.** The bacteria existed first, they were the first living creatures that did photosynthesis. Plants were next, because they evolved from bacteria. Then the atmospheric oxygen levels reached 20%, which allowed for the evolution of animals. Remember that the plants had to exist first because without photosynthesis there would not be enough oxygen in the atmosphere for animals to live.

b.) **The order again is 1,3,2.** The vertebrates in water existed first, followed by the first marine reptiles, and then came the marine mammals. The animals that first lived in water could get their oxygen from the water, it took many more mutations for animals to develop lungs, to get their oxygen from the air.

c.)

i.) **False.** If you look at the phylogenetic tree, you can see that the seagulls and pterodactyls evolved separately from the ancestral reptile; furthermore, the pterodactyl is a "dead end" – no living animals evolved from it. If seagulls evolved from pterodactyls, the tree would look like this:

<u>long ago</u> **<u>now</u>**

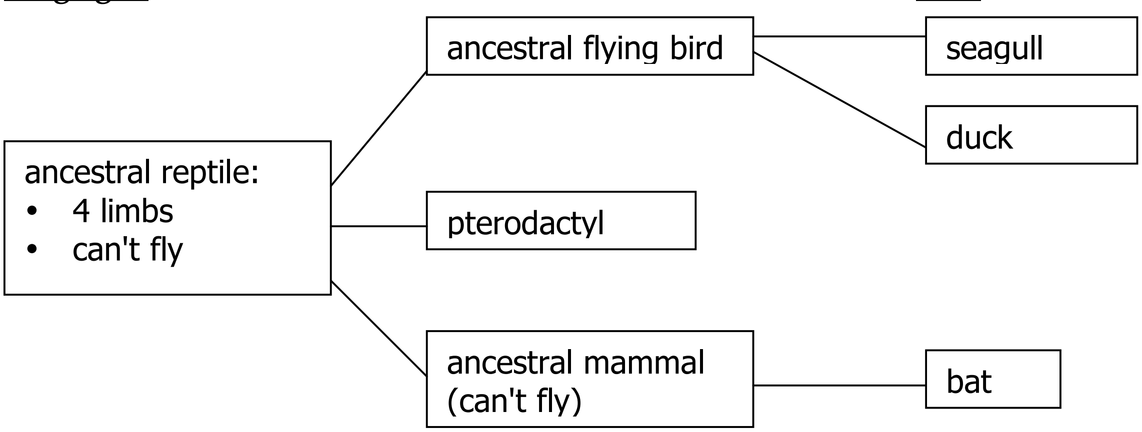


ii.) **True.** Bats did evolve from ancient reptiles, as shown in the tree.

iii.) **The wings of seagulls and ducks are homologous** – homologous structures (in this case wings) look alike due to <u>shared</u> ancestry. Both animals evolved from one common ancestor. See tree below:

iv.) **All except the wings of seagulls and ducks** are the result of convergent evolution. All of these are analogous – <u>not</u> due to shared ancestry. All of these animals developed wings separately from one another. See tree below:

<u>long ago</u> **<u>now</u>**



Question 4: Population Genetics

a.) In order to find the frequency of the B allele in this populations gene pool, first you must make a table.

Genotype	#	B	b
BB	70	140	0
Bb	5	5	5
Bb	25	0	50
Total alleles:		145	55

The frequency of the B allele is the total # of the B alleles divided by the total # of alleles.

Frequency of B = p = 145/200 = 0.725

b.) Likewise for the frequency of the b allele:

Frequency of b = q = 55/200 = 0.275

c.) Now use the equation $p^2 + 2pq + q^2$, just plug in the allele frequencies. $p^2 + 2pq + q^2$ <u>always</u> = 1. And only at HWE does BB = p^2 , etc. Remember, just because p + q = 1 does not mean it is at HWE; that is just to check your math. We use this equation because it is said that all five conditions hold for HWE, otherwise we can't do it.

Expected Freq. Of BB at HWE = p^2 = (0.725)(0.725) = 0.52

Expected Freq. Of Bb at HWE = 2pq = 2(0.725)(0.275) = 0.40

Expected Freq. Of bb at HWE = q^2 = (0.275)(0.275) = 0.08

d.) Now go back to the original population to calculate the genotype frequencies. The genotype frequencies are the # of individuals with that genotype divided by the total # of individuals in the population.

Freq. Of BB = <u>70/100</u> = 0.7

Freq. Of Bb = 5/100 = 0.05

Freq. Of bb = 25/100 = 0.25

Compare the observed genotype frequencies with those calculated
In part C - they do not match. Therefore the population is not at HWE.

e.) Create a new table using the same starting population, with the difference in the BB individuals.

Genotype	#	B	b
BB	*35*	*70*	0
Bb	5	5	5
Bb	25	0	50
Total:		75	55

Therefore, the frequency of B is:
75/130 = 0.58

Bio 112 Handout for Themes 3

This handout contains:
• Today's iClicker Questions
• an interesting article

iClicker Question #9A - <u>before</u> lecture

In the classic 1954 science fiction movie "Them", Los Angeles is terrorized by giant ants. These ants are roughly 1000-times larger than regular ants. Which of the following statements is correct?

A. The giant ants will have the same "skin" surface area as regular ants.
B. The giant ants will have roughly 1,000-times more "skin" surface area than regular ants.
C. The giant ants will have roughly 1,000,000-times more "skin" surface area than regular ants.
D. The giant ants will have roughly 1,000,000,000-times more "skin" surface area than regular ants.
E. None of the above.

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iClicker Question #9B - <u>after</u> lecture

As they develop, the birds growing in all bird eggs "breathe" through the shell; O_2 diffuses in and CO_2 diffuses out through many tiny holes in the surface of the shell.

An ostrich egg is roughly 10 inches in diameter; a chicken egg is roughly 2 inches in diameter. Based on this, assuming that the holes are the same size in all eggs:

A. You would expect more holes per square inch on the surface of an ostrich egg than on the surface of a chicken egg.
B. You would expect more holes per square inch on the surface of a chicken egg than on the surface of an ostrich egg.
C. You would expect the same number of holes per square inch on the surface of both eggs.
D. I don't know.

<u>Beaming in your answers</u>

1. Figure out your answer and select the appropriate letter (A-E).
2. Turn on your iCliker by pressing the "ON/OFF" button; the blue "POWER" light should come on. If the red "LOW BATTERY" light comes on, you should replace your batteries soon.
3. Transmit your answer as follows:
    a. Press the button corresponding to the answer you've selected (A thru E).
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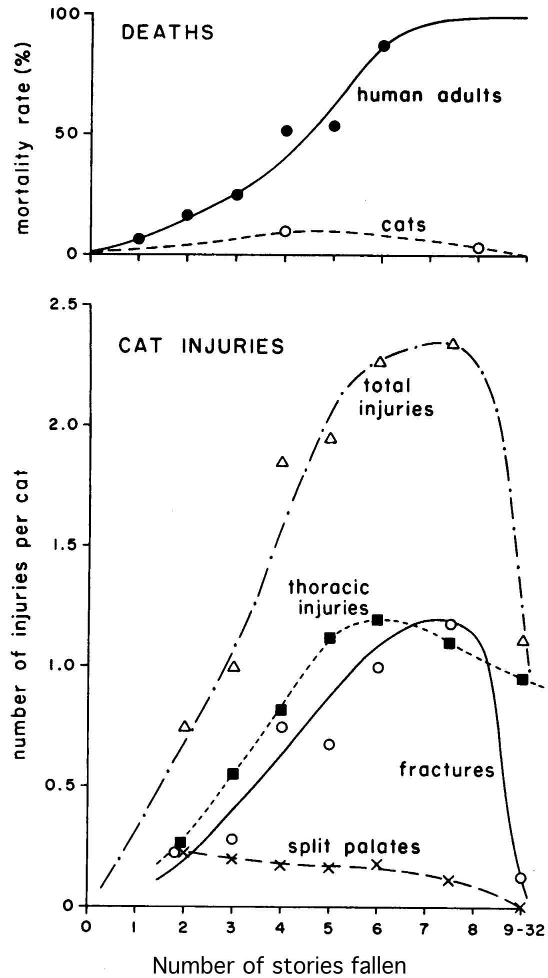
Bio 112:
Why cats have nine lives

Jared M. Diamond
[From *Nature* vol 332, pp. 586-587; April 14, 1988]

The famous adage that cats have nine lives stems in part from their ability to survive falls lethal to most people. This phenomenon has not received the scientific attention that it deserves. Filling this lacuna, a new study by W. O. Whitney and C.J. Mehlhoff (*J. Am. Vet. Med. Assoc.* 191, 1399-1403; 1987) applies principles of anatomy, physics and evolutionary biology to falling cats.

The authors were veterinarians at an animal hospital in New York City, where skyscrapers, open windows and paved ground combined to generate a database of 132 cats injured by falls of 2 or more stories, with a maximum of 32 stories and a mean of 5.5 + 0.3 (s.e.m.) (1 storey = 15 feet). Most victims landed on concrete after a free-fall. Omitting 17 cats that were euthanized by owners unable to afford treatment, 90 per cent of the cats (104 of 115) survived, whereas 11 died (mainly because of thoracic injuries and shock). The most remarkable feature of the results (see figure) is that incidence both of injuries and of mortality peaked for falls of around seven stories and decreased for falls from greater heights. For instance, the cat that free-fell 32 stories onto concrete was released after 2 days of observation in the hospital, having suffered nothing worse than a chipped tooth and mild pneumothorax.



Mortality rates for falling adult humans and cats (above), and number of total injuries and various types of injury per falling cat (below), as a function of number of stories fallen. (Based on the work by Waring and Demling and by Whitney and Mehlhoff.)

Falling adult humans differ from falling cats in their much higher mortality rate, monotonic mortality/height relation, different causes of death, and different sublethal injuries (Warner, K.G. & Demling, R.H. *Ann. emerg. Med.* 15, 1088-1093; 1986). As illustrated in the figure, higher falls are increasingly lethal for humans, and few adults survive falls of more than six stories onto concrete. The principal causes of death are head injuries and hemorrhage from visceral injuries. Although forelimb fractures are slightly commoner than hindlimb fractures in falling cats, falling adult humans most often break their legs, and falling children their arms (Smith, M.D. et al. *J. Trauma* 15, 987-991; 1975).

Straightforward theory relates injuries from falls to three sets of variables, as shown by Warner and Demling. First, the height of the fall determines the impact velocity. Second, the softness of the surface of impact affects the stopping distance and hence the impact force. Those people surviving falls from airplanes have landed on mud or snow, not concrete. And third, at least five properties of the falling body itself are relevant: its mass, which determines impact force (F) and energy; its cross-sectional area A, determining frictional drag during fall and also stress on impact (F/A); cross-sectional areas of bone, determining bone strength; cushioning of vital parts by fat and other soft tissue; and dissipation of impact forces through flexing of muscles and use of joints.

These theoretical considerations provide several reasons why cats survive falls that kill adult humans. First, because mass increases as the cube but surface area as the square of linear dimensions, falling large animals are in general more injury-prone than small ones, as they suffer greater impact stress, their bones experience greater stress, and they reach higher terminal velocities in free-fall because of a less favorable area/mass ratio. Even a small drop breaks an elephant's leg, but falling mice reach terminal velocity in the atmosphere much sooner and at a much lower value than do falling elephants.

Second, falling cats have a superb vestibular system and make gyroscopic turns such that all four feet are soon pointing downwards, regardless of the cat's orientation at the start of the fall. Hence cats dissipate the impact force over all four limbs. Falling human adults tend to tumble uncontrollably but land most often on two feet, next most often on their heads. Falling babies, because their relatively large heads shift their center of gravity towards the head, tend to land head-first with arms reflexively extended to break the fall. These facts contribute not only to the lower mortality of falling cats but also to the tendencies of falling babies adults and cats to broken arms, broken legs and breaks distributed over all four limbs, respectively.

Third, a cat falling in the atmosphere reaches a terminal velocity of about 60 m.p.h. (compared with 120 m.p.h. for adult humans) after only about 100 feet. As long as it experiences acceleration, the cat probably extends its limbs reflexively, but on reaching terminal velocity it may relax and extend the limbs more horizontally in flying-squirrel fashion, thus not only reducing the velocity of fall but also absorbing the impact over a greater area of its body. This may explain the paradoxical decrease of mortality and injury in cats that fall more than 100 feet.

Finally, cats that land with their limbs flexed dissipate much of the impact force through soft tissue. Parachutists are trained to dissipate impact forces by landing with knees and hips flexed, then rolling.

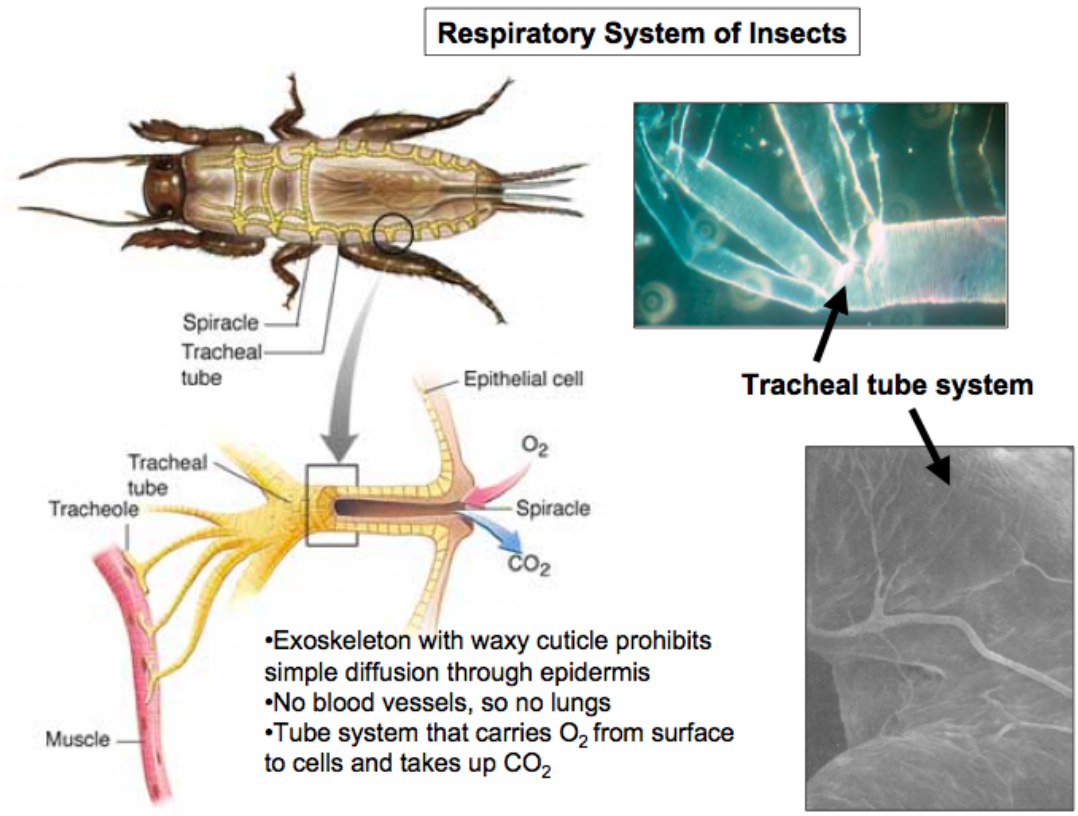
Evidently, falling cats have some advantages shared with any small animal of similar mass and shape but also have unique advantages of their own, notably their gyroscopic righting reflex and their limb flexing on landing. Small dogs that fall from buildings are prone to more serious injuries than cats. The cat-specific advantages have undoubtedly evolved through natural selection: most felid but few canid species are arboreal, so that millions of years of springing or falling from trees have favored those felids with the best vestibular systems. Thus, the nine lives of cats are a product of their evolutionary history.

Jared M. Diamond is Professor of Physiology at the University of California Medical School Los Angeles, California 90024, USA.

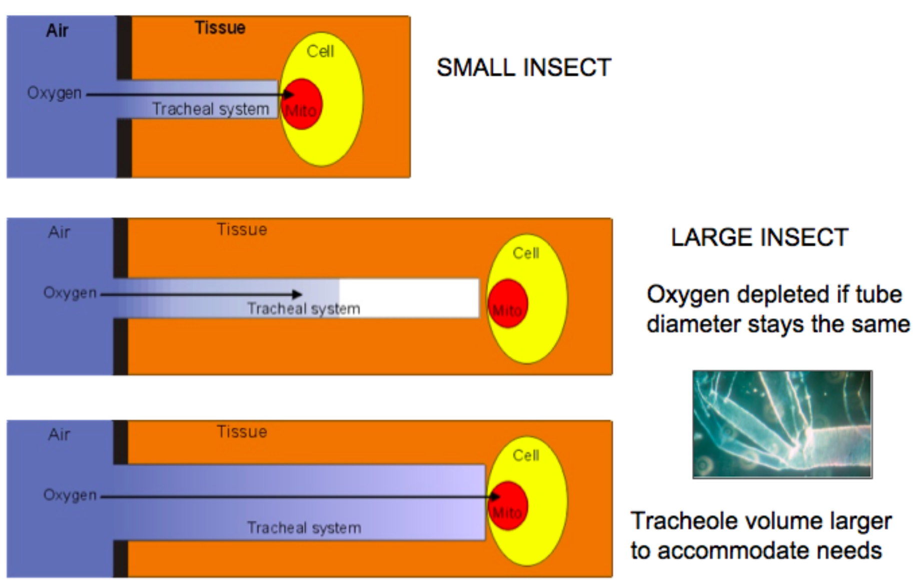
Size and Scale and Giant Insects

In the 1950's there were many science fiction horror movies about giant insects produced by nuclear radiation. For a variety of reasons, giant insects are impossible.

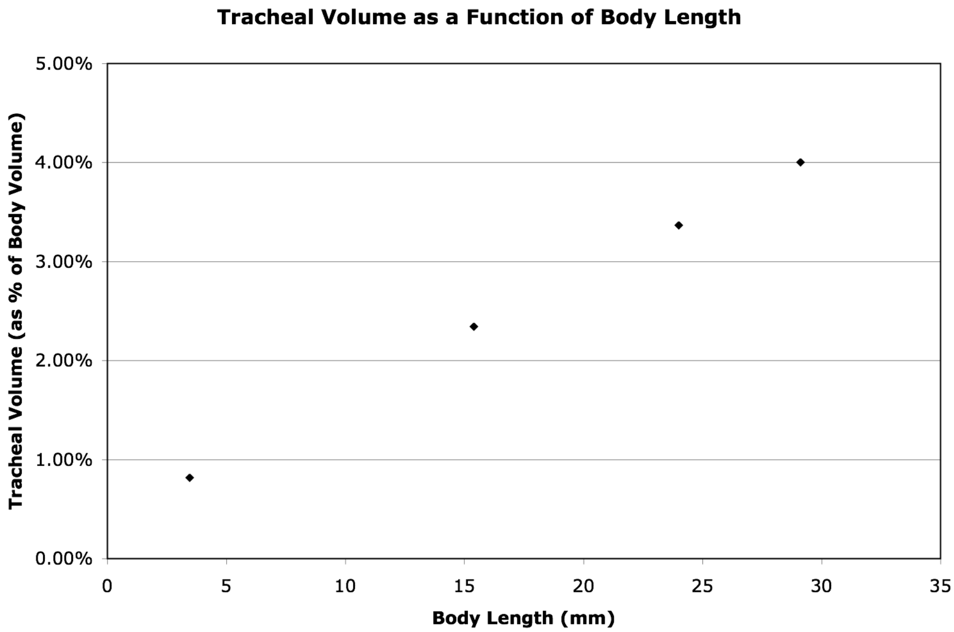
One important factor that likely limits insect size is respiratory capacity. As we will discuss in detail during the animal diversity lectures, insects breathe through pores in their skin using a system of tracheoles. This is shown below:



Larger insects require longer tracheal tubes to reach into their insides. In order to function properly, longer tracheal tubes must also be larger in diameter. This is illustrated below:



In a recent paper (*Increase in tracheal investment with beetle size supports hypothesis of oxygen limitation on insect gigantism.* Proceedings of the National Academy of Sciences 104(32): 13,198 – 13,203; this paper is available free online; you don't have to read it, but you can if you want), Alex Kaiser *et al.* collected looked at four related beetle species of very different size and measured the percent of their body volume that was taken up by their tracheal system. Their data are shown below:



1) Would you expect the % of body volume devoted to the tracheal system to increase, decrease, or stay the same if larger beetles were simply scaled-up smaller ones?

2) Why does the % of body volume devoted to the tracheal system increase in the larger beetles?

3) Using these data, roughly how big could a beetle be?

Note: it is important to keep in mind the dangers of extrapolation. As Mark Twain wrote, in *Life on the Mississippi* (1883; Ch 17), "In the space of one hundred and seventy-six years the Lower Mississippi has shortened itself two hundred and forty-two miles. That is an average of a trifle over one mile and a third per year. Therefore, any calm person, who is not blind or idiotic, can see that in the Old Oolitic Silurian Period,' just a million years ago next November, the Lower Mississippi River was upwards of one million three hundred thousand miles long, and stuck out over the Gulf of Mexico like a fishing-rod. And by the same token any person can see that seven hundred and forty-two years from now the Lower Mississippi will be only a mile and three-quarters long, and Cairo and New Orleans will have joined their streets together, and be plodding comfortably along under a single mayor and a mutual board of aldermen. There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact."

Themes 3 - 6

Bio 112 Handout for Themes 4

This handout contains:
• Today's iClicker Questions
• Figures for today's lecture

iClicker Question #10A - before lecture

Which of the following is(are) true?

A. All organisms reproduce using eggs and sperm.
B. All diploid organisms reproduce using eggs and sperm.
C. Some eukaryotic organisms can live as haploids.
D. All of the above.
E. None of the above.

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iClicker Question #10B - after lecture

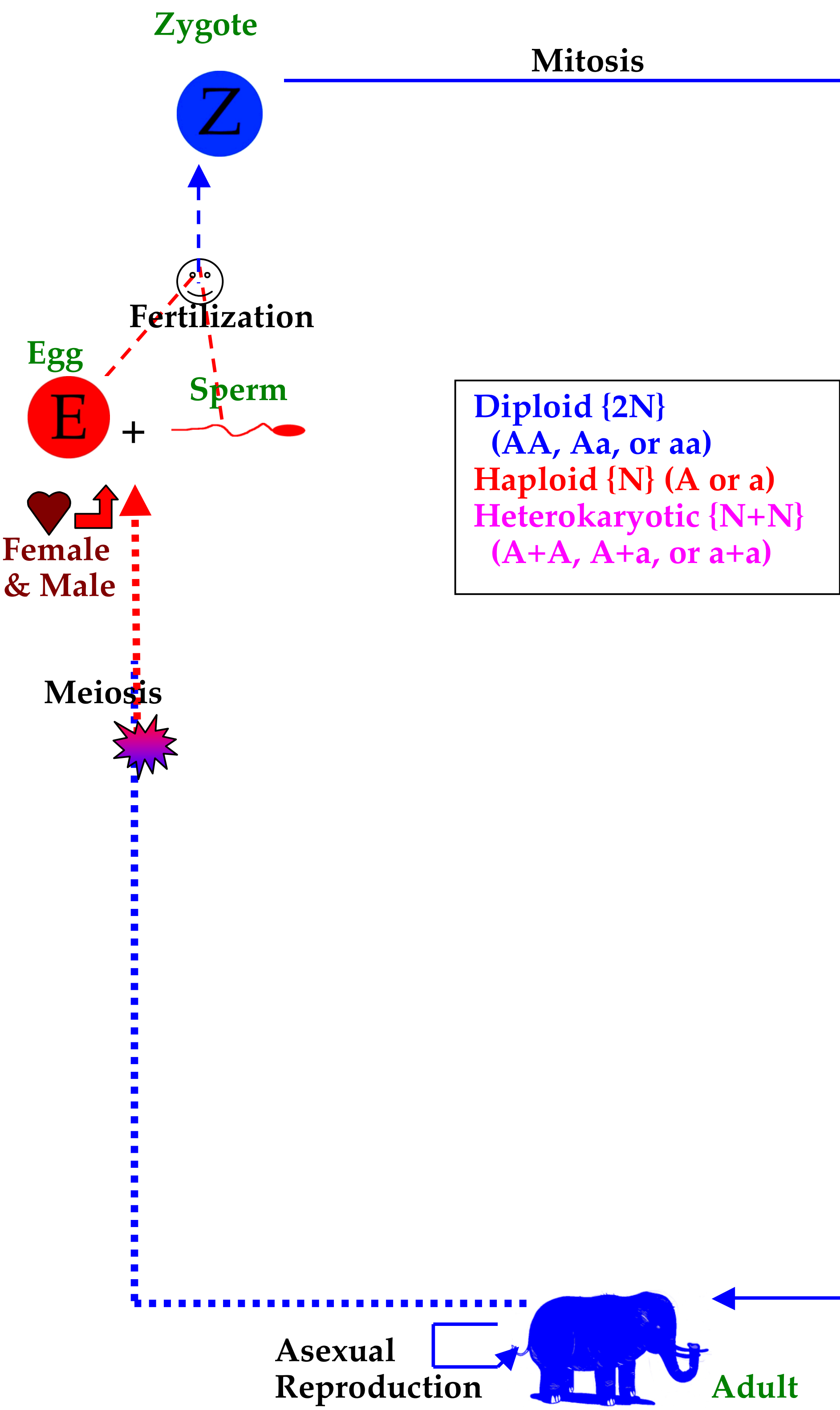
Which of the following is(are) true about sexual reproduction in eukaryotes?

A. it always involves eggs and sperm.
B. it always involves meiosis.
C. it always involves formation of a heterokaryon.
D. All of the above.
E. None of the above.

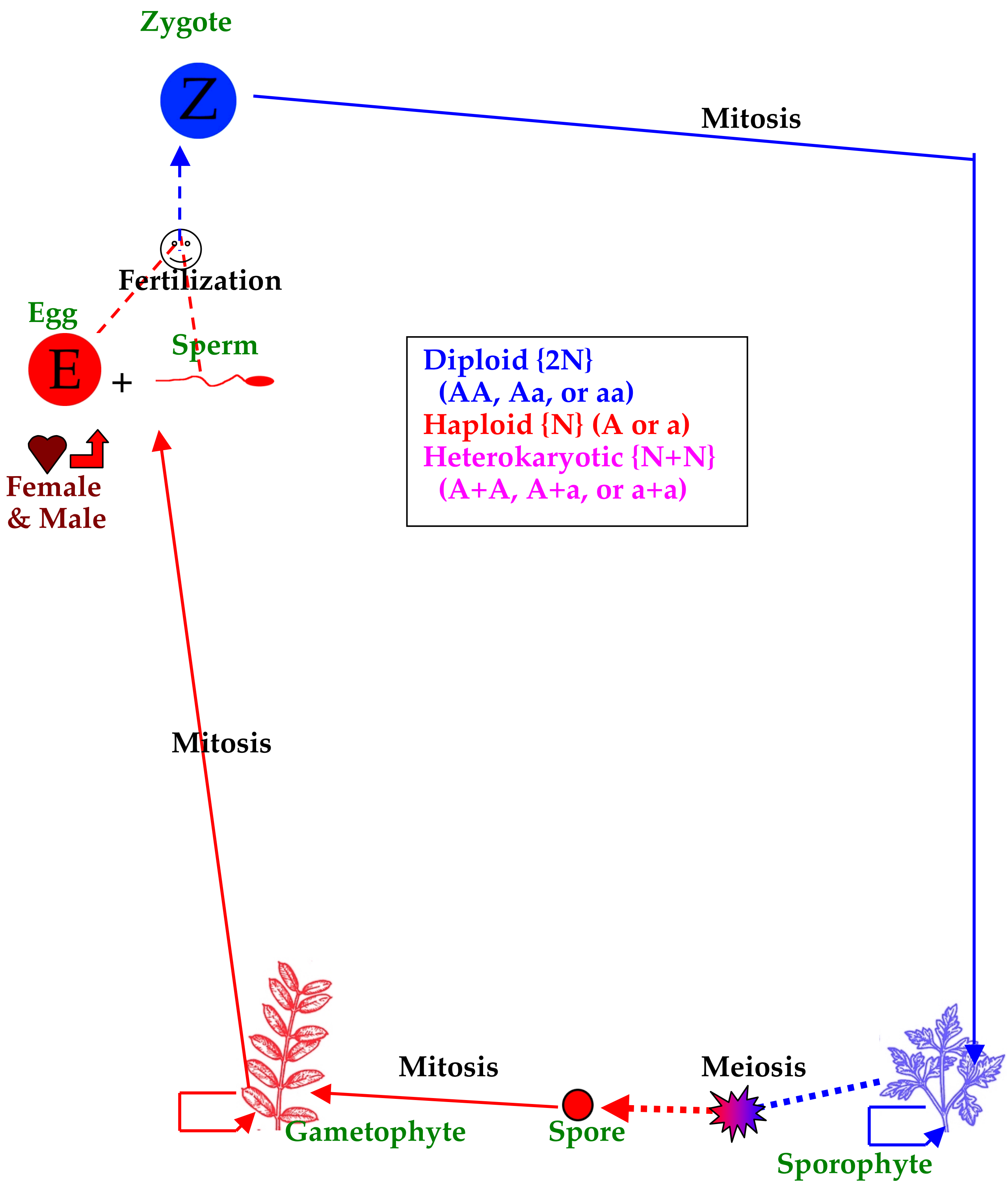
Beaming in your answers

1. Figure out your answer and select the appropriate letter (A-E).
2. Turn on your iCliker by pressing the "ON/OFF" button; the blue "POWER" light should come on. If the red "LOW BATTERY" light comes on, you should replace your batteries soon.
3. Transmit your answer as follows:
   a. Press the button corresponding to the answer you've selected (A thru E).
   b. The "STATUS" light will flash green to indicate that your answer has been received. If the "STATUS" light flashed red, your answer was not received; you should re-send it until you get a green "STATUS" light.

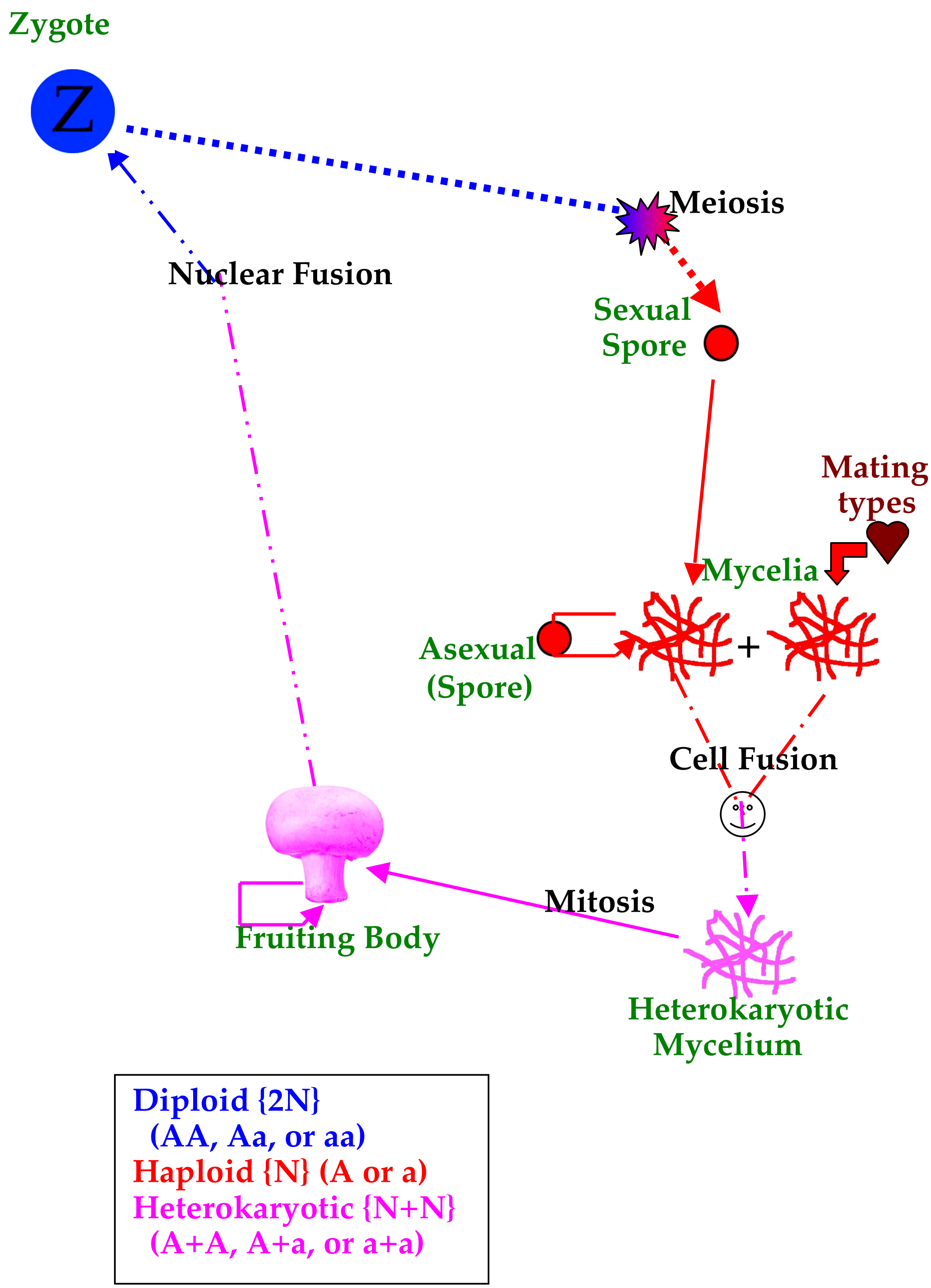
Animal Life Cycle



Plant Life Cycle



Fungal Life Cycle



Life Cycles Combined