FAO memprediksi bahwa tingkat Produksi Pangan harus meningkat 70% untuk menghindari terjadinya kelaparan dan kemiskinan

Sumber: FAO “How to Feed the World in 2050”, Rome 2009

Pesan Utama:

- Peningkatan produksi pangan (nabati dan hewani) adalah keharusan untuk mengimbangi laju jumlah penduduk

- Peningkatan produksi pangan dapat dilakukan:

1. *Ekstensifikasi atau memperluas area produksi*
2. *Mengoptimalkan produktivitas melalui:*

✓ Pemuliaan tradisional dan solusi agronomis

✓ Pendekatan Bio-teknologi

Forest for Food
(Fakultas Kehutanan UGM, 2013)

Forest for Food
(Fakultas Kehutanan UGM, 2013)

Pemuliaan Tradisional untuk Jagung*:*
from wild plants to commercial varieties

Teosinte

Jagung

Pemuliaan Tanaman Kedelai

Tetua Tanaman Kedelai

Varietas Kedelai Saat ini

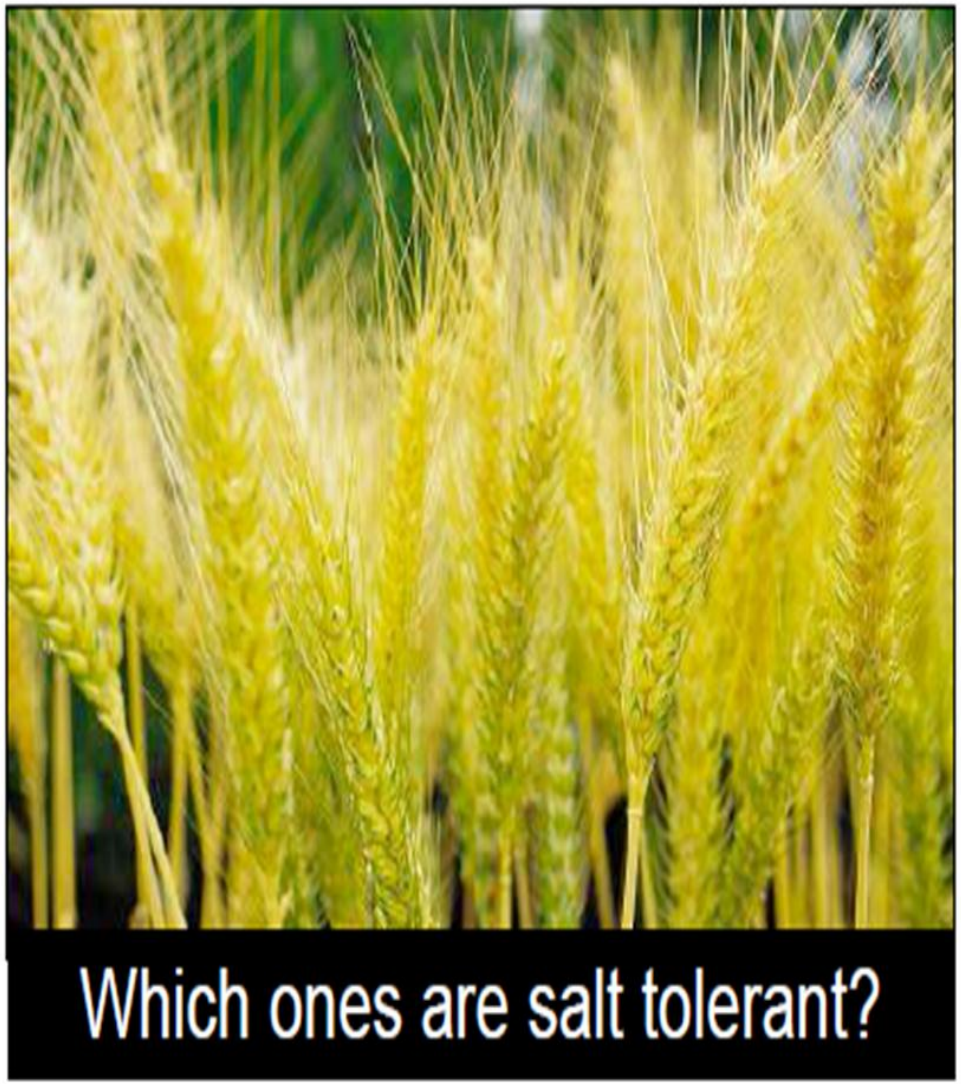
Pemuliaan Tanaman Tradisional

- Keterbatasan sumber daya genetik
- Perpindahan material genetik (*gen*) terjadi secara acak
- Tidak hanya gen pembawa karakter genetik unggul yang pindah, tetapi juga gen gen lainnya pembawa karakter non-unggul
- Waktu yang diperlukan untuk mendapatkan varietas baru sangat lama (10 – 15 tahun)

PARENT 1 PARENT 2

X

=



High yield
Salt sensitive

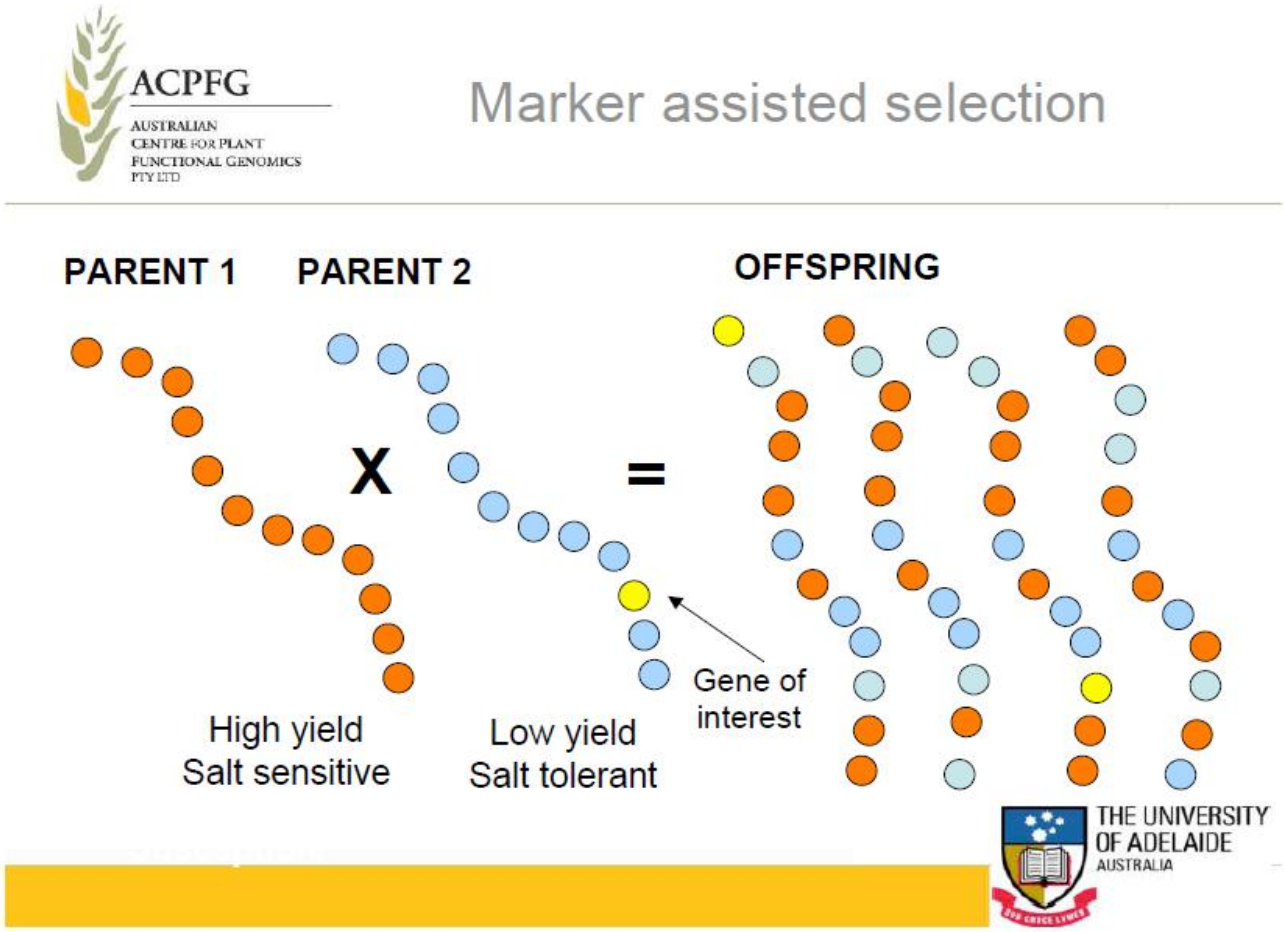
Low yield
Salt tolerant

THE UNIVERSITY

Dengan Bioteknologi

- Percepatan seleksi varietas baru yang diharapkan (5 – 10 tahun lebih cepat)
- Menggunakan penanda seleksi dalam bentuk marka molekuler/genetik (*molecular/genetic markers*)
- Dikembangkan Tanaman Produk Rekayasa Genetika (PRG)

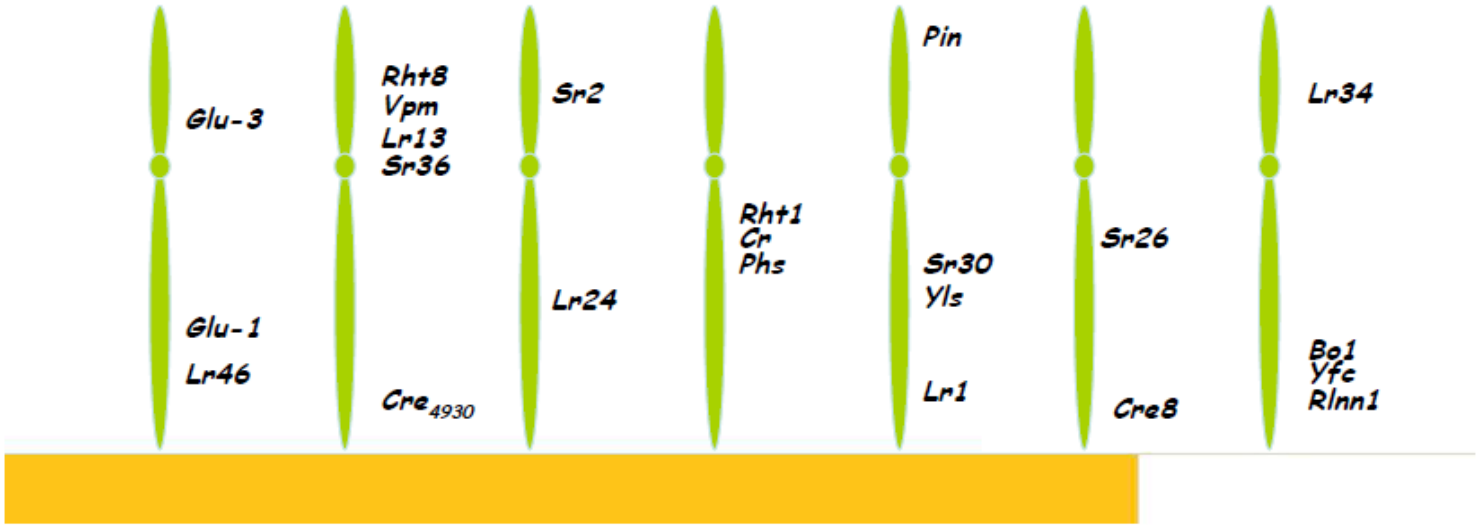
Marker-assisted Selection



ACPFG
AUSTRALIAN CENTRE FOR PLANT FUNCTIONAL GENOMICS PTY LTD

Marker assisted selection accelerates breeding

- Use ‘genetic markers’ to track segments of DNA
- Speeds introgression of desirable traits
- Over 30,000 genes in barley and 100,000 in wheat



Boran (relatively susceptible)

N'Dama (tolerant)

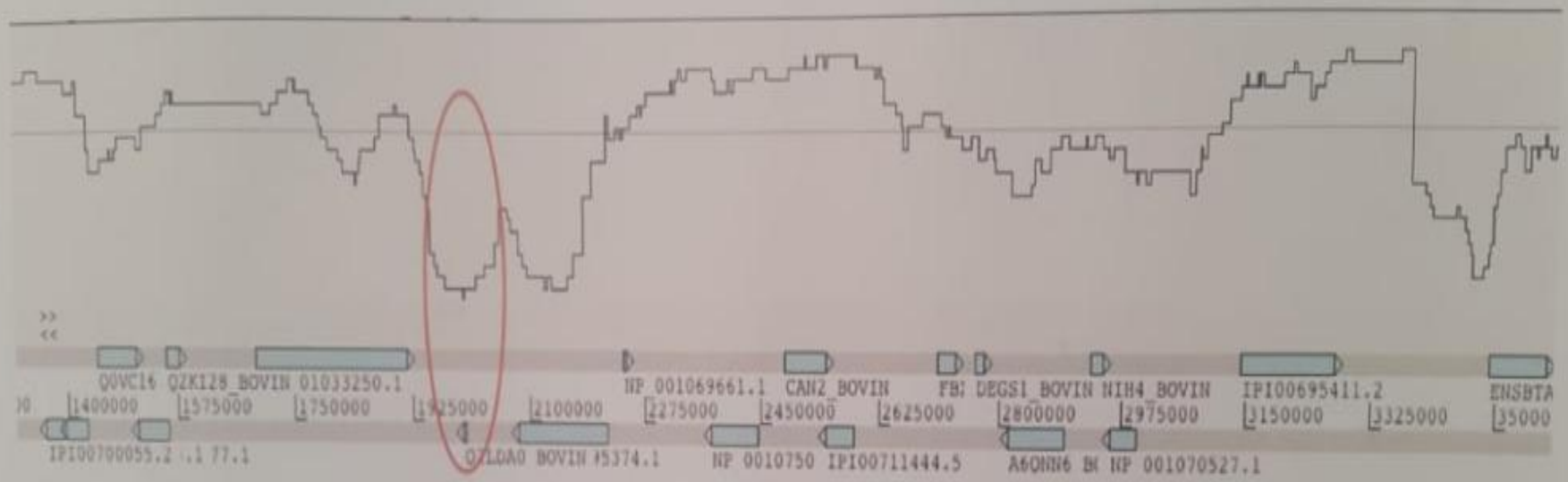
Boran cattle are much more susceptible to to trypanosomiasis than N'Dama. The gene mapping studies ILRI in Nairobi showed that genes at ten places in the genome controlled the response to infection. A surprising observation was that both Boran and N'Dama had 'Good' and 'Bad' genes. The graphs under each animal show the effect of the 'Bad' genes below the midline and the effect of the 'Good' genes abo the midline. The difference between the two breeds is that the 'Good' genes in N'Dama have a larger effe relative to the 'Bad' ones than Boran.

Next Generation sequencing to the rescue

Next generation sequencing is transforming genetics. One ABI SOLiD instrument can generate 50Gb of sequence in a run, compared to only 2Gb in a human or cow genome. That means we can sequence each genome many times over to ensure highly accurate detection of differences between breeds.

We have sequenced DNA from 10 Boran from the ILRI ranch at Kapiti and 20 N'Dama from Gambia to discover the majority of the common differences between these breeds

Gen Tlr5 berperan dalam ketahanan penyakit pada Sapi N'Dama



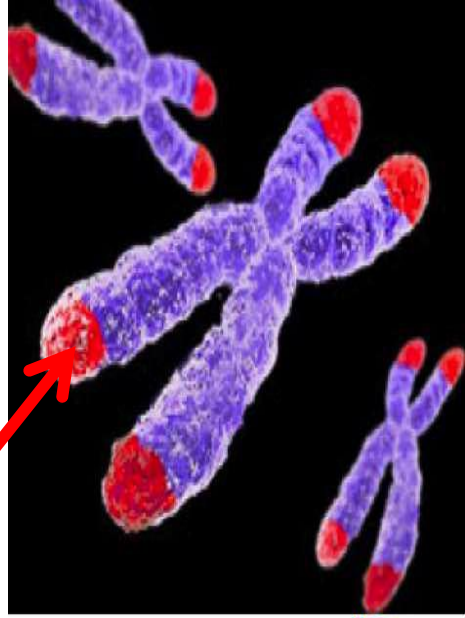
Minor allele frequencies in N'Dama chromosome 16 where there is a 'good' gene.

The dips in the graph are regions where there is very little variation in N'Dama, this could have been caused by selection for a beneficial variant of a gene either by the process of domestication or because one variant was better at resisting disease than another. The circle highlights the Tlr5 gene that is important in the innate immune response and could therefore have been selected to resist trypanosomiasis and / or other diseases. Less is known about the other genes that appear to be under selection but they may also be important

- Gene on chromosome 10 determines floppy vs. erect ears.

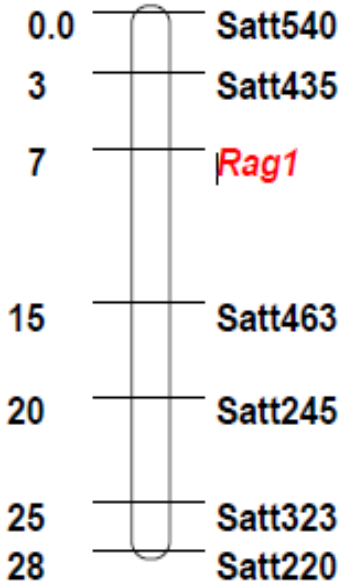
Gen penentu bentuk telinga pada hewan Anjing terletak pada kromosom 10

- Gene on chromosome 7 (*Rag1*) determines whether soybean plants are resistant or susceptible to soybean aphids.



Rag1 Resistant Line

rag1 Susceptible Line



Gen: sekuens basa nitrogen pembawa informasi genetik

LOC_Os08g07590

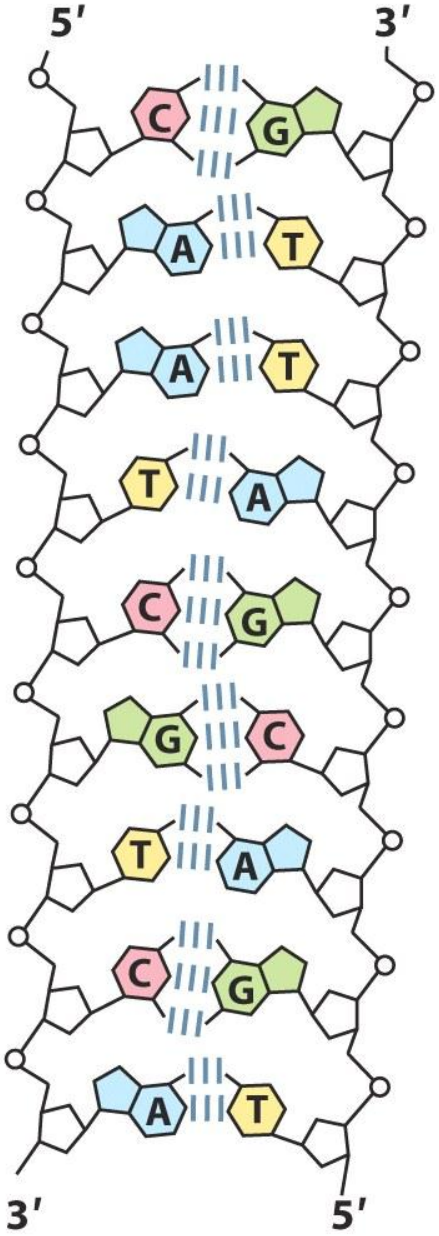
CDS

>12008.m04897

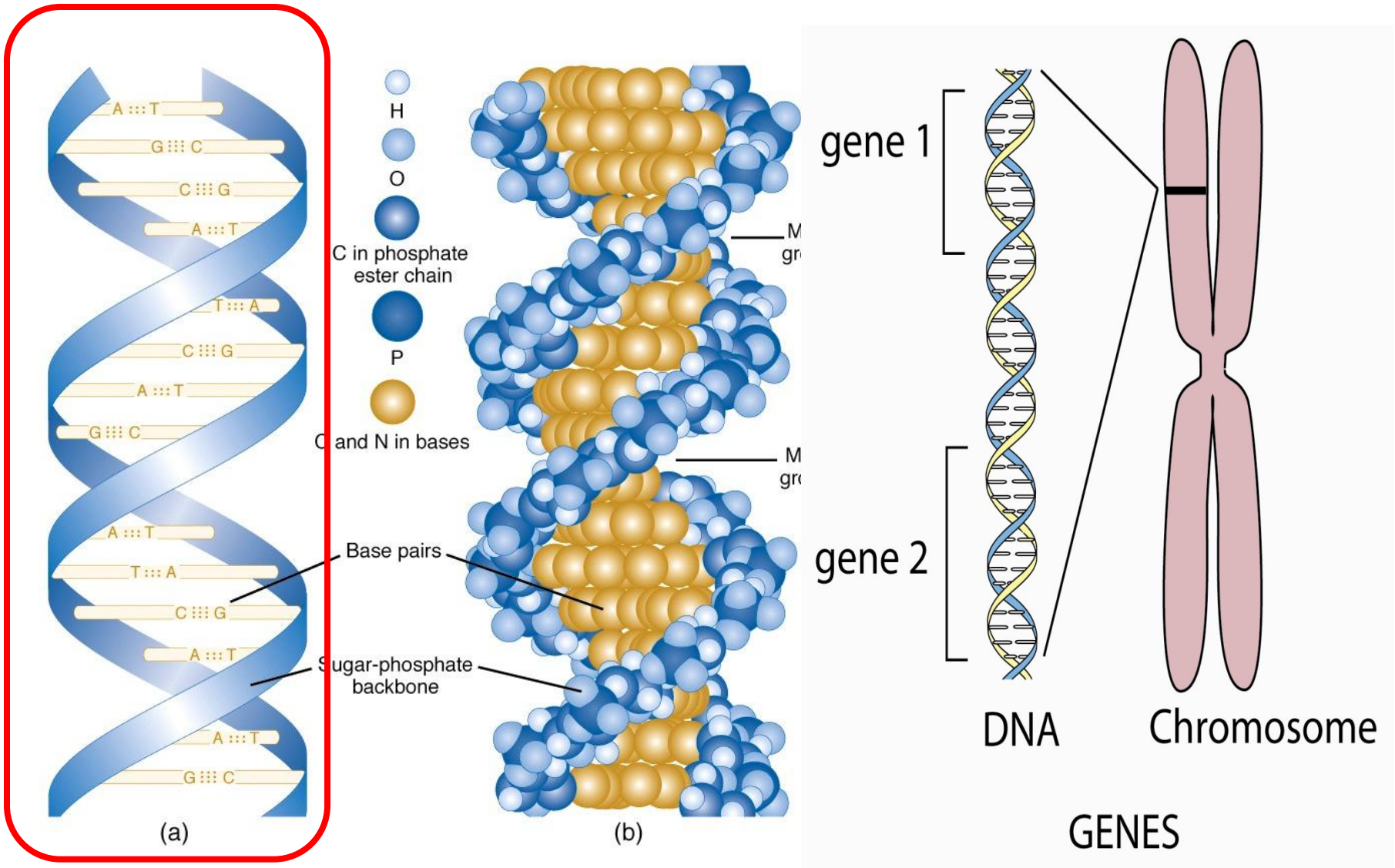
ATGGCCGCCATGCTCGCTCGCCTCGCCGGCAAGCAGCAGCAGCTGCTGCTGCAGTACGCG
CTCGCCGCTCGCCGGCGCCGCCCGGCCGACGCCTCCCCGGCGTGGTTCGGGCCCTACCCC
TACTTTGGTCTGCACCATTCCTCGGCGGCAGCCGCCGCCTCAAGTCGTACAACGCGGCGGC
TGGGGTTGCCGTGGGCGGTGACAAGGCCGCCGCCGACCACCACCACCGCCACGCCGTCG
GAGCTGATCTCGACGTCGGCGAGCTCGCCTCCGAGGAGCACTACTCCGCCGCCGGGACGT
CGTCGTCGTCATCCCGCGAGTACCACAGCGTTGCTCAAACGGTGGCGGCGGCTGATGGCG
ACTTCGACGGCGGCGAGAAGATGGCAACAAGGCCGGCGGCGAGAGGTGGCGGCGCCAA
AGCAAGTGTACTACTGGGGTGGGGAGAGCCGGAGCCAGGAGGTGGCCCACACTACAATT
GA

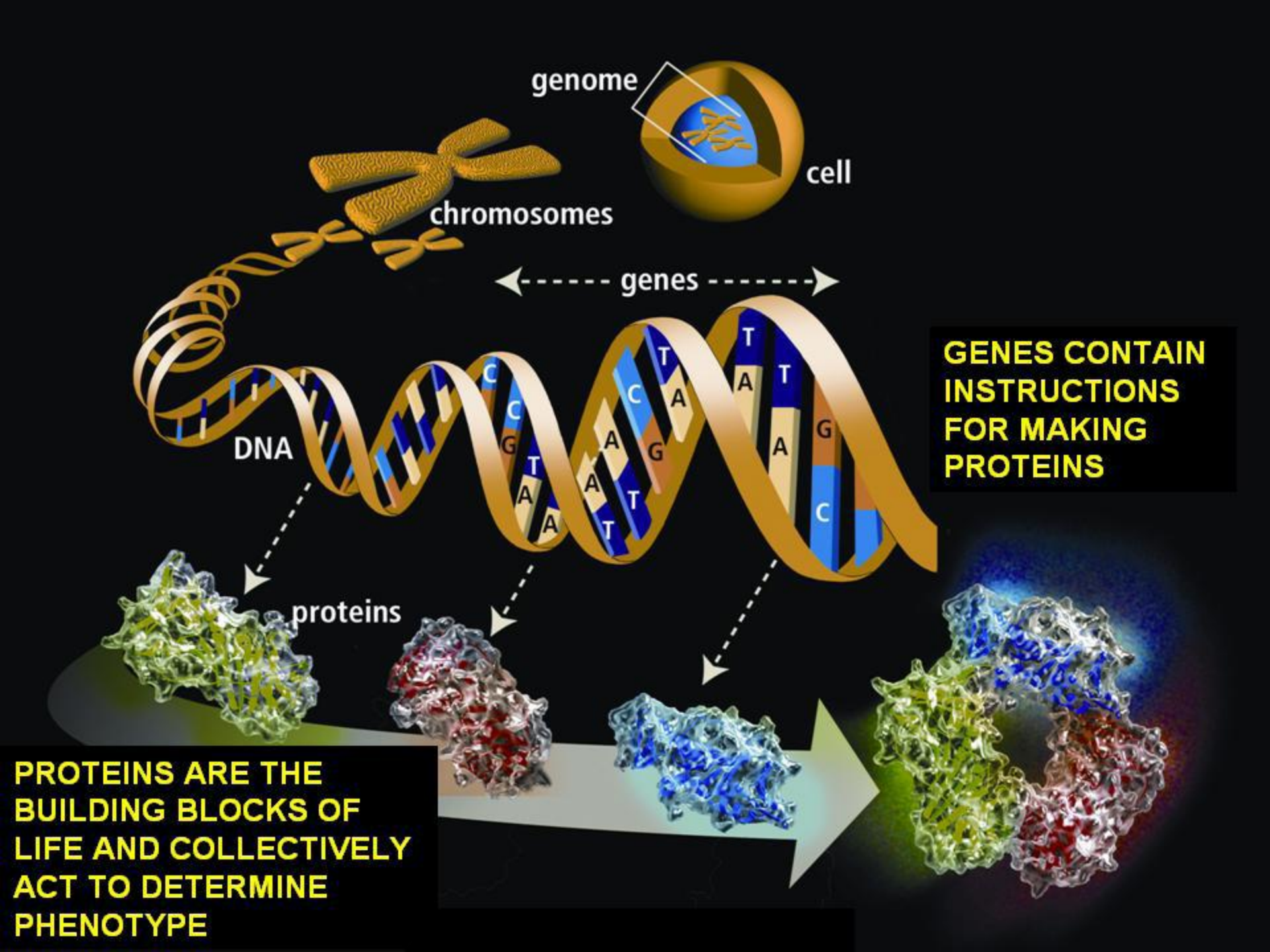
RANGKAIAN BENANG DNA

- Basa penyusun suatu benang DNA yang antiparallel tidak sama melainkan bersifat komplemen terhadap benang pasangannya.
- Basa C berpasangan dengan G, sedangkan A dengan T. Hal ini sangat bemanfaat dalam kaitan untuk penyimpanan dan pemindahan.

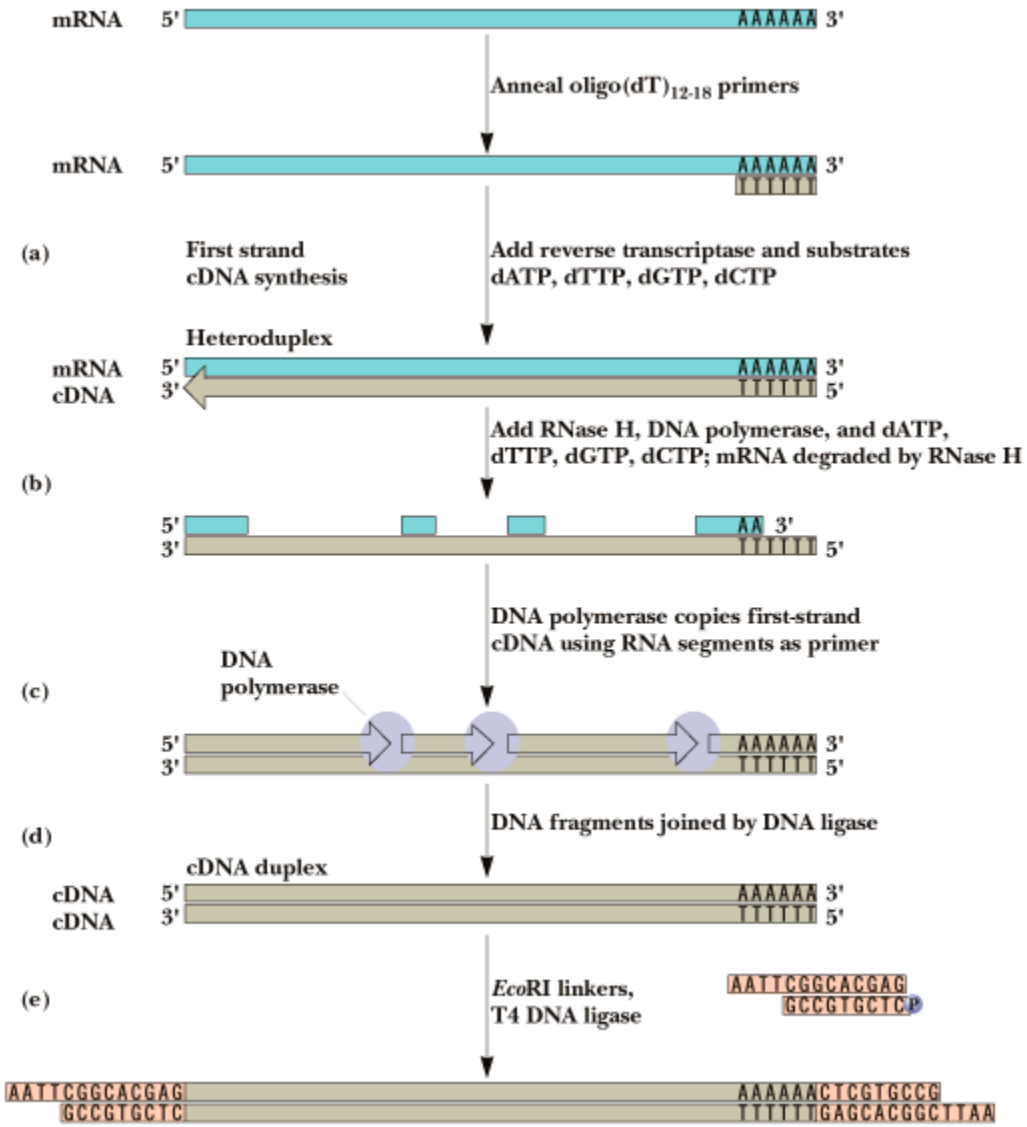


STRUKTUR DNA




genome
cell
chromosomes
genes
DNA
proteins
GENES CONTAIN INSTRUCTIONS FOR MAKING PROTEINS
PROTEINS ARE THE BUILDING BLOCKS OF LIFE AND COLLECTIVELY ACT TO DETERMINE PHENOTYPE

DNA dapat disintesis di luar Sel Hidup



*Eco*RI ended–cDNA duplexes for cloning

DNA dapat Digandakan dengan PCR (Polymerase Chain Reaction)

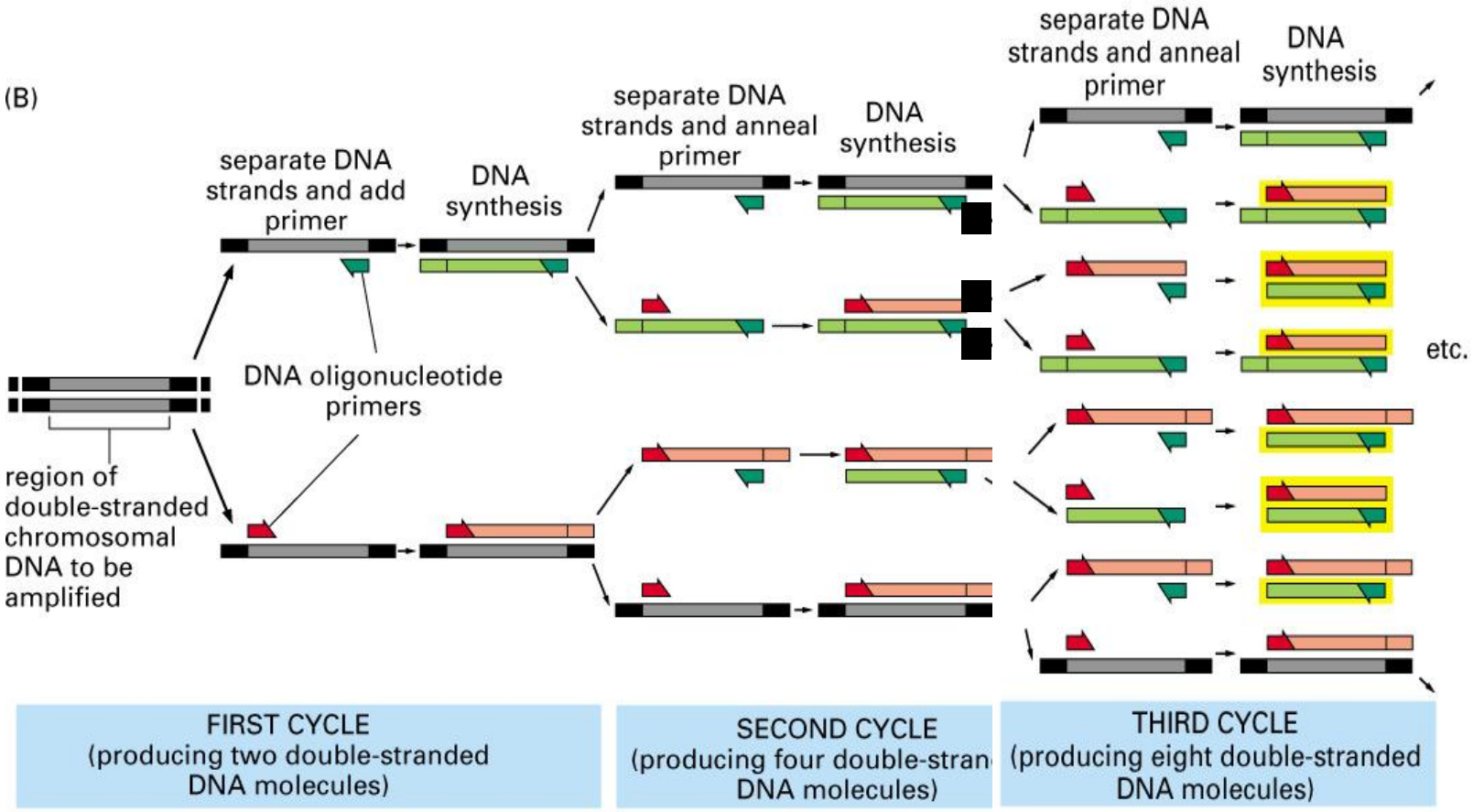
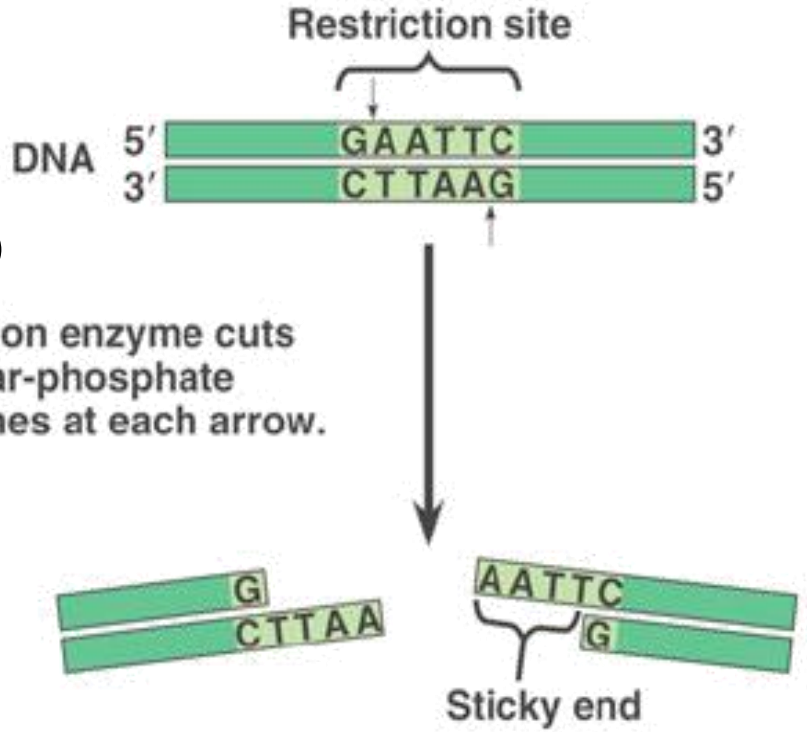


Figure 8–39 part 2 of 3. Molecular Biology of the Cell, 4th Edition.

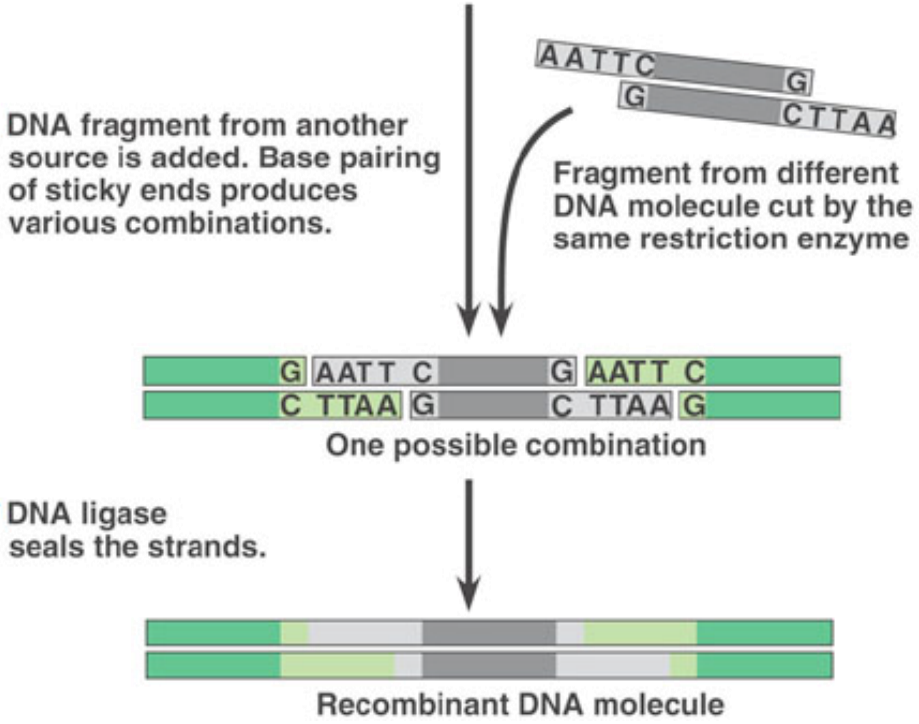
Figure 8–39 part 3 of 3. Molecular Biology of the Cell, 4th Edition.

DNA Bisa Dipotong

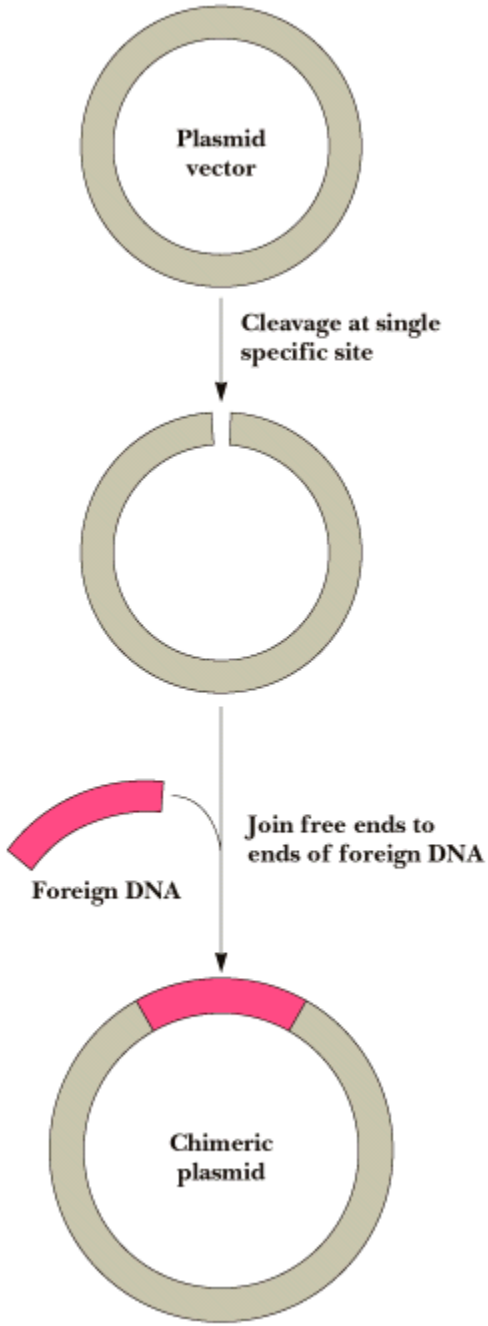
- **Menggunakan enzim endonuklease restriksi**
  - **Ujung "lengket" (sticky ends)**
  - **Ujung "tumpul" (blunt ends)**
- **Penamaan enzim**
  - ***Eco*RI**
  - ***E*** **= genus (*Escherichia*)**
  - ***co*** **= species (*coli*)**
  - **R = strain**
  - **I = # of enzyme**



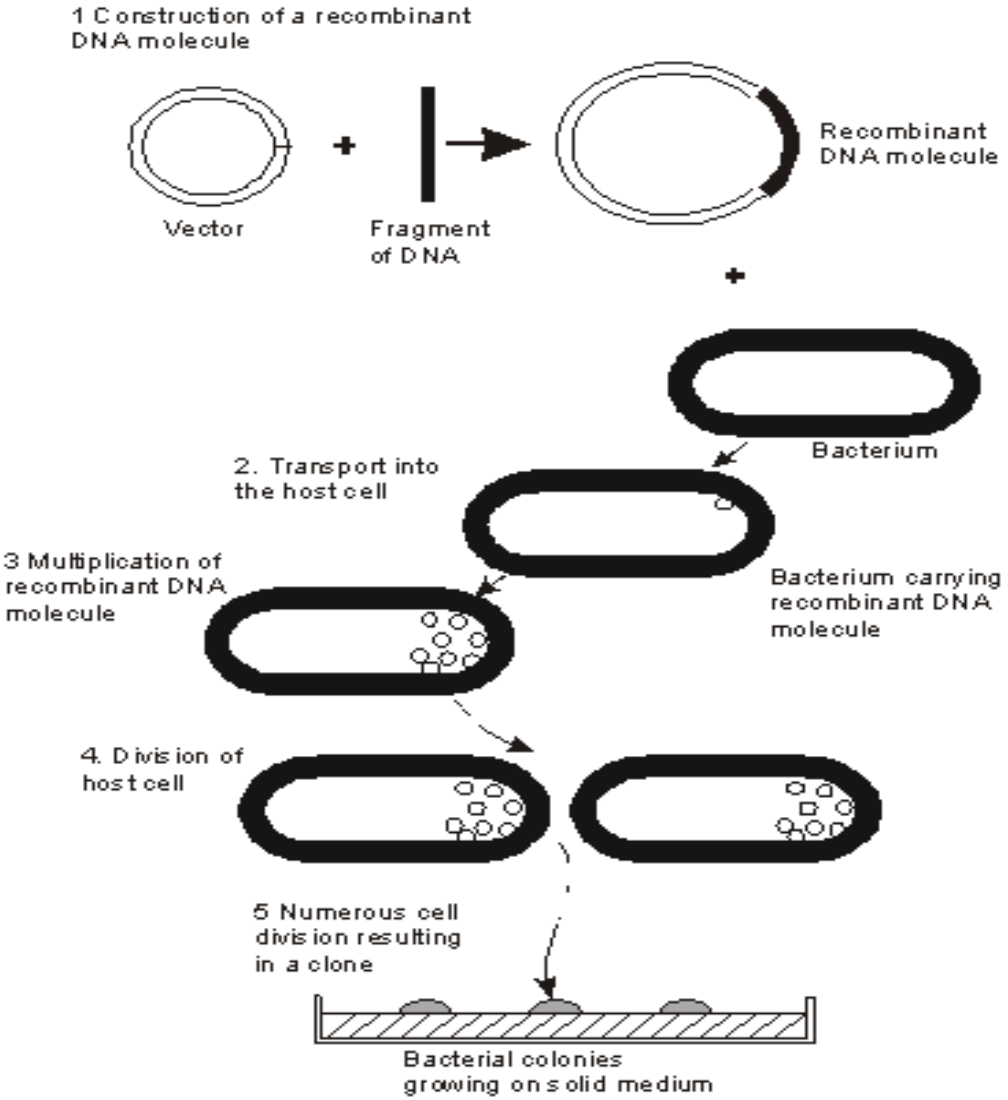
DNA bisa Disambung



- Pembentukan ikatan-H pada ujung-ujung yang komplemen (sticky ends)
- Ligase membentuk ikatan fosfodiester untuk merekatkan benang-benang DNA


Plasmid vector
Cleavage at single specific site
Foreign DNA
Join free ends to ends of foreign DNA
Chimeric plasmid

Kloning DNA (Penggandaan DNA)



DNA Rekombinan

- Teknik pertama yang menentukan proses kloning gen adalah isolasi DNA plasmid atau kromosom dilanjutkan dengan melokalisir gen yang diharapkan dengan cara memotong untaian DNA dengan enzim endonuklease restriksi

- Enzim endonuklease restriksi (khususnya endonuklease restriksi tipe II) mempunyai lokasi pemotongan yang spesifik, maka potongan DNA yang dihasilkan akan mempunyai bentuk potongan yang sama (Brown, 1995).

Construction of pNZ-orf3.4

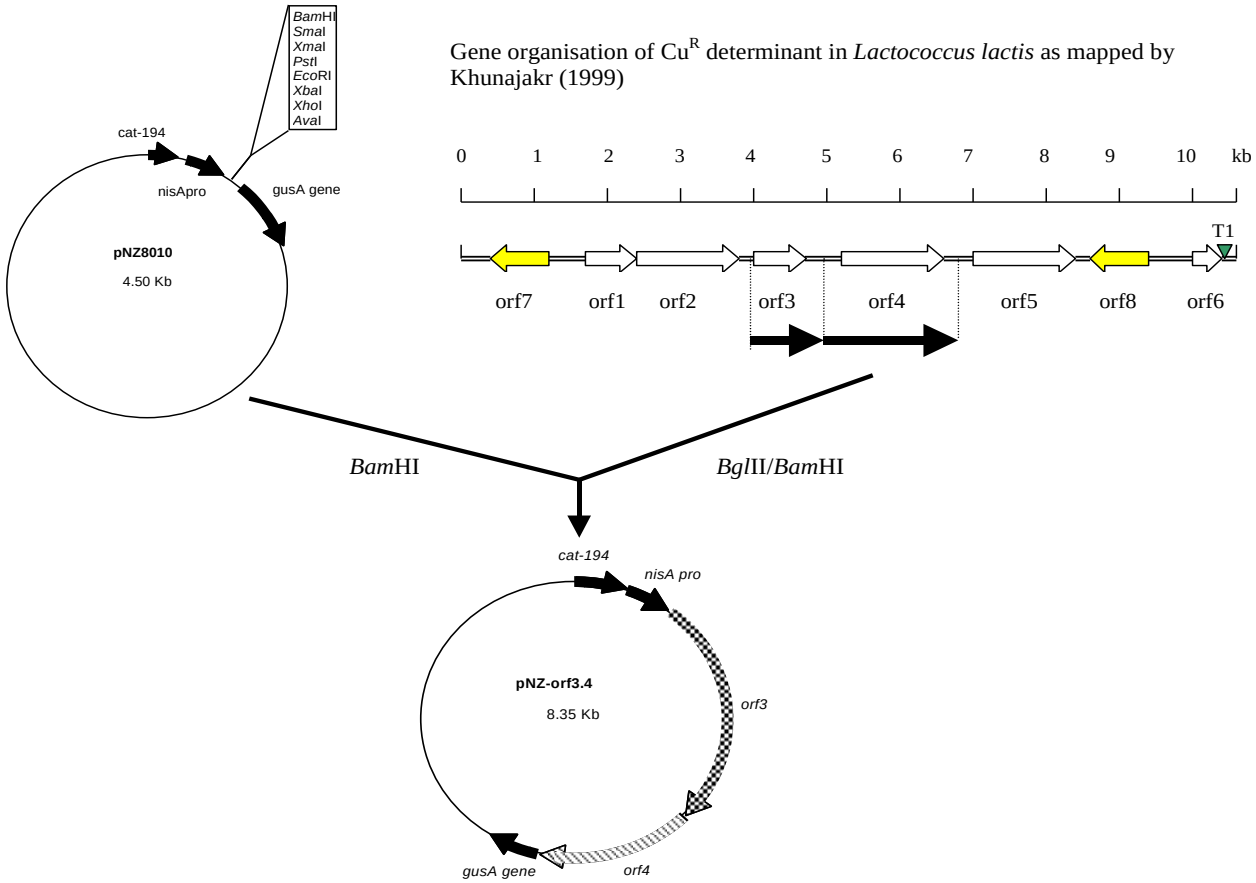
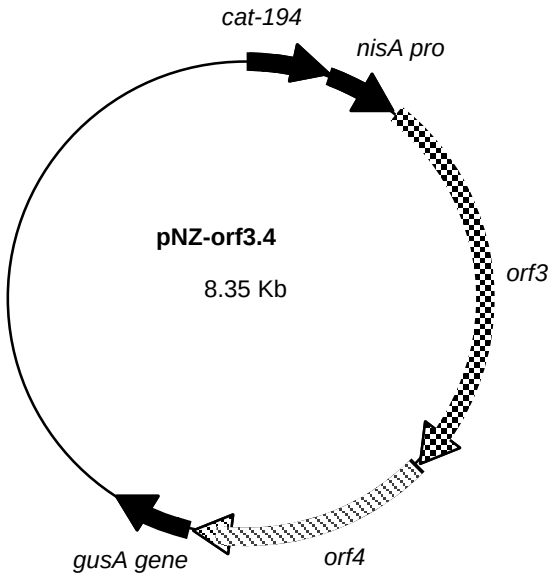


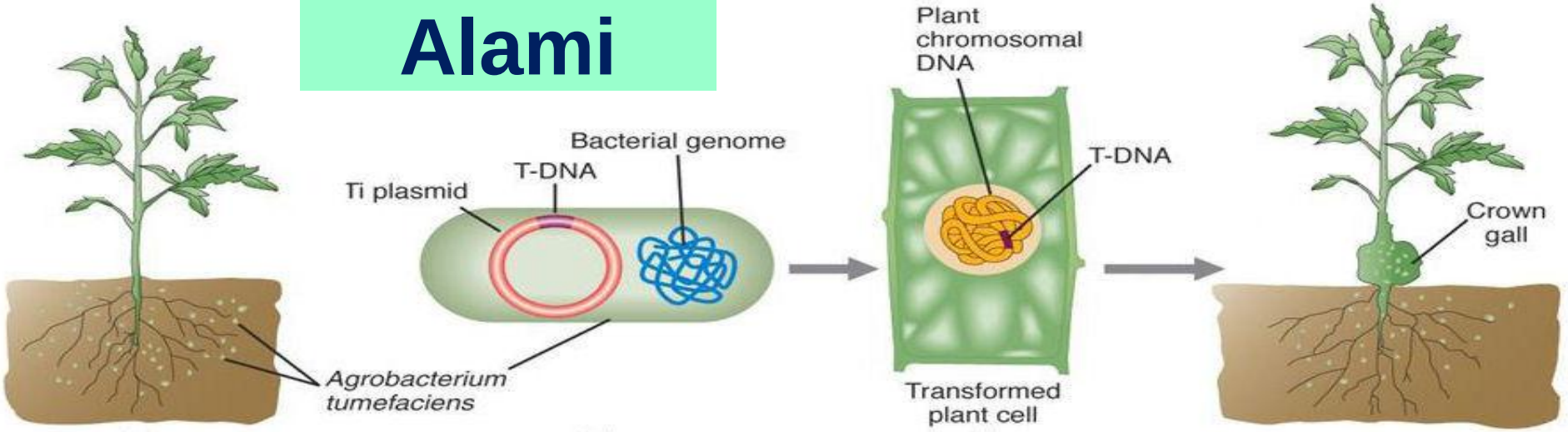
Figure 9. Plasmid pNZ-orf3.4 construction by ligation of *Bam*HI digested pNZ8010 with *Bam*HI/*Bgl*II digested pND951

Conclusion

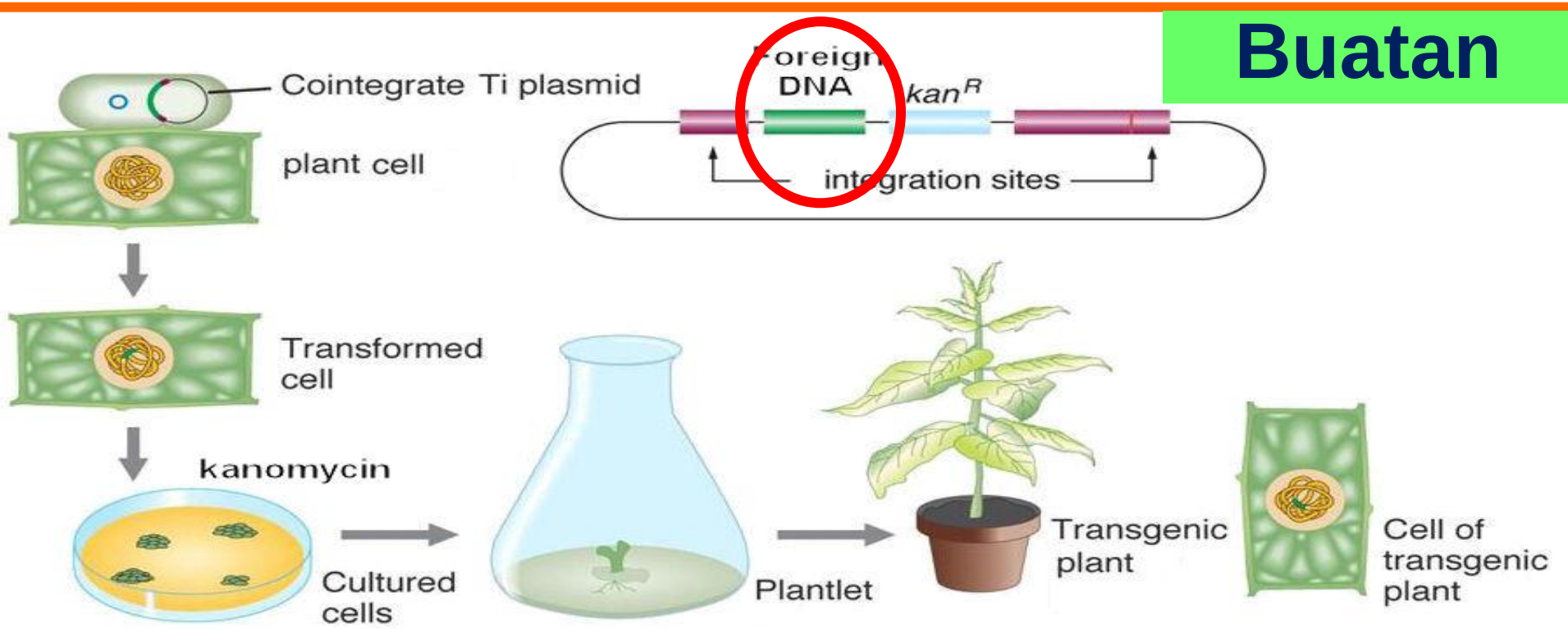


- **A plasmid recombinant bearing *orf3+orf4* has been constructed**
- **The presence of *cop* genes could be possible used as selection marker**
- **Most likely that *orf4* has a determinant effect on copper resistance**

Alami



Buatan

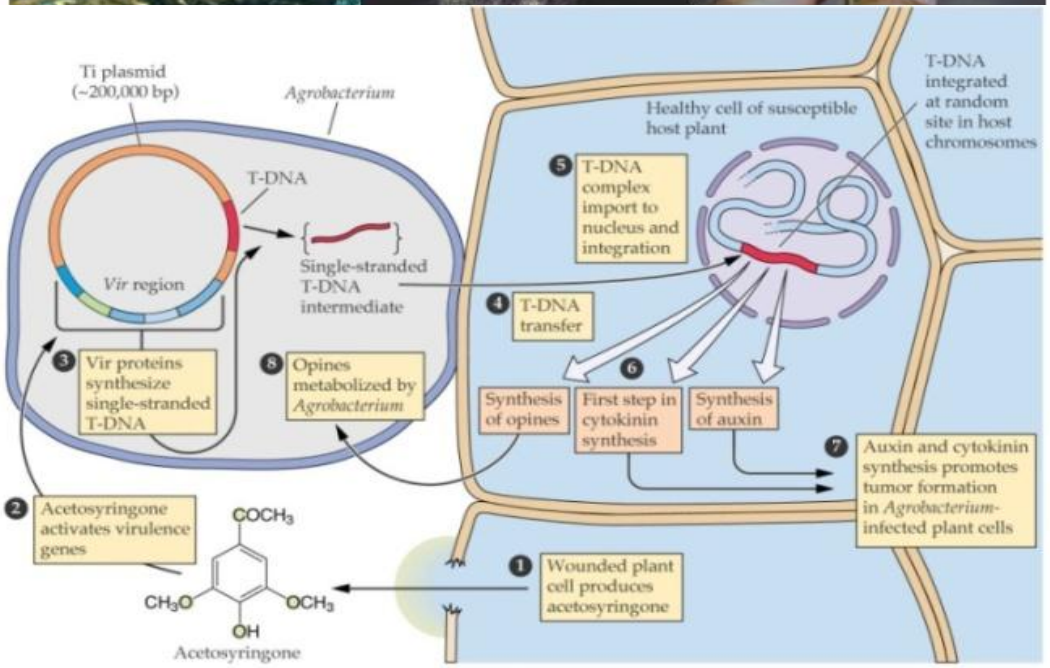


Rekayasa Genetika:

- Hanya gen interes pembawa karakter unggul yang dipindahkan
- Proses perpindahan menggunakan metode transformasi
- Tanaman yang dihasilkan disebut tanaman Produk Rekayasa Genetik (PRG) atau sering disebut tanaman transgenik

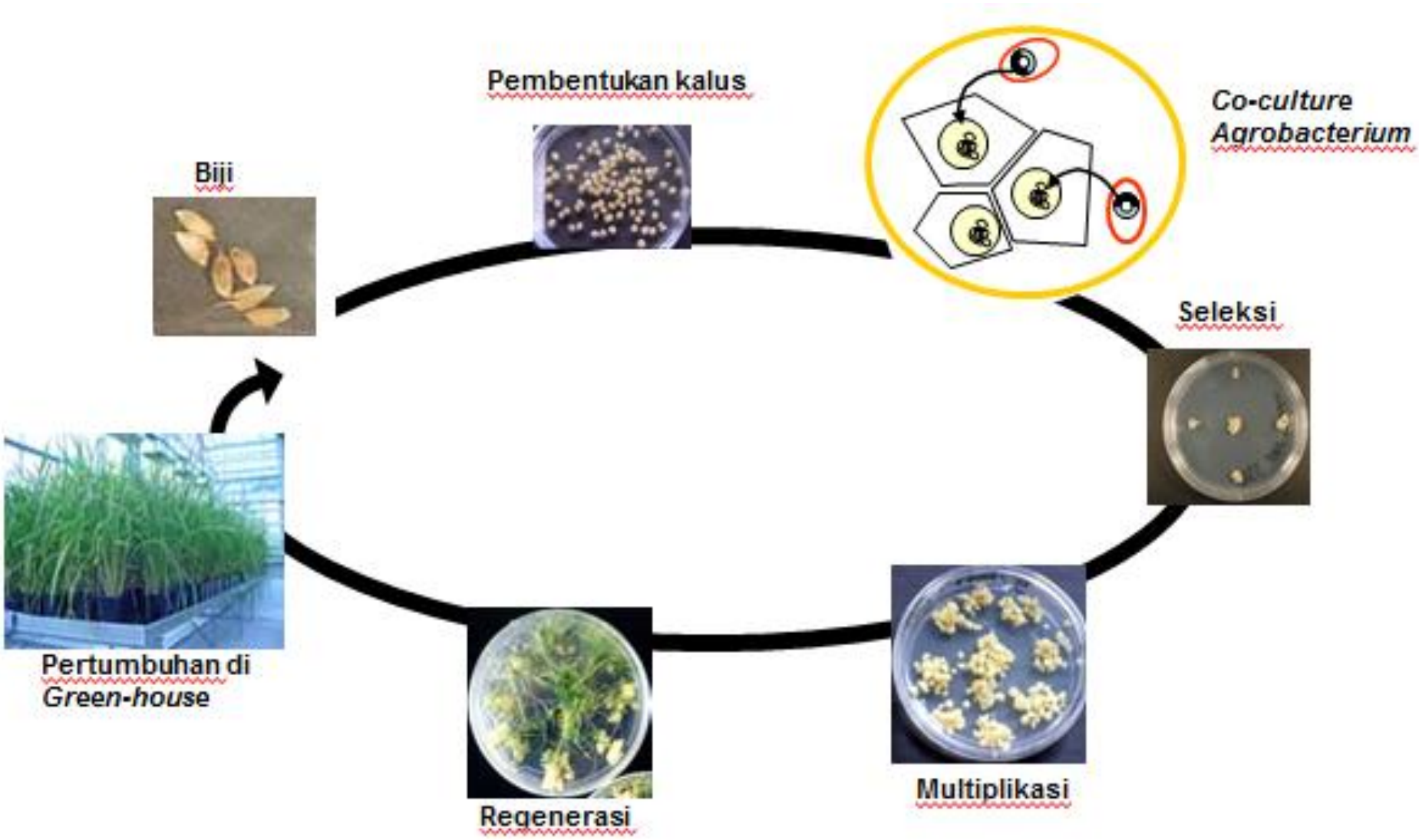
Transfer Genetik Alami

(*crown gall diseases*) oleh *Agrobacterium tumefaciens* (Chrispeels dan Sadava, 2003).

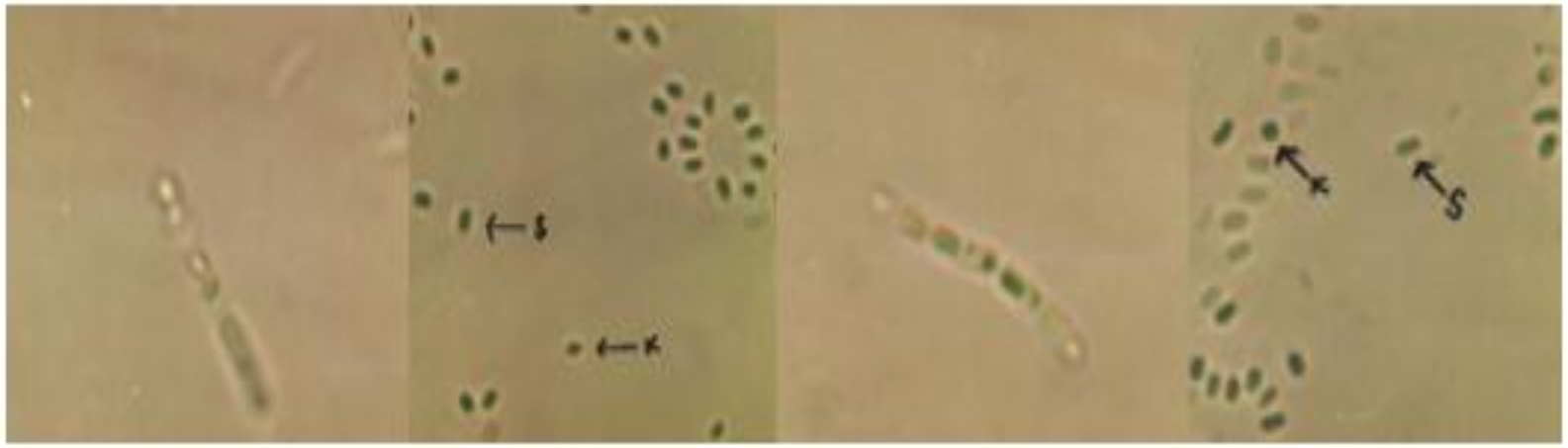


Perpindahan material genetik dari bakteri *Agrobacterium tumefaciens* ke dalam kromosom tanaman (Chrispeels dan Sadava, 2003).

Transformasi Genetik dengan *Agrobacterium* (Sallaud *et al.*, 2003)



Bt: *Bacillus thuringiensis*



- Bakteri tanah penghasil kristal protein cytolisin (cyt) dan delta-endotoksin (cry)
- Menjadi toksin pada serangga dengan sistem pencernaan yang basis (pH >10) dan mempunyai reseptor spesifik
- Kristal cry toksik terhadap serangga Lepidoptera, sedang kristal cyt toksik terhadap serangga Diptera dan Koleoptera

Kapas Bt

Contoh tanaman kapas yang tahan serangga (kanan) dan tidak tahan serangga (kiri) hama *cotton bollworms* (Glare dan O'Callaghan, 2000).

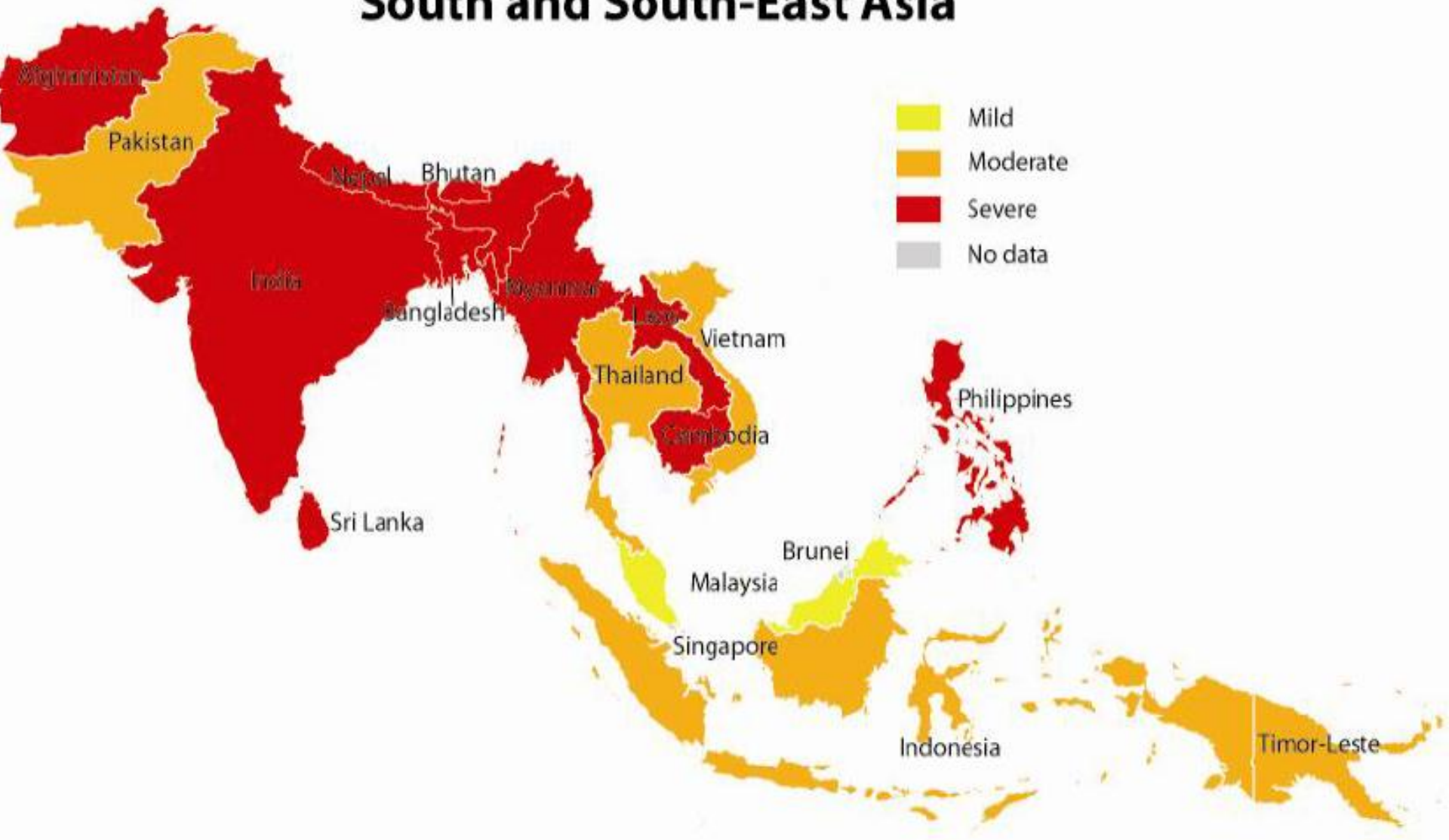
Kapas Bt di India

Jagung Bt

Jagung Non Bt

Jagung Bt

Severity of Vitamin A Deficiency in South and South-East Asia



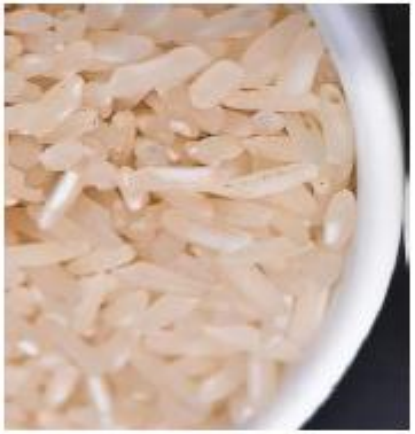
Source: Global Prevalence of Vitamin A Deficiency in Population at Risk 1995-2005: WHO Global Database on Vitamin A Deficiency (http://www.who.int/vmnis/en/)

[1] Severity cutoffs based on serum or plasma retinol <0.70 µmol/l in preschool-age children (mild: ≥2%-<10%; moderate: ≥10%-20%; severe: ≥20%)

HarvestPlus

Golden Rice

→ A genetically modified rice that produces high amount of beta-carotene in its grains



Ordinary Rice

+

phytoene synthase (*psy*) gene from maize

and

phytoene desaturase (*crtI*) gene from a common bacterium

Golden Rice

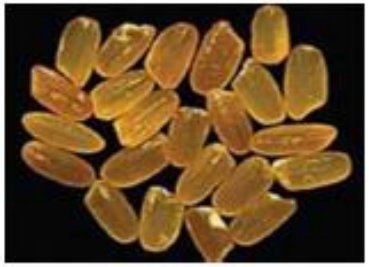
2000

Prototype
Taipei 309 variety
1.2-1.8 µg/g

2003

Golden Rice 1
Cocodrie variety
Up to 8 µg/g

2005



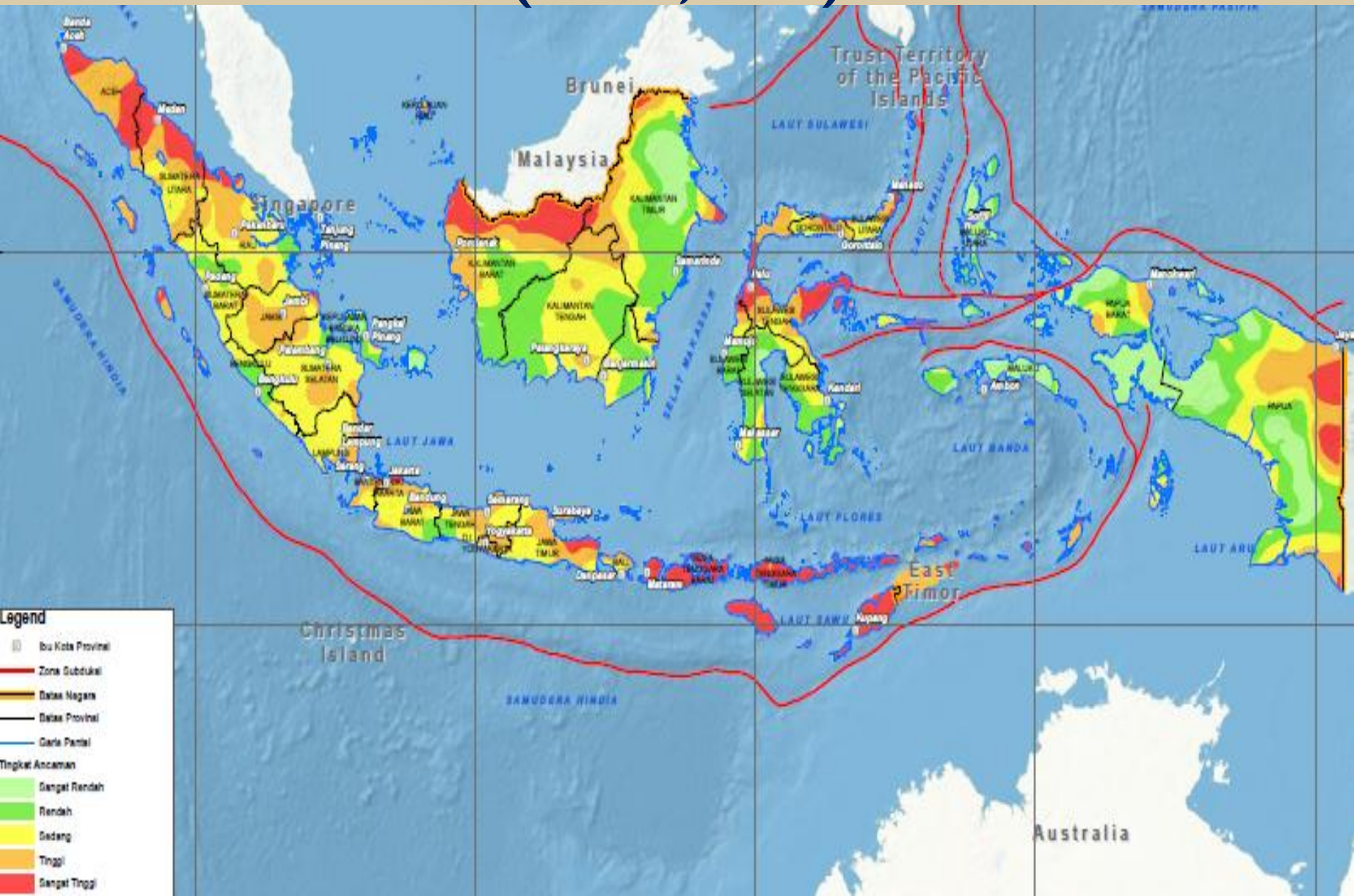
Golden Rice 2
Kaybonnet variety
Up to 36.7 µg/g


Tidak disemprot
Disemprot

Solusi Teknologi untuk Daya Saing Produk Pertanian: Bioteknologi untuk Keunggulan Lokal

- Pemanfaatan bioteknologi untuk pengembangan produk unggulan lokal (*endowment*) yang tidak dimiliki negara lain:
  1. *Tanaman tropis (tebu, padi, sawit, coklat, dll)*
  2. *Buah-buahan dan sayuran tropis*
  3. *Hewan ternak tropis*
  4. *Vaksin tropis*
  5. *Mikrobia tropis*

Peta Kekeringan di Indonesia tahun 2010 (BNPP, 2010)



Drought-tolerant Sugarcane in Indonesia (Prof. Bambang Sugiharto, Univ Jember)

Bioteknologi untuk Menjawab Tantangan Kebutuhan Pangan:

1. Jumlah penduduk yang semakin besar (meningkat setiap tahun)
2. Adanya pengaruh pemanasan global (*global warming*)
3. Alih fungsi lahan produktif menjadi area industri dan perumahan
4. Alih fungsi bahan pangan menjadi sumber energy (*biofuels*) dan sumber pakan