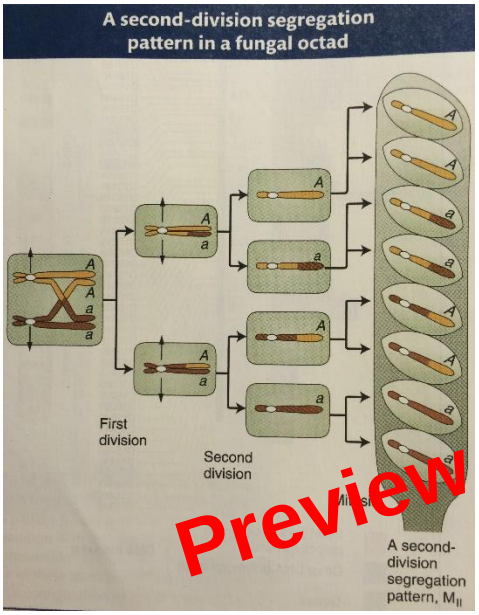
- For linked genes, single crossovers give rise to 100% T outcomes
- DCOs, as stated above, give rise to (PD:NPD:TT//P:N:T) in a 1:1:2 ratio → NPDs are 1/4 of the total number of DCOs for linked markers.
- Because NPDs arise *only* as a result of double crossover for linked genes, it is useful to express the formula in terms of NPDs. Therefore we can state the following quantities:
  - Number of tetrads with a double crossover = 4N (N as a single unit, 4 is the total number)
  - Number of tetrads with a single crossover = T - 2N (A total of T tetratypes, but 2N of those are from DCOs, the rest must be SCOs, which give rise exclusively to T)
  - Total number of recombinants = 2(4N) + (T-2N) = 6N + T

An extension of the formula above,

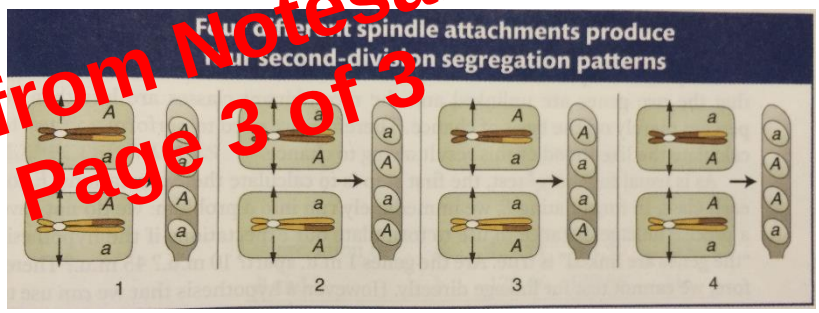
$$Recombination\ frequency, \%Rf = \frac{\frac{1}{2}T + NPD}{PD + NPD + TT} \times 100\%$$

Gene-centromere distance 2




- In *Neurospora crassa*, meiosis occurs within the tight confines of a narrow ascus → ordered tetrads → allow us to infer the *arrangement of each chromatid of homologous chromosomes* during Meiosis I and II
- Each meiocyte produces an array of 8 ascospores, octad (4 products of meiosis + postmeiotic mitosis)

Example: When A CROSS a; if crossover occurs, there will be ¼ different patterns in the octad, each pattern showing *blocks of 2 adjacent identical alleles*






| Octads | | | | | |
|---|---|---|---|---|---|
| A | a | A | a | A | a |
| A | a | A | a | A | a |
| A | a | a | A | a | A |
| A | a | a | A | a | A |
| a | A | A | a | a | A |
| a | A | A | a | a | A |
| a | A | a | A | A | a |
| a | A | a | A | A | a |
| 126 | 132 | 9 | 11 | 10 | 12 |
| Total = 300 | | | | | |

- First division segregation pattern, $M_I$ (First 2 columns; when no recombination between gene and centromere) (AAAAaaaa, aaaaAAAA)
- Second division segregation pattern, $M_{II}$ ($3^{rd}$-$6^{th}$ column: one single crossover)

(AAaaAAaa, aaAAaaAA, AAaaaaAA, aaAAAAaa)

$M_{II}$ frequency = (9+11+10+12)/300 = 14%. BUT this is percentage of *meioses*! Map units are defined as percentage of recombinant chromatids issuing from *meiosis* AND a crossover in any meiosis results in only 50% of recombinant chromatids, therefore

$$\text{Gene-centromere distance} = \left(\frac{Number\ of\ 2nd\ division\ octads}{total\ octads} \times 100\right) \div 2$$