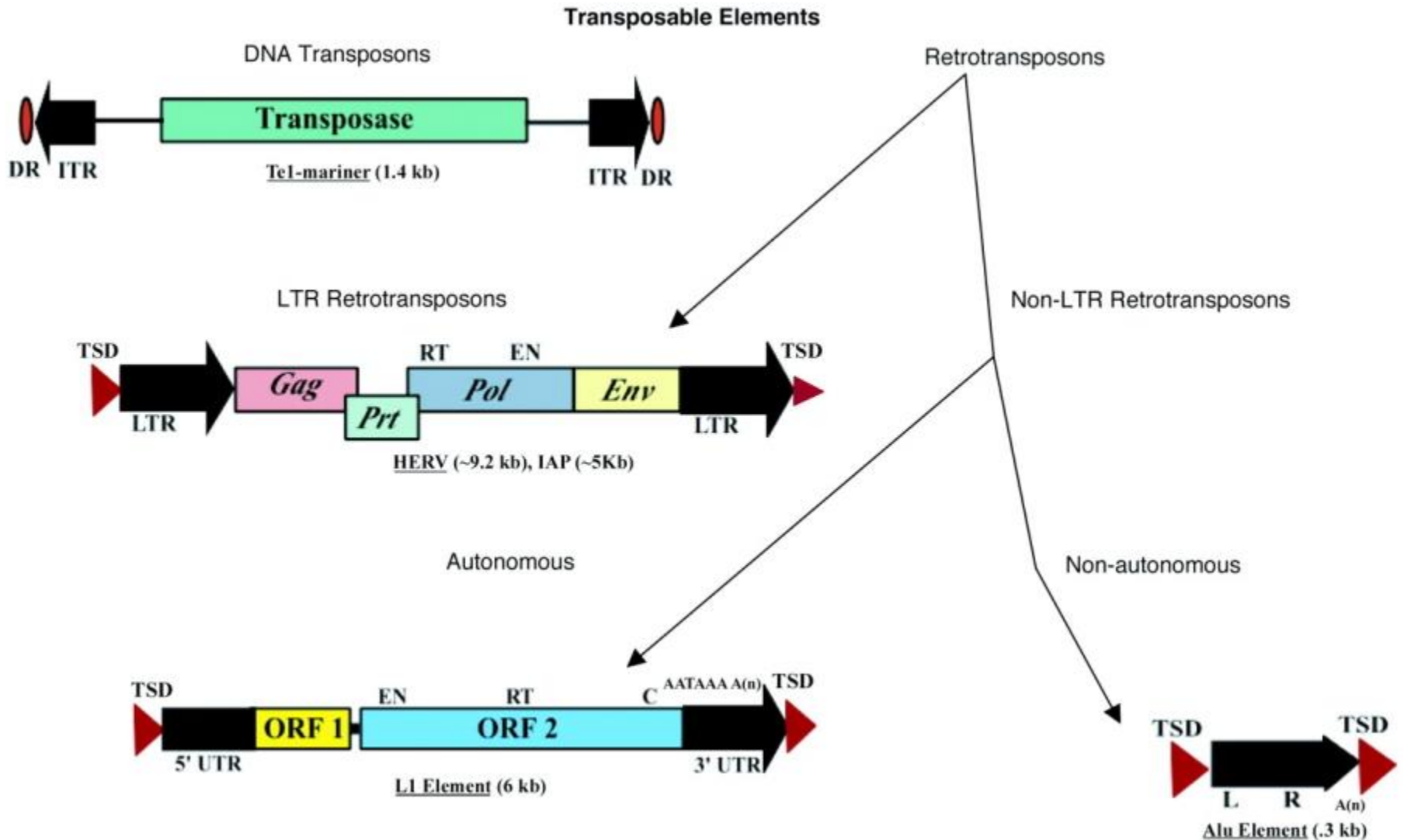


# Molekulargenetik der Eukaryoten

## WS 2014/15, VL 6



Erwin R. Schmidt  
Institut für Molekulargenetik

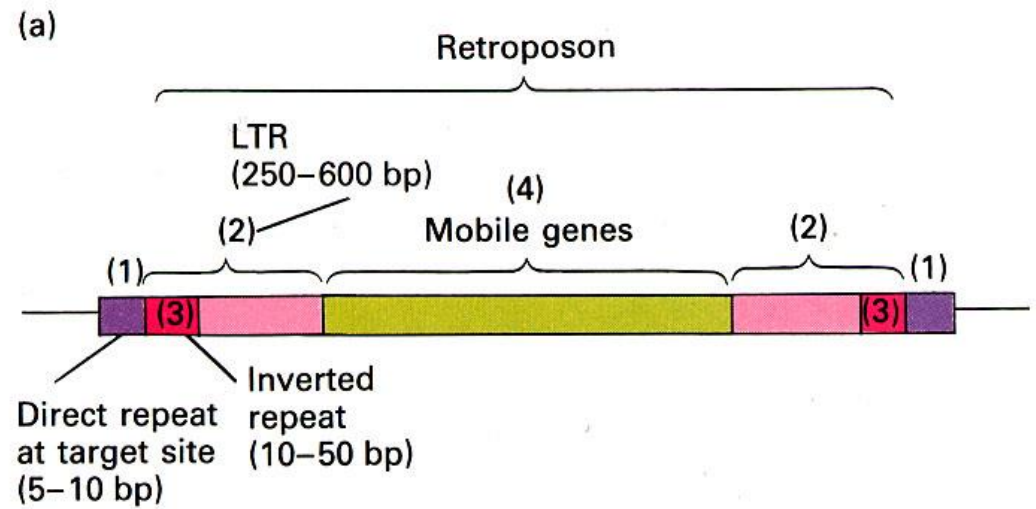


## Aus: Transposons: The Jumping Genes

By: Leslie A. Pray, Ph.D. © 2008 Nature Education

Citation: Pray, L. (2008) Transposons: The jumping genes. Nature Education 1(1)

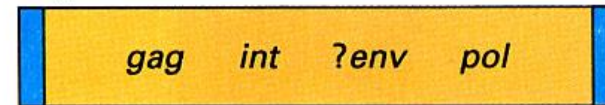
# Retrotransposons



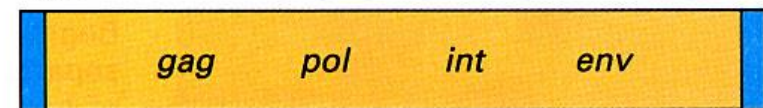
(b) Retroviral DNA



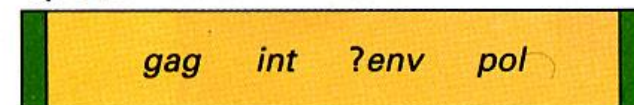
*Copia*



17.6



Ty 912



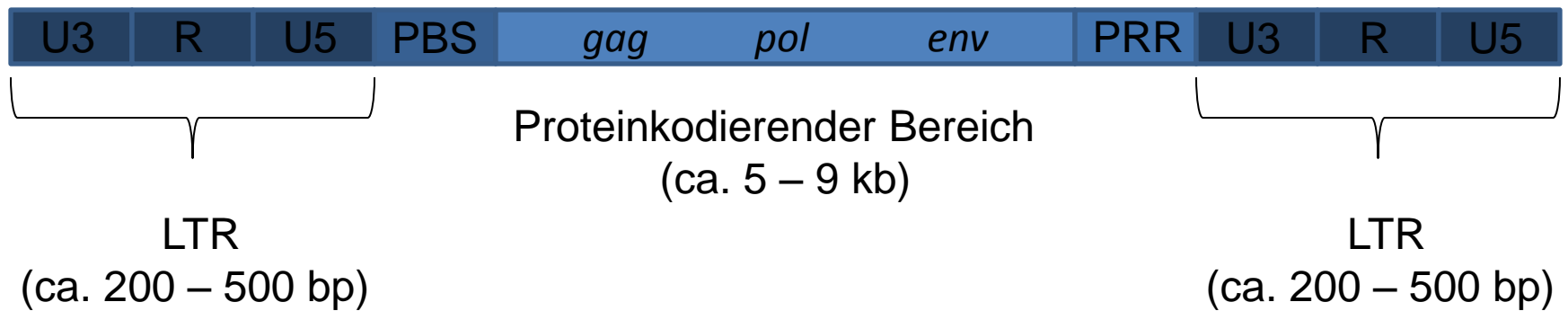
1 kb

# Retrotransposons

Table 19.1 Retroposons can be divided into the viral or nonviral superfamilies.

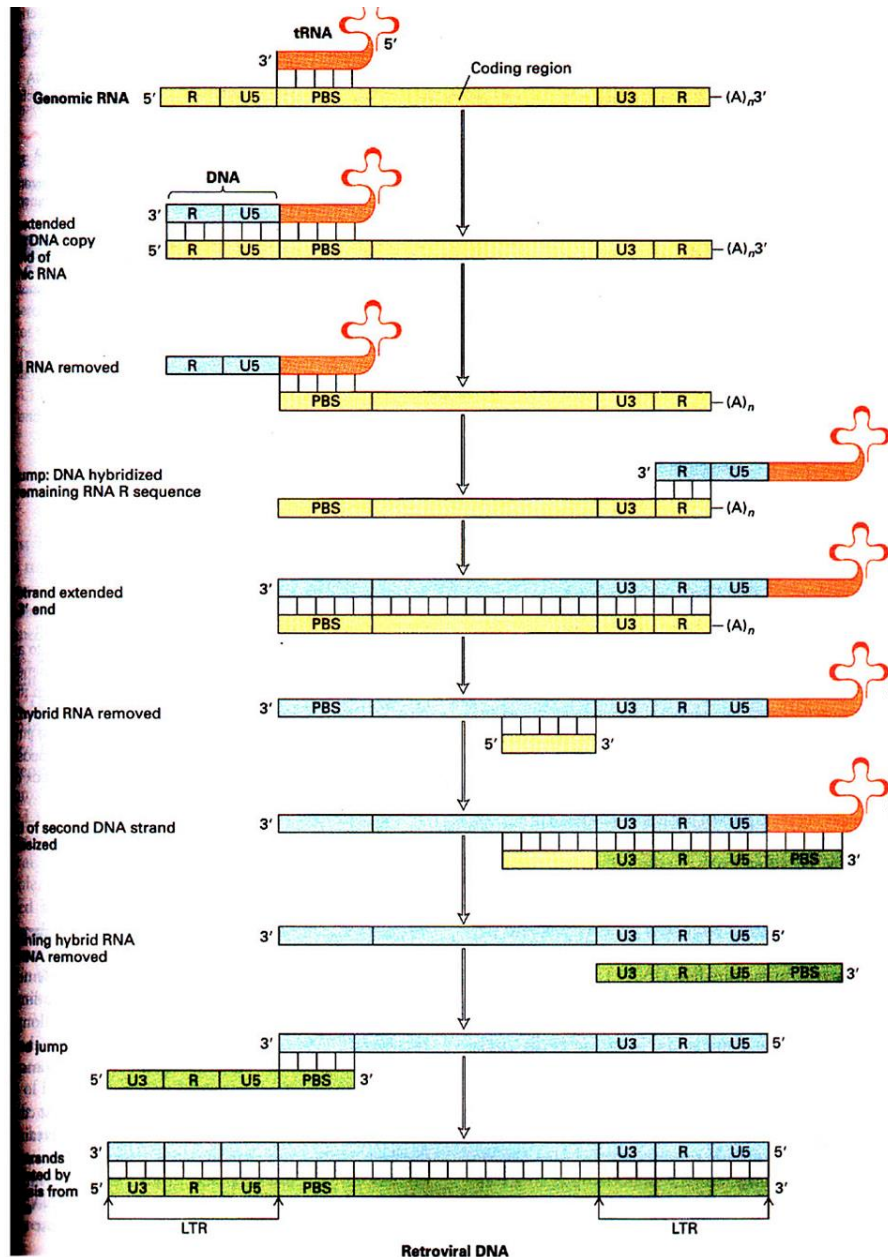
	Viral Superfamily	Nonviral Superfamily
Common types	<i>Ty</i> ( <i>S. cerevisiae</i> ) <i> copia</i> ( <i>D. melanogaster</i> ) LINES L1 (mammals)	SINES B1/Alu (mammals) Processed pseudogenes of pol III transcripts
Termini	Long terminal repeats	No repeats
Target repeats	4-6 bp	7-21 bp
Reading frames	Reverse transcriptase and/or integrase	None (or none coding for transposon products)
Organization	May contain introns (removed in subgenomic mRNA)	No introns

# Retrovirus/Retrotransposon



- U3: unique sequence near 3' terminus
- R: repeated sequence
- U5: unique sequence near 5' terminus
- PBS: Primer Binding Site
- PRR: Purin Rich Region

# Replikation und LTR-Entstehung bei Retroviren



tRNA bindet an PBS der viralen RNA

DNA-Synthese in 3'-Richtung durch virale RT

R und U5-RNA durch RNase H entfernt

DNA bindet an virale RNA am 3'-Ende, komplette virale RNA wird synthetisiert

RNA wird entfernt (RNase H), bis auf PRR, dient als Primer

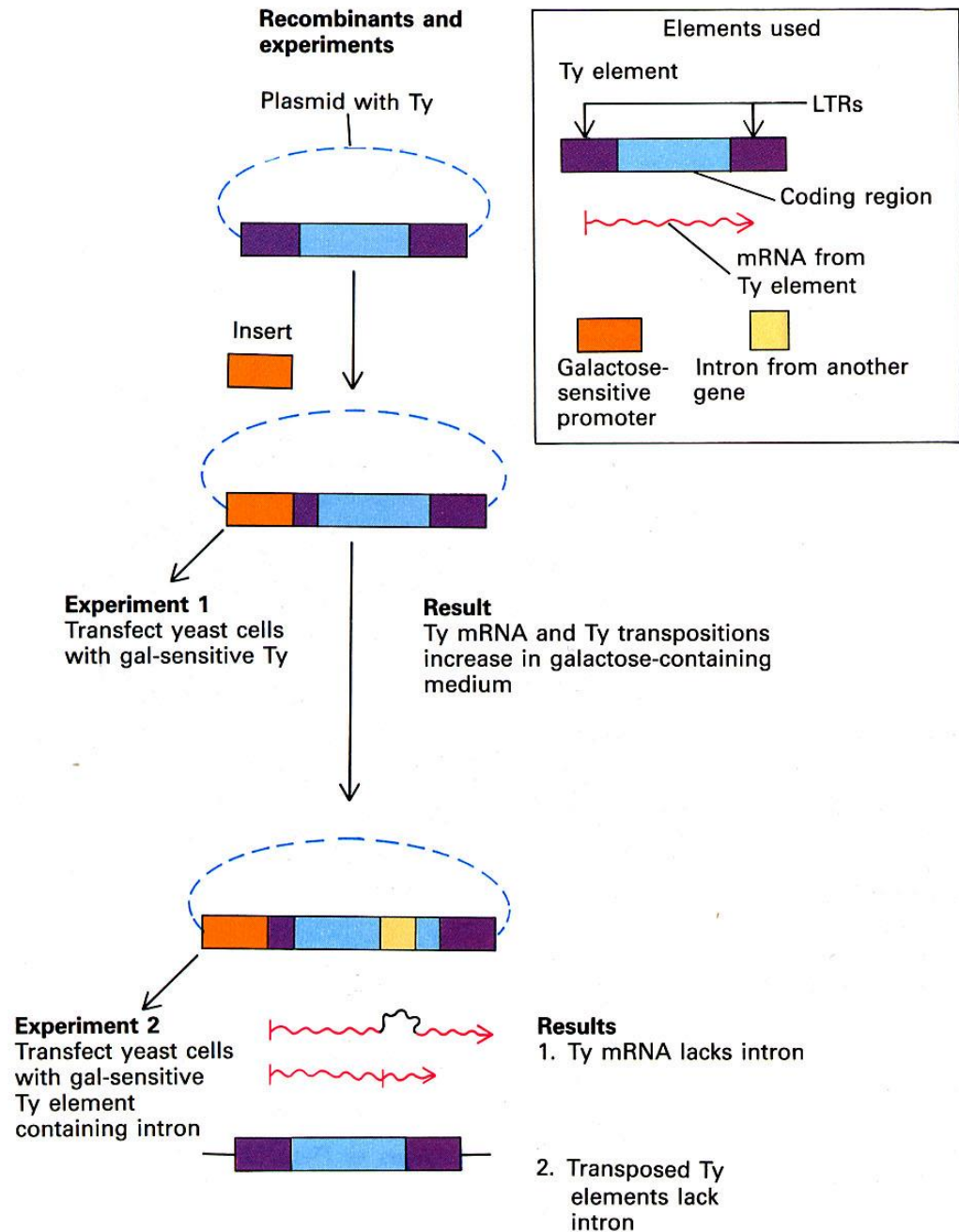
Synthese des Plus-Strangs in 3'-Richtung (inkl. PBS)

RNA wird entfernt

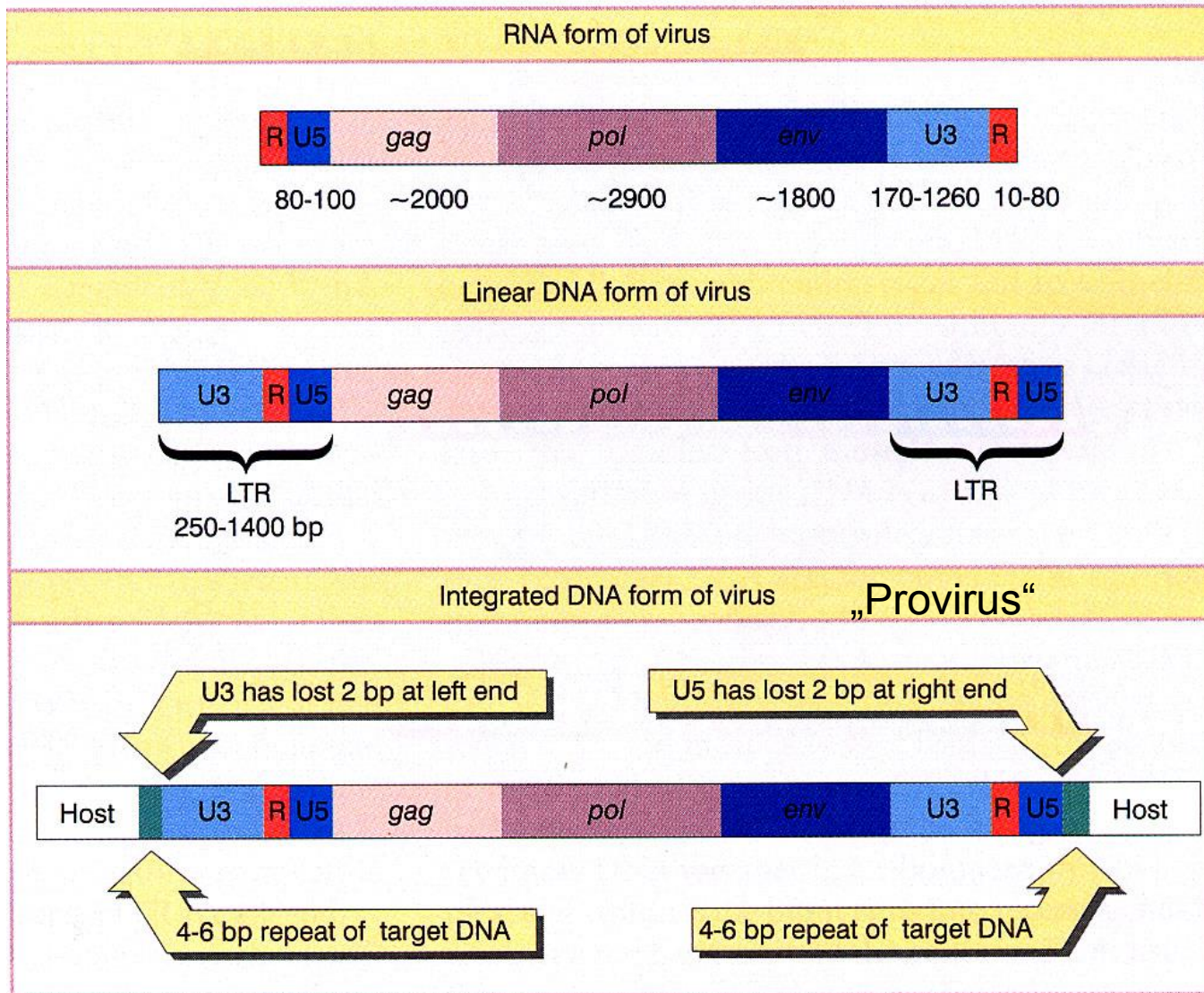
PBS dient als Primer für DNA-Synthese

komplette virale RNA wurde in ds DNA überschrieben, dabei sind LTRs entstanden

# Beweis für Retro- transposition



# Retroviren unterscheiden sich in der DNA- und RNA-Form



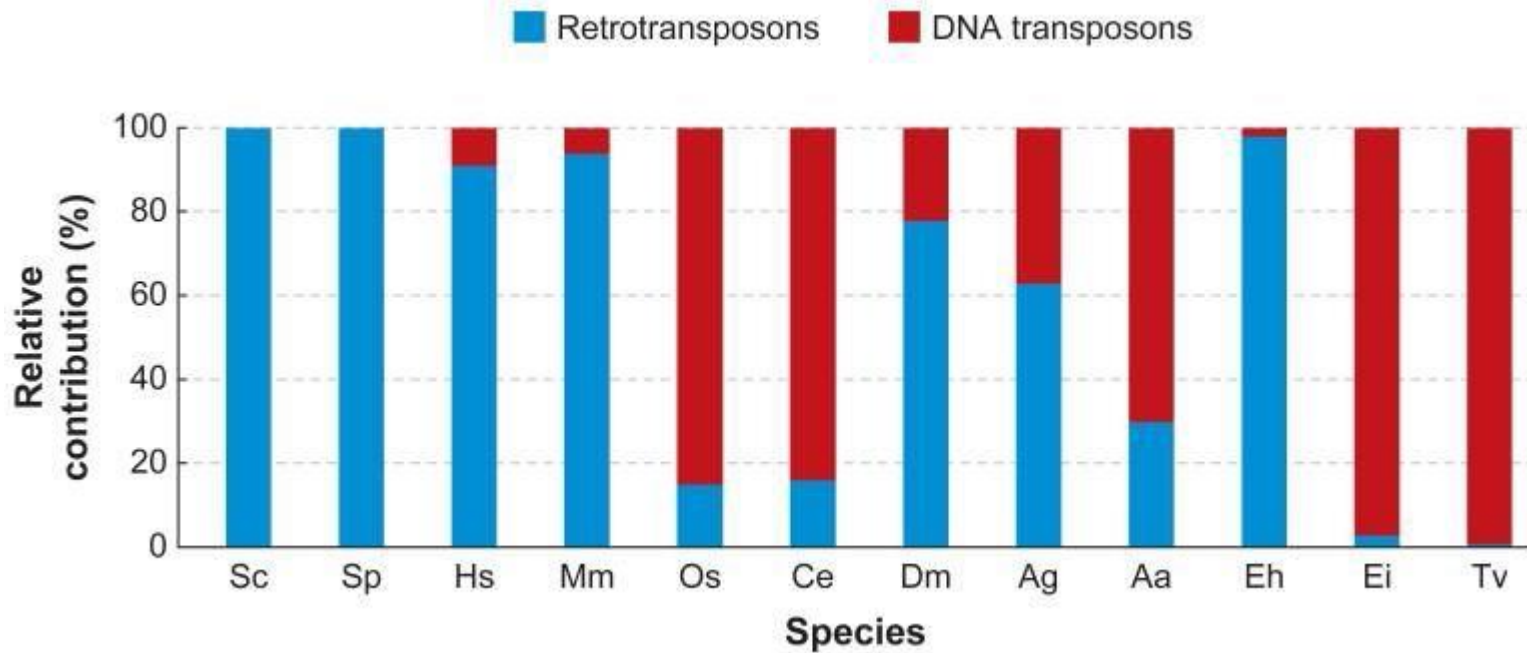
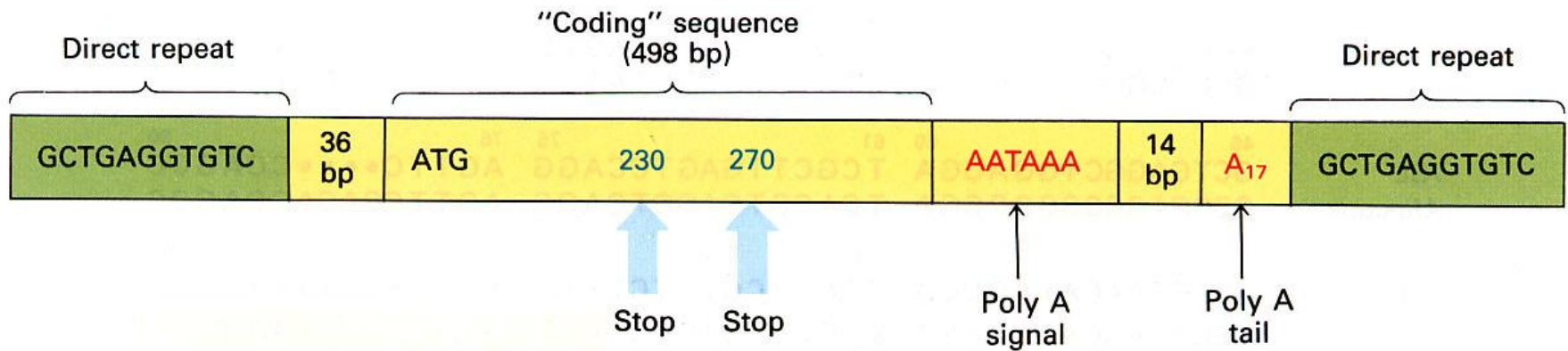


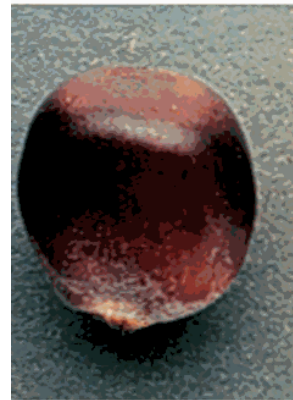
Figure 1 : The relative amount of retrotransposons and DNA transposons in diverse eukaryotic genomes.

This graph shows the contribution of DNA transposons and retrotransposons in percentage relative to the total number of transposable elements in each species. Species abbreviations: Sc: *Saccharomyces cerevisiae*; Sp: *Schizosaccharomyces pombe*; Hs: *Homo sapiens*; Mm: *Mus musculus*; Os: *Oryza sativa*; Ce: *Caenorhabditis elegans*; Dm: *Drosophila melanogaster*; Ag: *Anopheles gambiae*, malaria mosquito; Aa: *Aedes aegypti*, yellow fever mosquito; Eh: *Entamoeba histolytica*; Ei: *Entamoeba invadens*; Tv: *Trichomonas vaginalis*.

# Prozessierte Pseudogene



# DNA-Transposons



*Bz*

Normal form



*bz*

Point mutation



*bz-m*

TE  
^  
Transposable element insertion

# DNA-Transposons: Körnerfarbe bei Mais

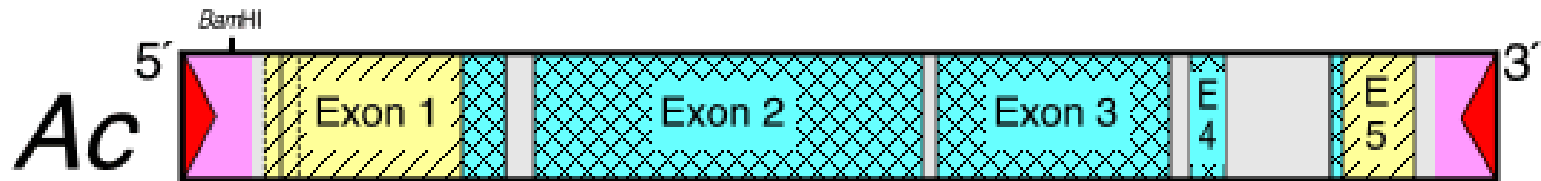


Petunia\_Hybriden,  
Transposon Tph1,  
blockiert Anthocyansynthese



van Houwelingen et al. 1998  
Plant J. 13:39-50

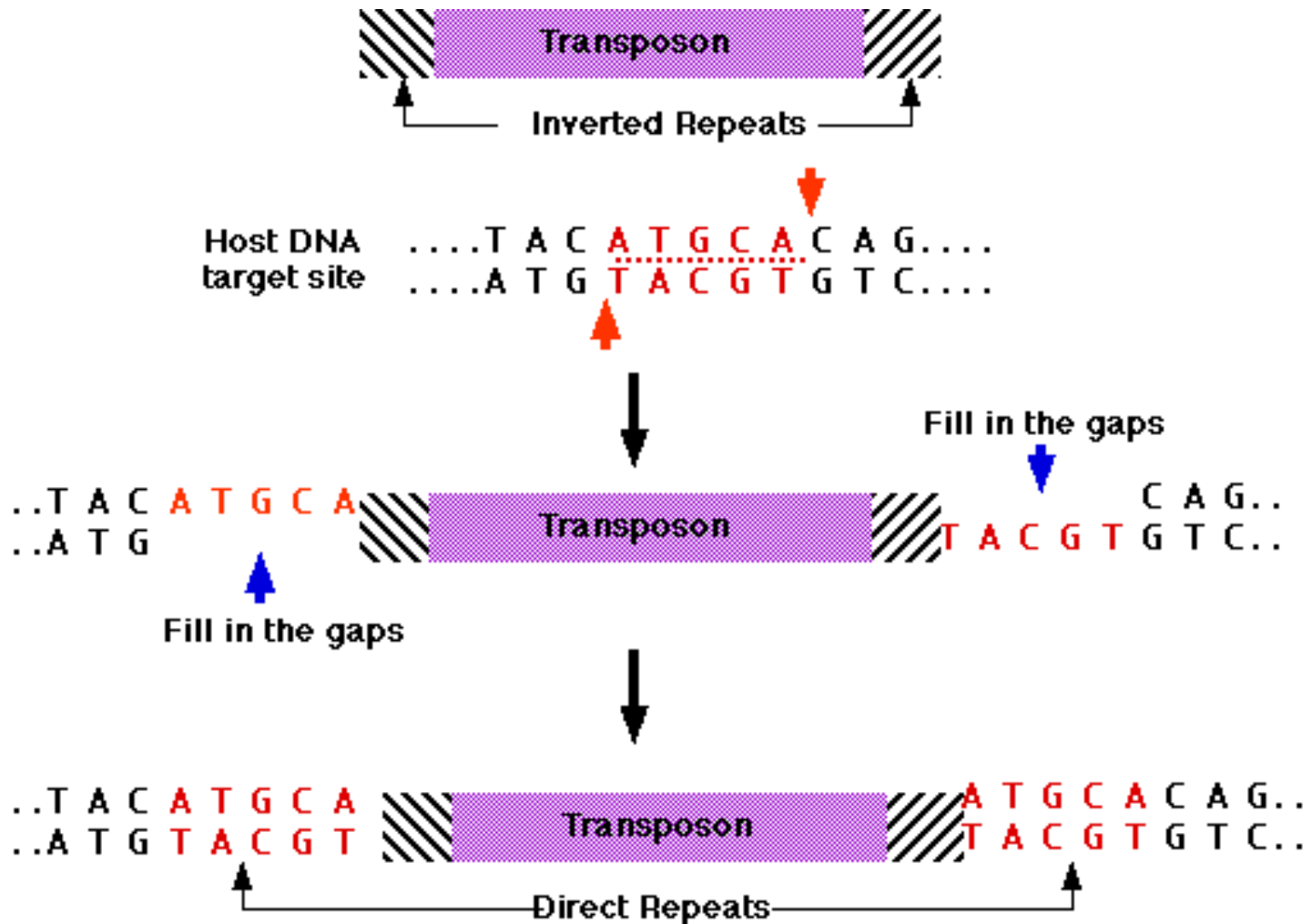
# Activator Element „Ac“ bei Mais



Das „Ac“-Element ist durch kurze „direct repeats“ flankiert

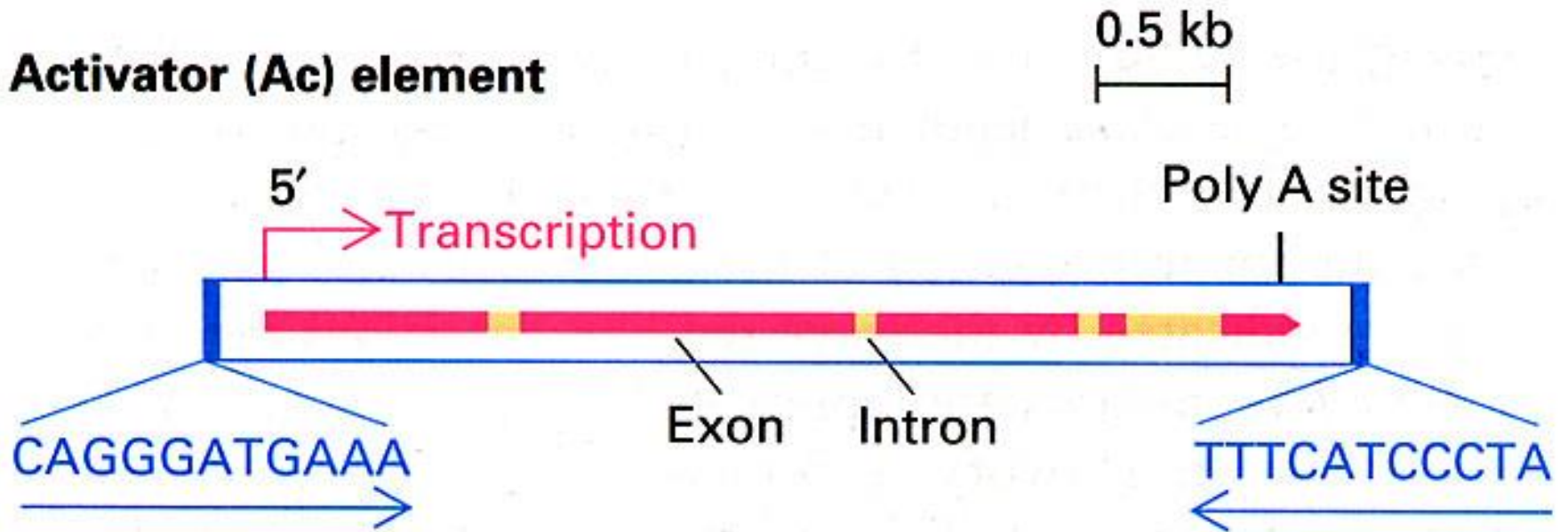


# DNA-Transposons erzeugen „target site duplications“

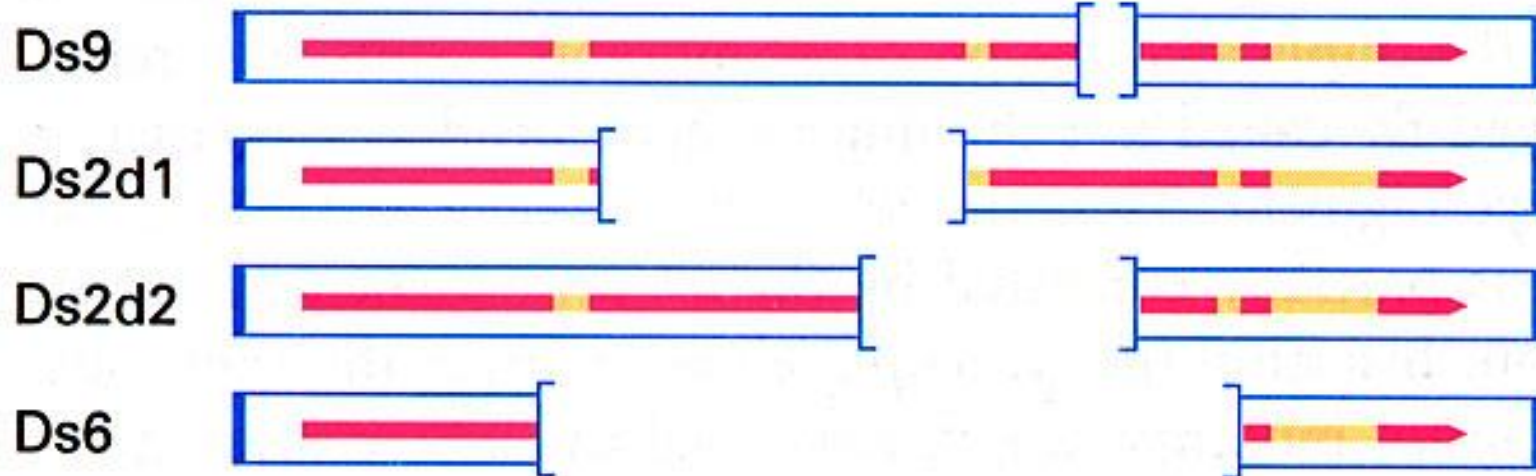


Das Ac-Element besitzt eine aktive Transposase, Ds-Elemente sind „nicht-autonom“

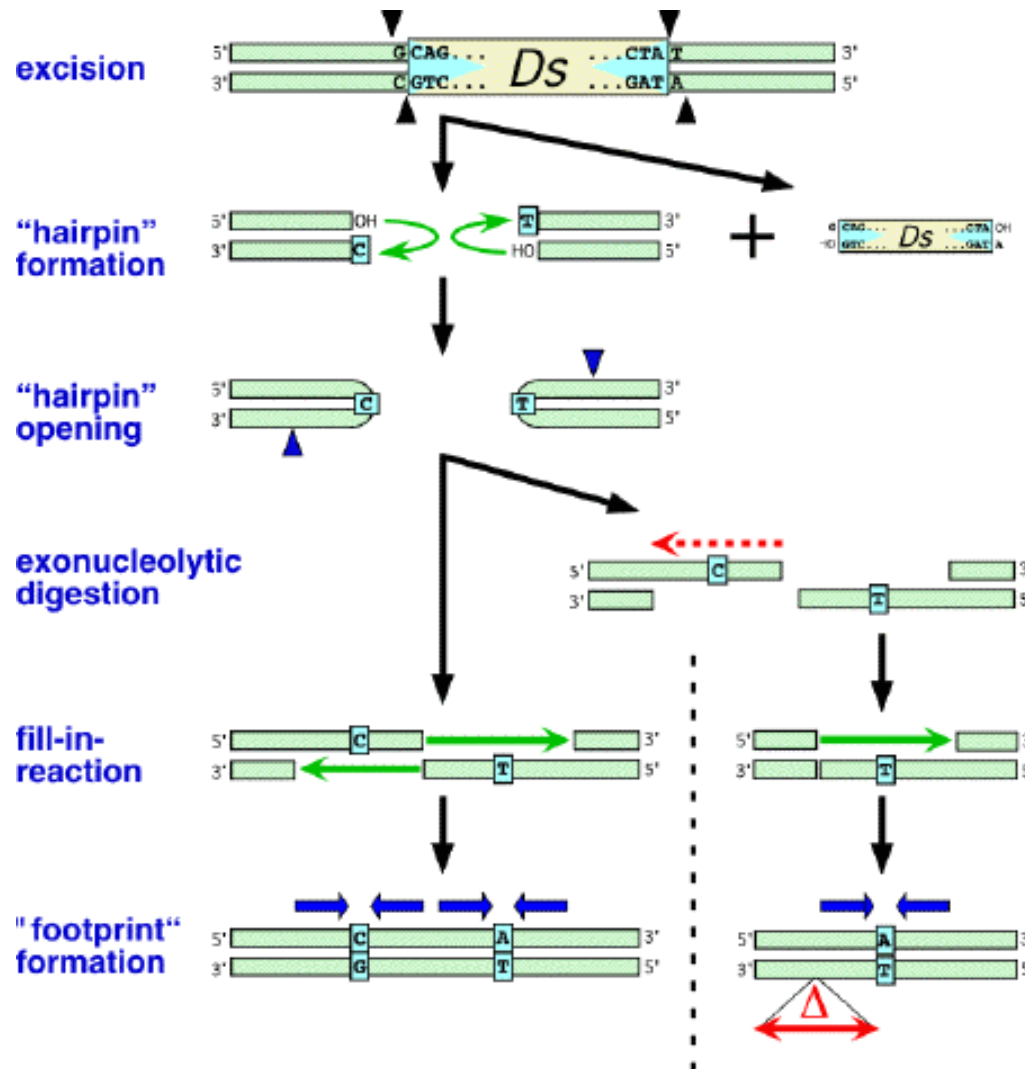
## Activator (Ac) element



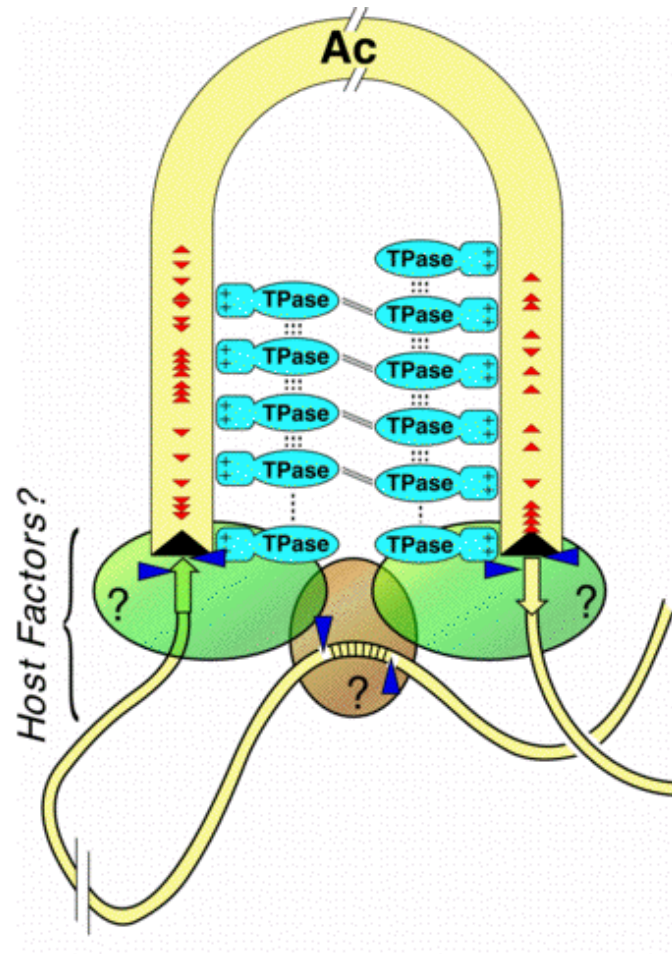
## Dissociation (Ds) elements



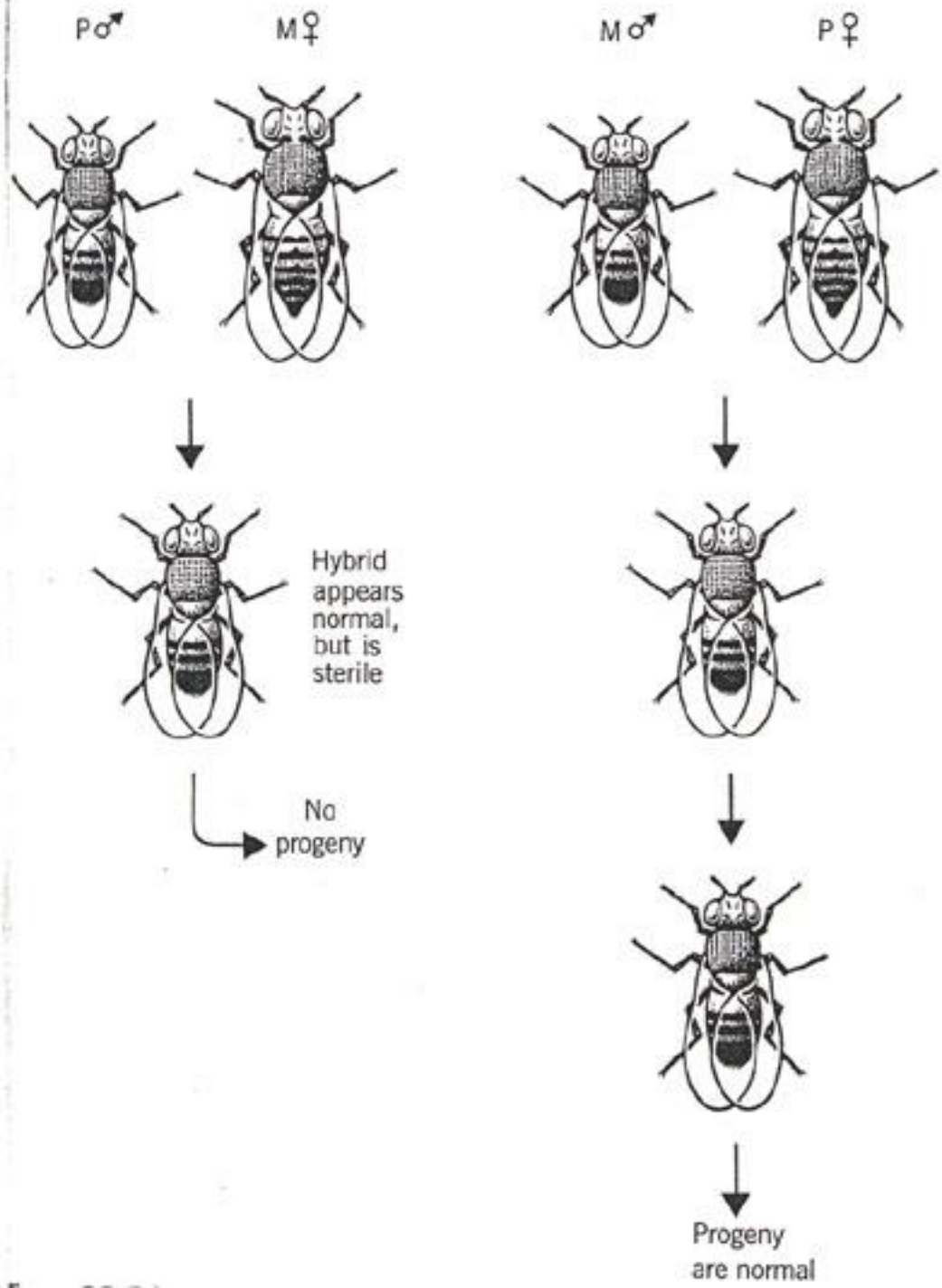
# Bei der Exzision entstehen „footprints“



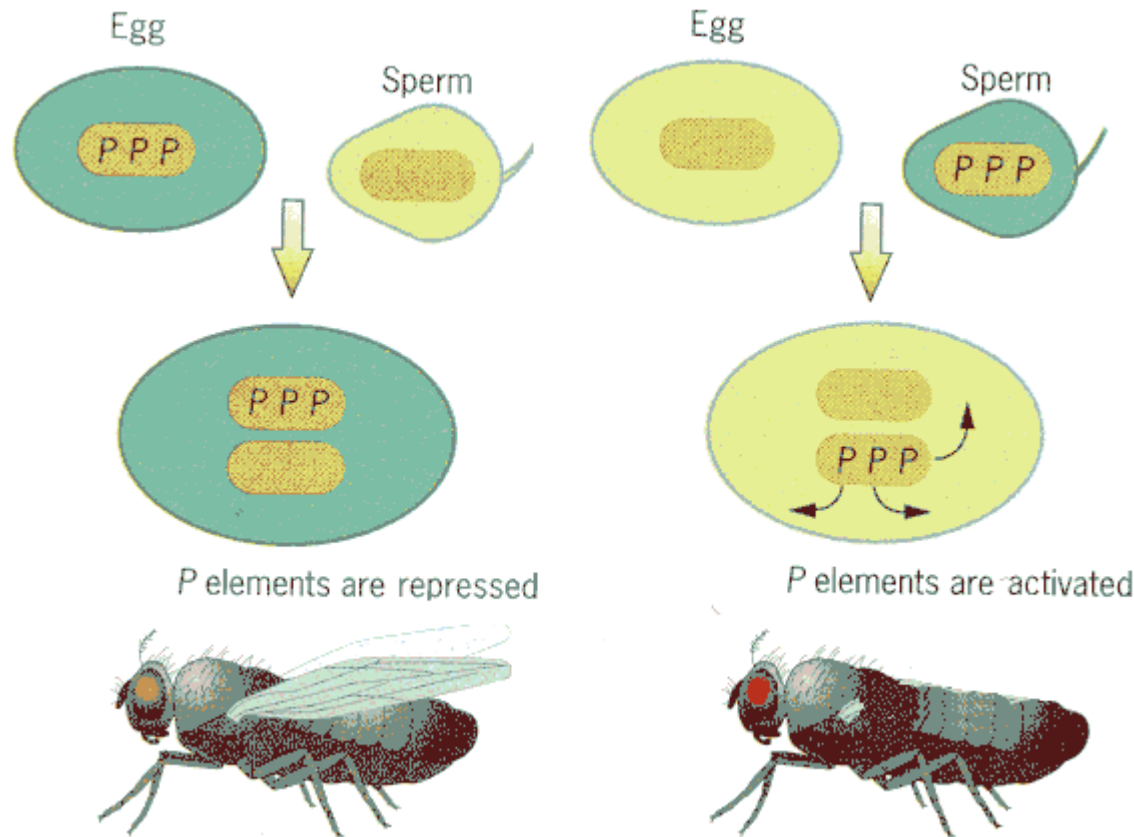
Bei der Transposition spielen die „inverted repeats“ eine große Rolle



Die P-Elemente von Drosophila erzeugen „hybrid dysgenesis“



# Reziproke Kreuzungen führen zu unterschiedlichen Ergebnissen



# Die P-Elemente von Drosophila:

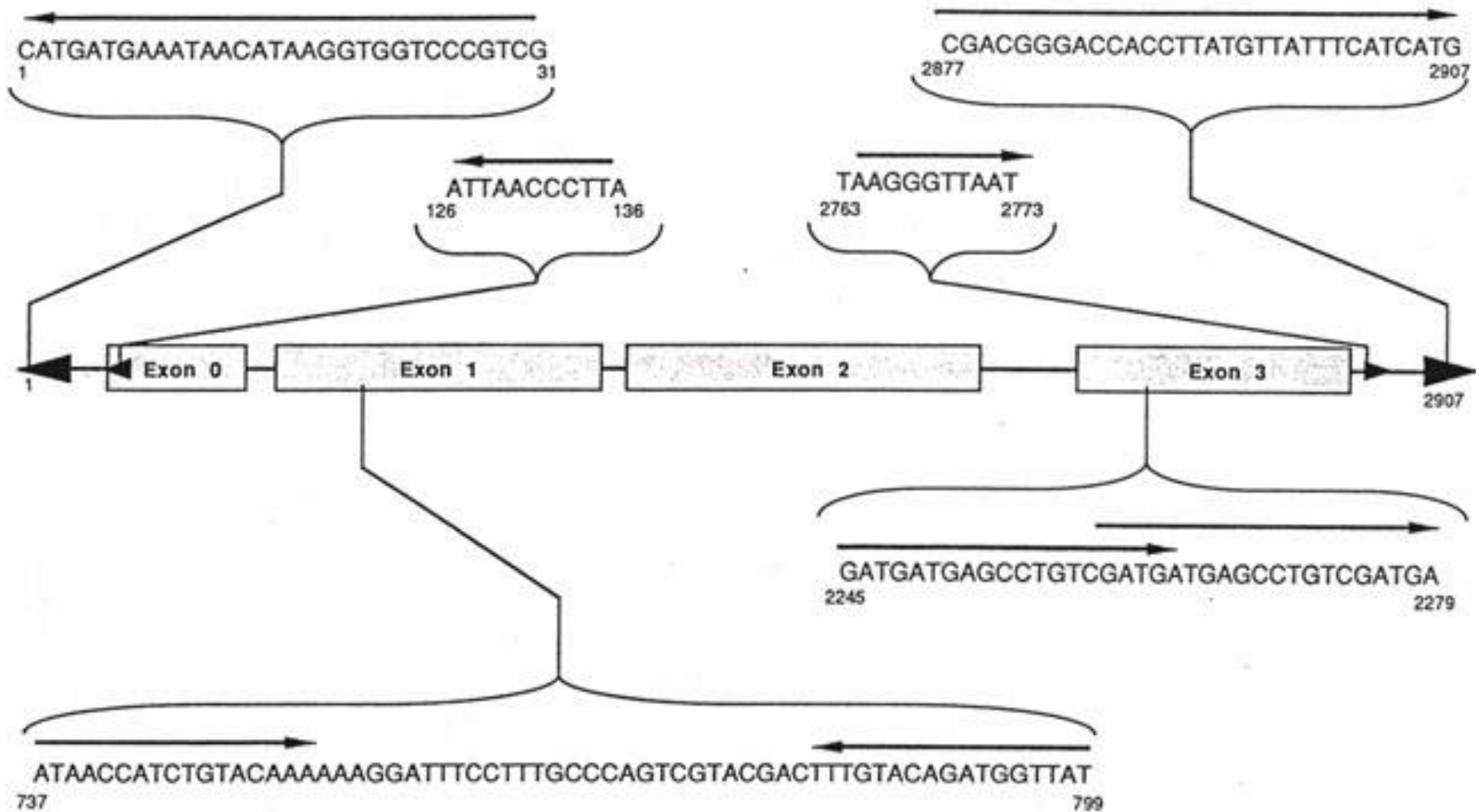
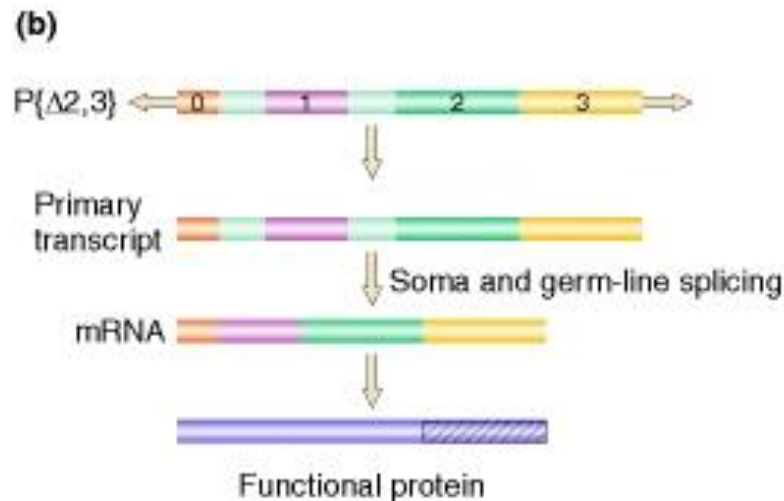
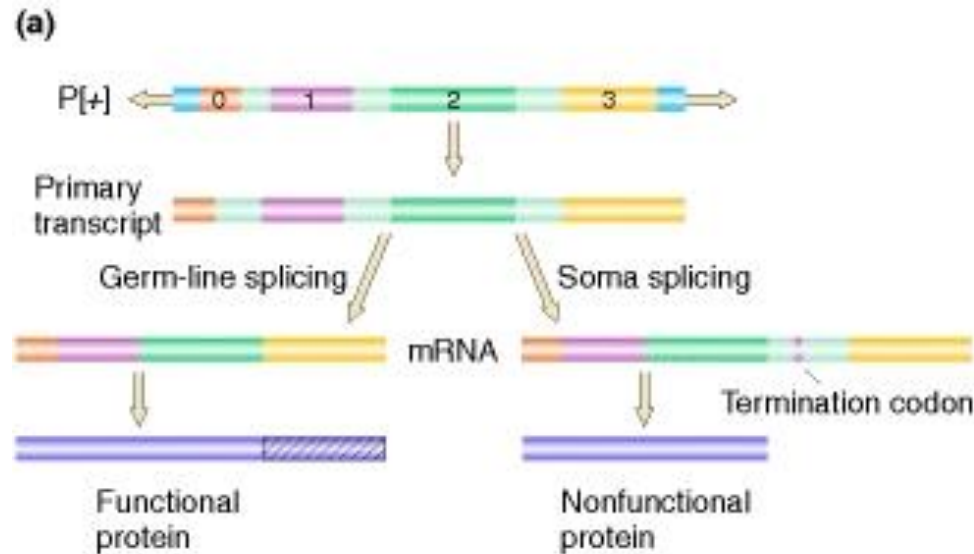


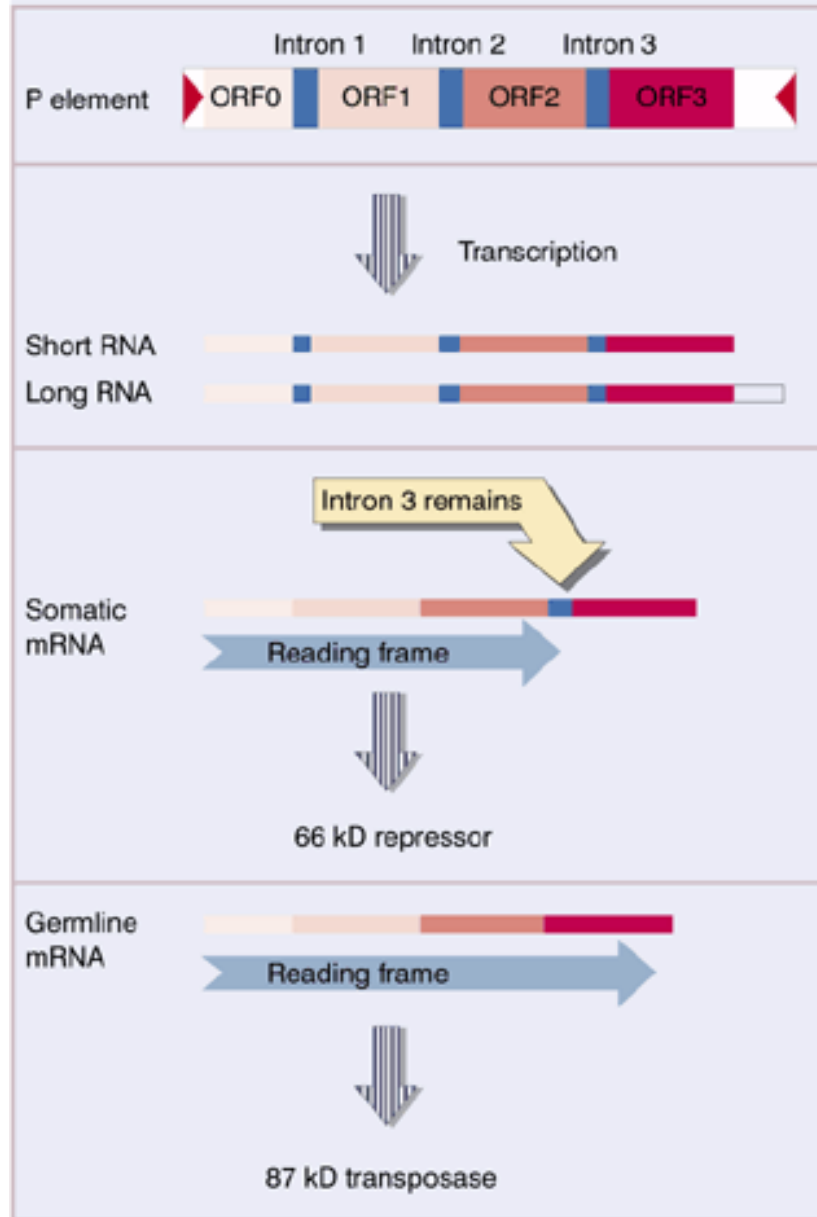
Figure 3. The complete P element and its repeat structures. The sequence was obtained by O'Hare and Rubin (155).

# Alternatives Splicing führt zur aktiven Transposase oder zu einem Repressor



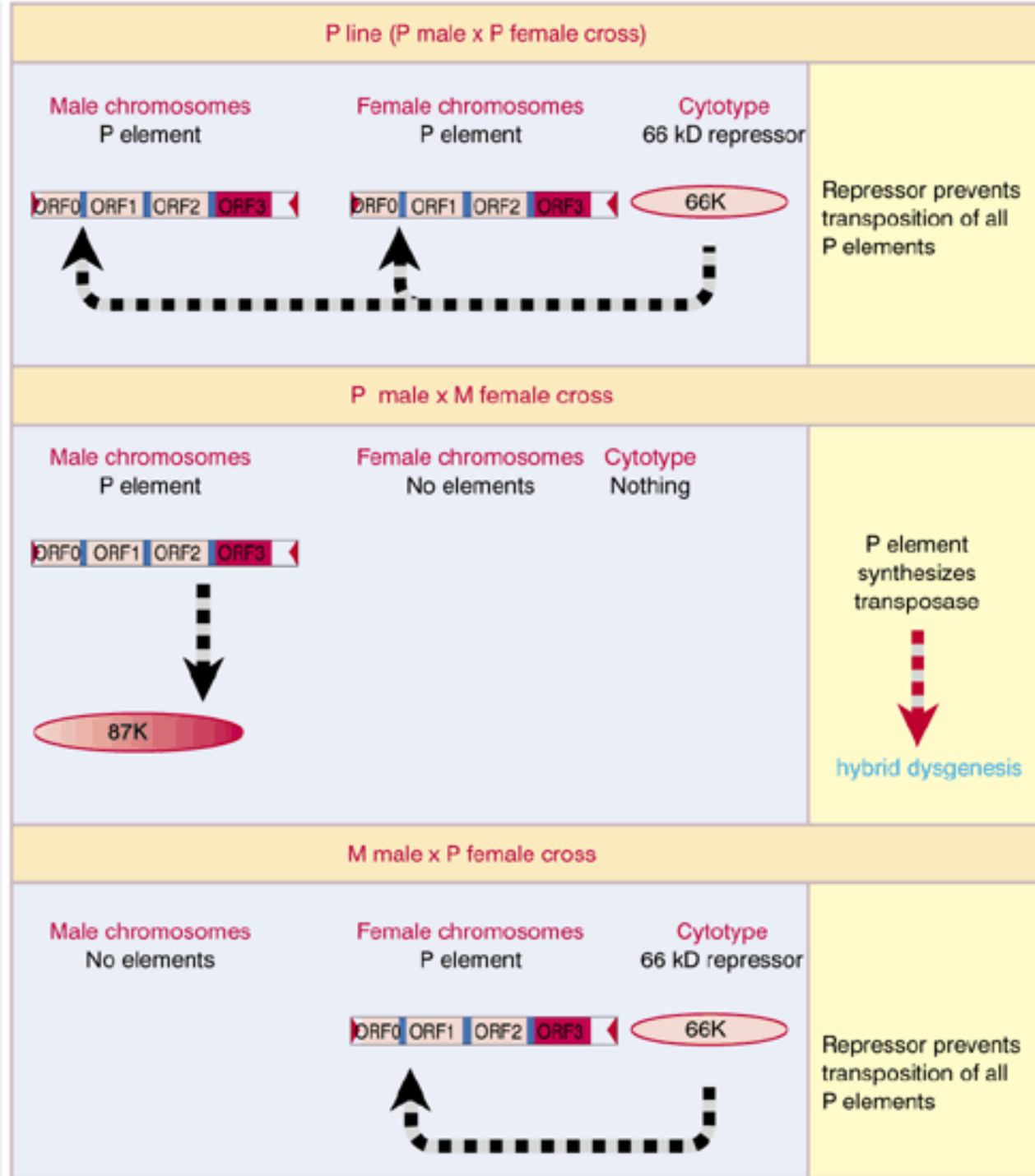
# Die P-Elemente von Drosophila:

**Figure 15.26** The P element has four exons. The first three are spliced together in somatic expression; all four are spliced together in germline expression.



**Figure 15.27** Hybrid dysgenesis is determined by the interactions between P elements in the genome and 66 kD repressor in the cytotype.

Die „hybrid dysgenesis“ ist die Folge von einem Wechselspiel von aktiver Transposase in Keimzellen von P-freien Tieren und dem Repressor in P-haltigen Tieren

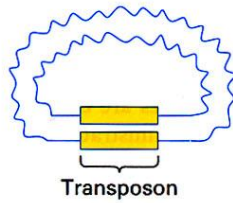


# Klassifizierung von Transposons über den Mechanismus

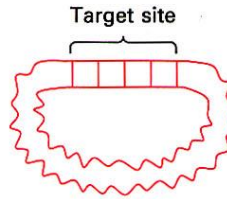
- Replikative Transposition (copy & paste)
- Konservative Transposition (cut & paste)
- (Retro(trans)position)

# Mechanismus der replikativen Transposition

Circular plasmid with transposon

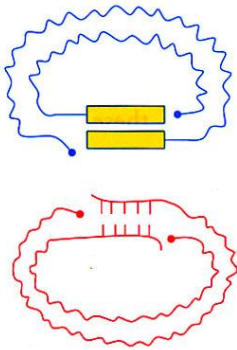


Target DNA (bacterial chromosome)

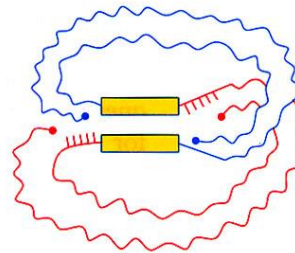


◀ **Figure 10-24** Proposed model for duplication and integration of a bacterial transposon and a circular recipient chromosome (*top*). This process results in two copies of the transposon, one inserted at the target site in the recipient chromosome with a target site duplication of five bases. [See J. Shapiro, 1979, *Proc. Nat'l Acad. Sci. USA* 76:1933; K. Mizuuchi, 1983, *Cell* 35:785.]

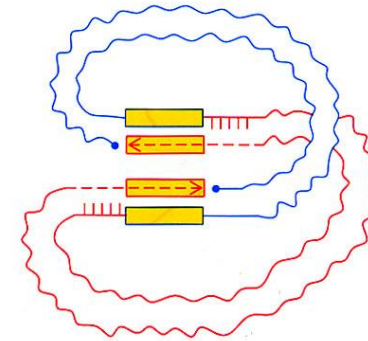
(a) Staggered cuts are made at ends of transposon and target site



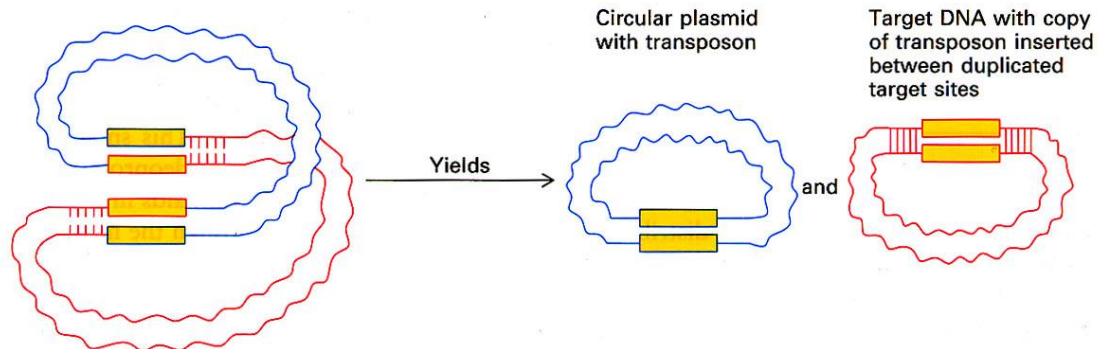
(b) Strand transfer occurs between 3' ends of transposon and 5' ends of target DNA



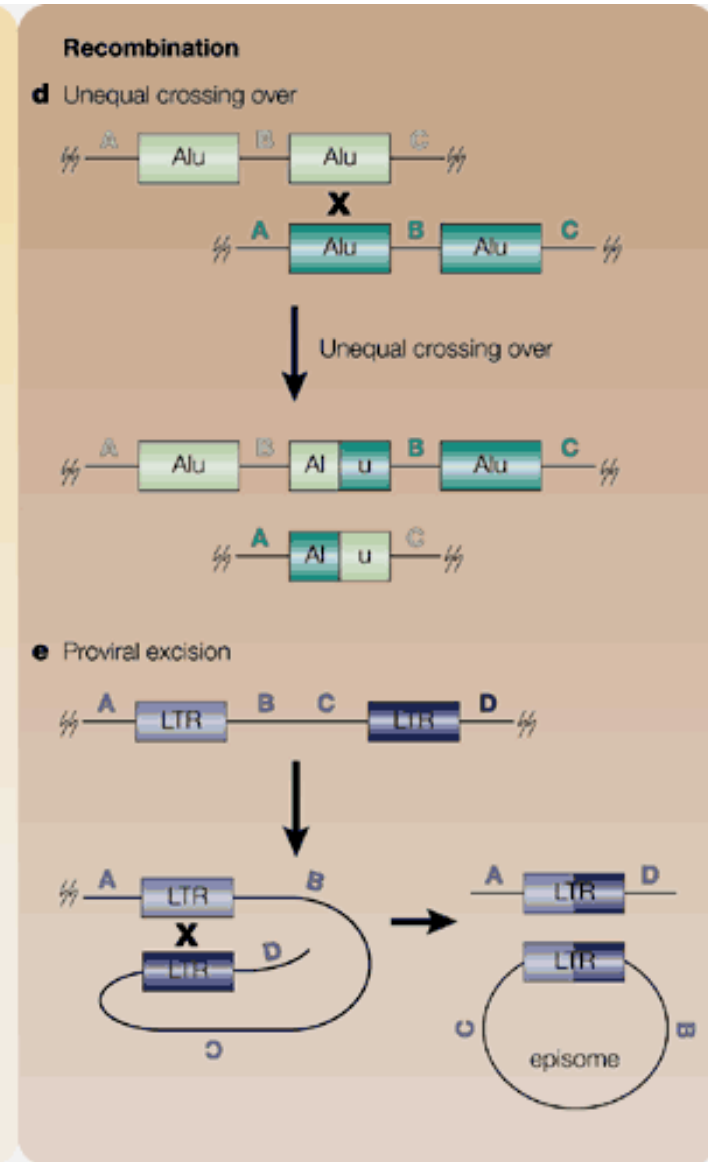
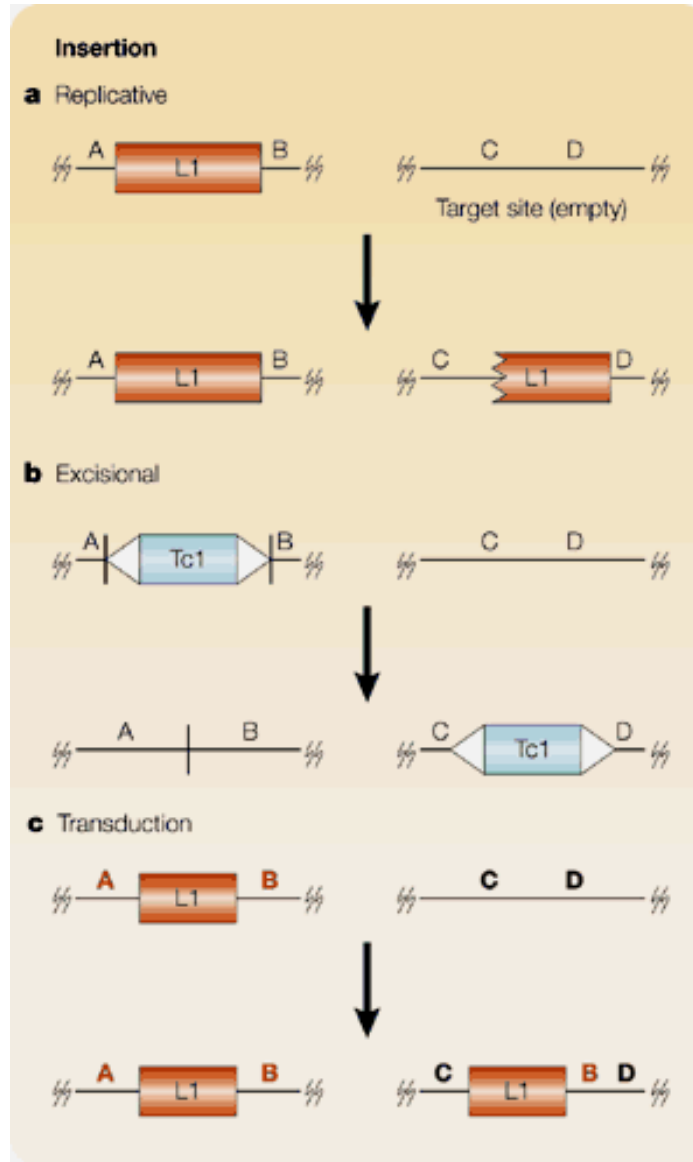
(c) Copying of transposon begins at free 3' ends of target DNA, beginning with duplication of target site



(d) Completion of replication yields cointegrate containing plasmid DNA, target DNA, and two copies of transposon. Cointegrate is resolved by site-specific recombination.



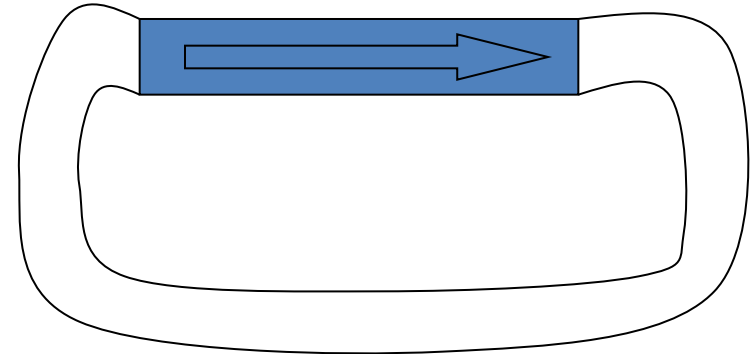
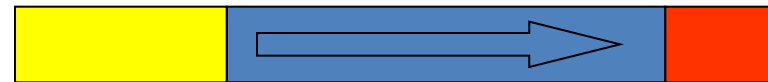
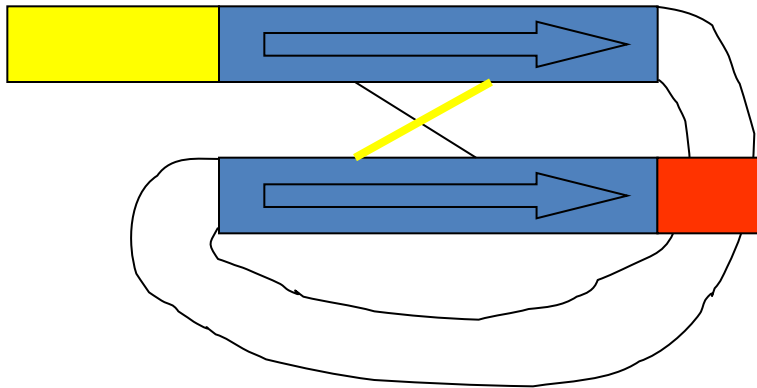
# Vermehrung und Transposition von repetitiven Elementen



# Effekte von Transposons

- Bei entgegengesetzter Orientierung:
  - Inversion
- Bei gleichsinniger Orientierung:
  - Deletion

# Interspergierte repetitive Elemente können Inversionen und Deletionen erzeugen



# Interspergierte repetitive Elemente können Inversionen und Deletionen erzeugen

