$$(p+q)^2 = \underset{AA}{p^2} + \underset{Aa}{2pq} + \underset{aa}{q^2} = 1.0$$

Allele and genotype frequencies

Allele & genotype frequencies

- Can we predict *genotype* frequencies from *allele* frequencies? (If "sometimes", when?)

- Do genotype frequencies intrinsically change over time, or do they remain constant?

- **We'll answer these by considering variation at one gene at a time...**

“A” gene hypothetical scenario

- Two alleles: “A” and “a”
- Three possible genotypes: “AA” “Aa” “aa”

- Each has a “frequency”, totaling 100%
  - e.g., 78% of *alleles* are “A”, **so**
    22% of *alleles* are “a”

  - 25% of *individuals* “AA”, 50% of *individuals* are “Aa”, **so**
    25% of *individuals* are “aa”

Calculating genotype frequencies

- Every individual is diploid (2N)
- Can get by counting:
  - Total number: 10
  - Frequency AA = 1 / 10 = 0.1
  - Frequency Aa = 6 / 10 = 0.6
  - Frequency aa = 3/ 10 = 0.3
  - **TOTAL ALWAYS ADDS UP TO 1**

Aa aa aa
aa AA
Aa
Aa Aa Aa

Calculating allele frequencies

- Every individual is diploid (2N)
- Can count “A”s and “a”s

Aa aa aa
aa AA
Aa
Aa
Aa Aa
Aa

Calculating allele frequencies

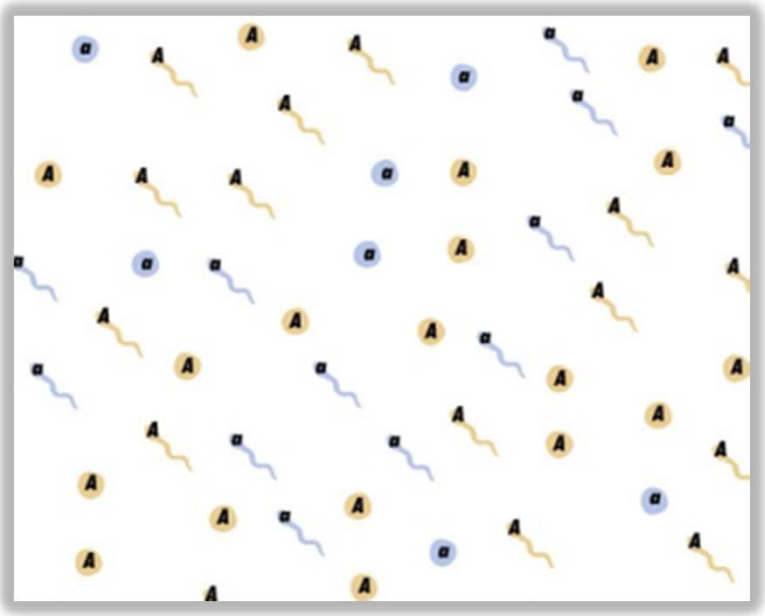
- Every individual is diploid (2N)
- Can count “A”s and “a”s
  - freq(A) = 8/20 = 0.4
  - freq(a) = 12/20 = 0.6

Aa aa aa
aa AA
Aa
Aa Aa Aa
Aa

- Better way:
  - **freq(A) = freq_AA + ½ freq_Aa = 0.1 + ½ 0.6 = 0.4**
  - **freq(a) = freq_aa + ½ freq_Aa = 0.3 + ½ 0.6 = 0.6**

Pool of gametes…

- All individuals of sexual species **start** as 2 gametes
  - Gametes are **1N**
  - Many marine invertebrates "spew" gametes that make individuals



60% of these are "A"; 40% of these are "a"

Use "joint probability" multiplication to determine genotype frequencies in offspring

- 60% of sperm "A"; 60% of eggs "A"
  40% of sperm "a"; 40% of eggs "a"

- Probability of "AA" individual:
  - "A" sperm fertilizes "A" egg
  - 0.6 x 0.6 = 36%

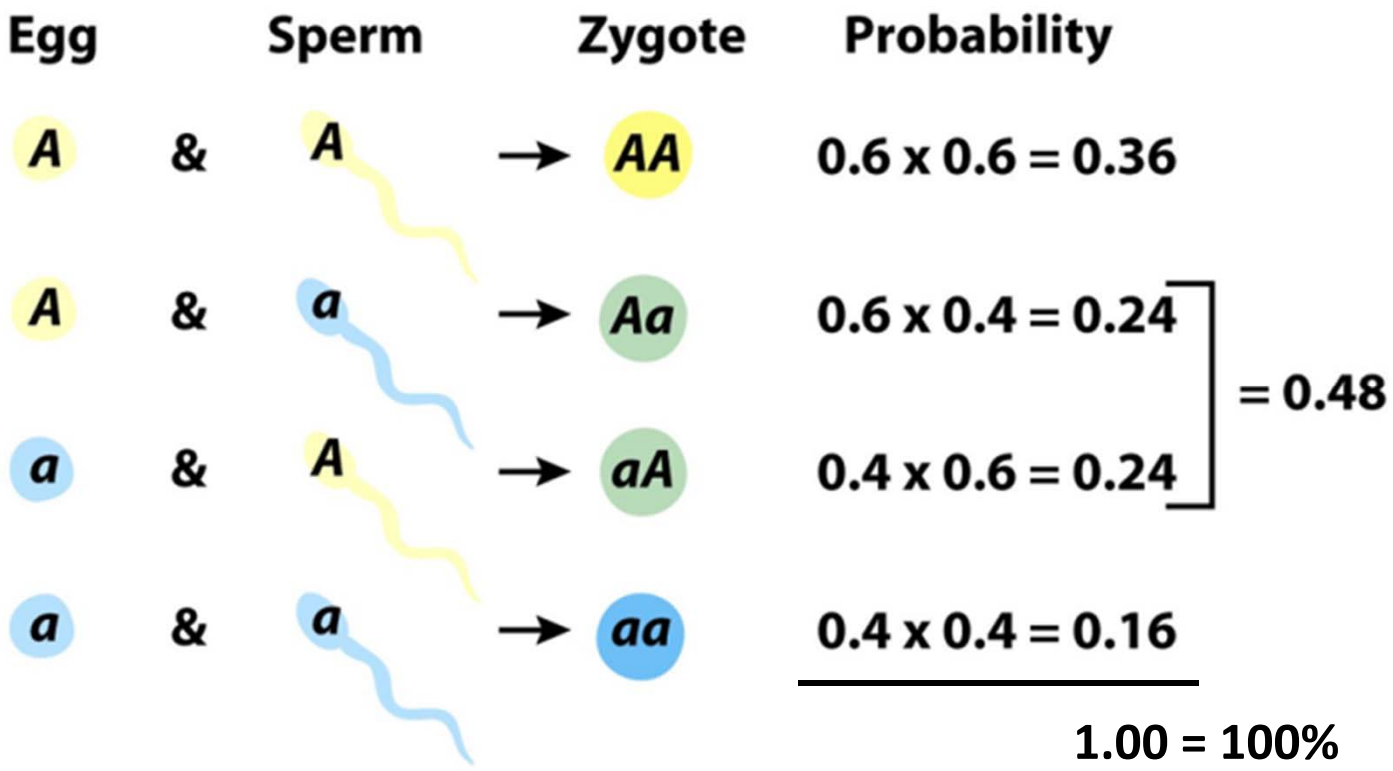
Joint probabilities…

Egg		Sperm		Zygote	Probability
A	&	A	→	AA	0.6 x 0.6 = 0.36

BUT, there are TWO ways to make a Aa zygote

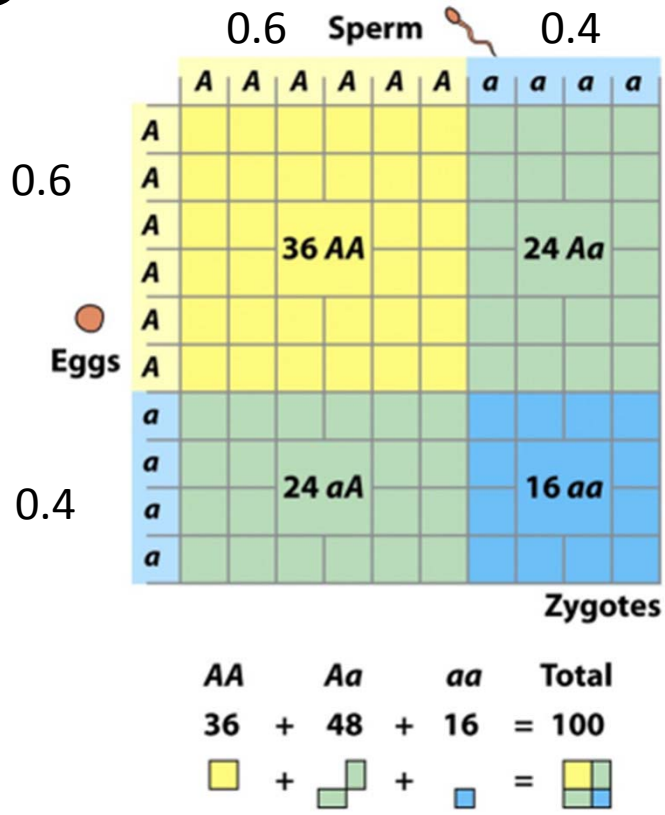
a	&	a	→	aa	0.4 x 0.4 = 0.16

Joint probabilities…



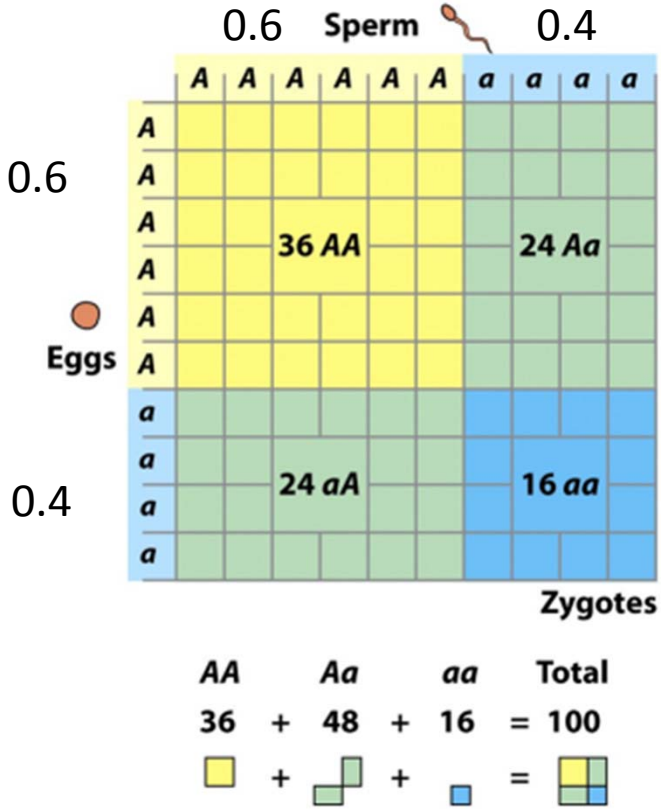
Another way of looking at the same thing…

- Modified Punnett square shows relative amounts of "A" and "a" gametes



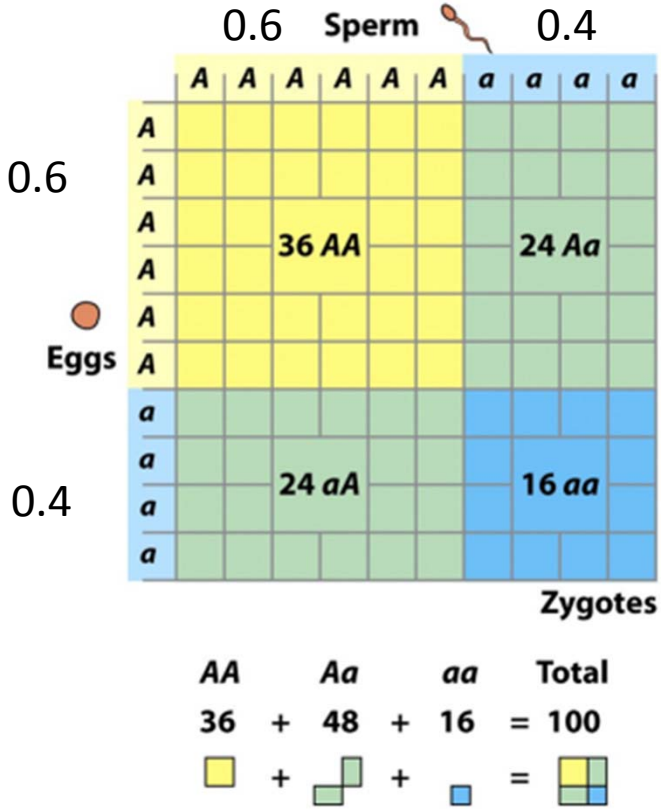
Can we calculate the "allele" frequencies?

- **YES**, ALWAYS when you have genotype frequencies.
- **AA**: 0.36 -> all A
- **Aa**: 0.48 -> half A
- Frequency of A =
  - 0.36 + ½ (0.48) = **<u>0.6</u>**
- Frequency of a = ?



Self-perpetuates!

- Allele “A” frequency was 0.6 in gametes
- Gametes created 0.36/0.48/0.16 genotype frequencies
- These genotypes produce 0.6 “A” gametes



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