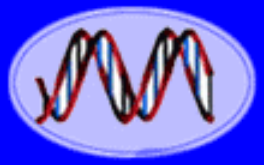
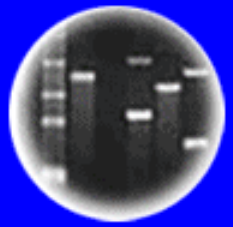


DNA
Genetic Code of Life

Entire Genetic Code
of a Bacteria



DNA Fingerprinting

Cloning: Ethical Issues
and Future Consequences

Plants of Tomorrow

HC70A, PLS530, & SAS70A
Winter 2012
Genetic Engineering in Medicine, Agriculture, and Law

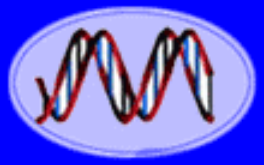
Professors Bob Goldberg, Channapatna Prakash, & John Harada

Lecture 5
What Are Genes & How Do They Work: Part Three

UCLA

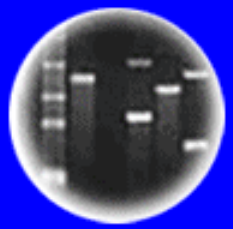
TUSKEGEE UNIVERSITY

UCDAVIS
UNIVERSITY OF CALIFORNIA



DNA
Genetic Code of Life

Entire Genetic Code
of a Bacteria



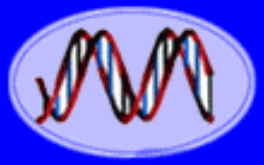
DNA Fingerprinting

Cloning: Ethical Issues
and Future Consequences

Plants of Tomorrow

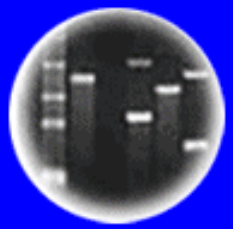
Last Tuesday's Lecture: What Are Genes & How Do They Function - Part Two

1. What is a Gene?
2. What are the Structure & Chemical Properties of DNA?
3. How is Polarity in DNA Established & Lead to Biological Uniqueness?
   a) What is the Role of Deoxyribose Sugar in Establishing Polarity 5' to 3'? The Hub!
   b) How Does the Formation of Phosphodiester Bonds Lead to 5' to 3' Polarity and Unique Sequences?
4. Where Are Genes Located in the Cell?
   a) What are Chromosomes and What Do They Do?
   b) What is the Structure of Eukaryotic Chromosomes? How do they Fit into a "Small" Nucleus
   c) What is the Evidence That Genes Work Independently of One Another? What is Colinearity Between Genes & Proteins?
5. What Are Alleles & How Do They Contribute to Genetic Diversity?
6. What is the Anatomy of a Gene?
7. What Are Control Sequences & How Do They Program Development?
8. How Does the Eye Gene Control Eye Development?
   a) How Does the Eye Genetic Regulatory Network Work to Program Eye Formation?
9. How Can an Eye Be Produced on a Leg Using Genetic Engineering?
10. Demonstration - DNA Fingerprinting



DNA
Genetic Code of Life

Entire Genetic Code of a Bacteria



DNA Fingerprinting

Cloning: Ethical Issues and Future Consequences

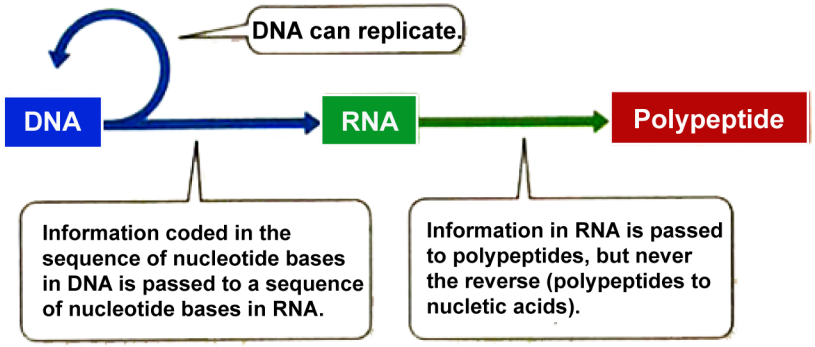
Plants of Tomorrow

TODAY'S THEMES

1. How Does DNA Replication Occur?
2. What is Required For DNA Replication & What is the Importance of Replication For Genetic Engineering?
3. What Are the Properteis of a Genetic Engineering Vector?
4. What is the Polymerase Chain Reaction (PCR) and How is PCR used?
5. How Has PCR Revolutionized Genetic Engineering?
6. How Do Mutations Occur & Lead To Genetic Diversity?
7. How Can Pedigrees Be Used To Follow the Inheritance of Mutant Genes?
8. How Do Mutations Change Phenotypes?
9. What is the Colinearity Between Genes & Proteins (how does DNA→protein)?
10. What is the Genetic Code?
11. What are the Properties of the Genetic Code?
12. How Do Gene Expression Processes Differ in Eukaryotes & Prokaryotes?
13. How Can Splicing Cause One Gene To Specify Several Different Proteins?
14. Yo!-It's in the DNA Sequences- What Are the Implications For Genetic Engineering?
15. Epigenetics – Modifications of DNA

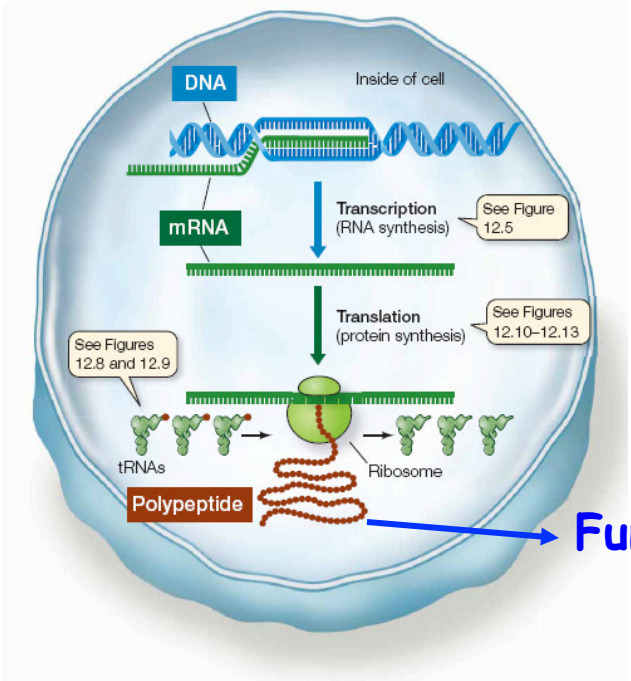
How Do Genes Work-A Review

① Replication



② Gene Activity to Function & Phenotype

Gene Activity → Protein → Function → Phenotype (Trait)

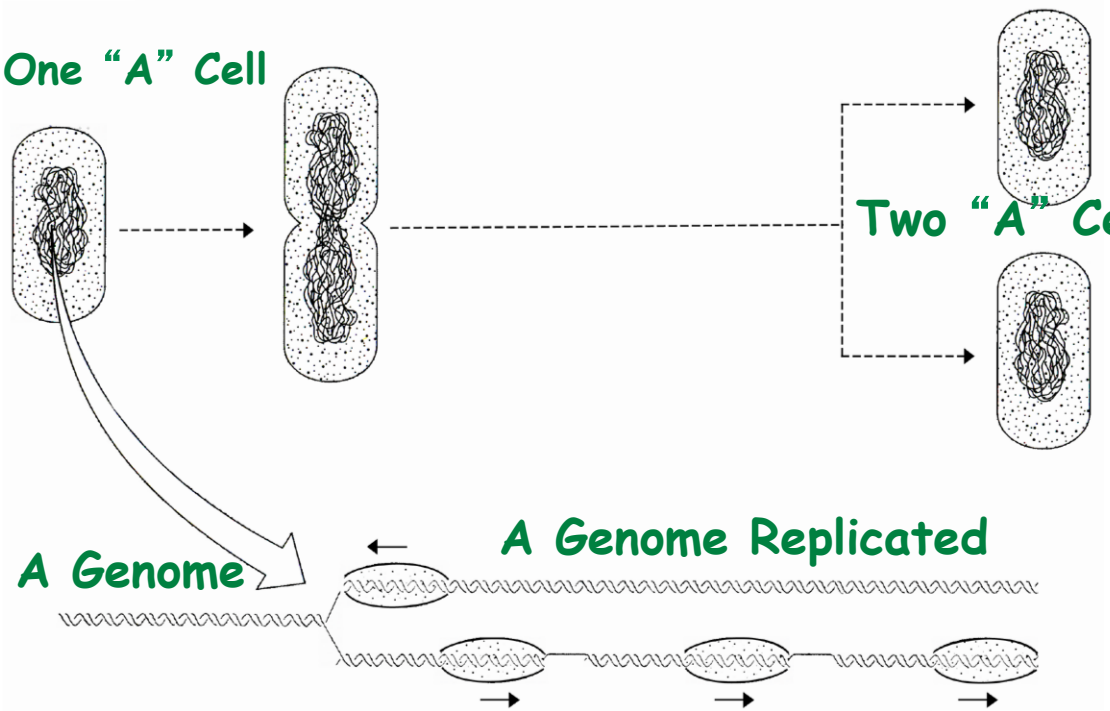


Function →

A Gene is NOT Expressed Unless A Functional Protein Produced!

1

How Are Genes Replicated Each Cell Generation?

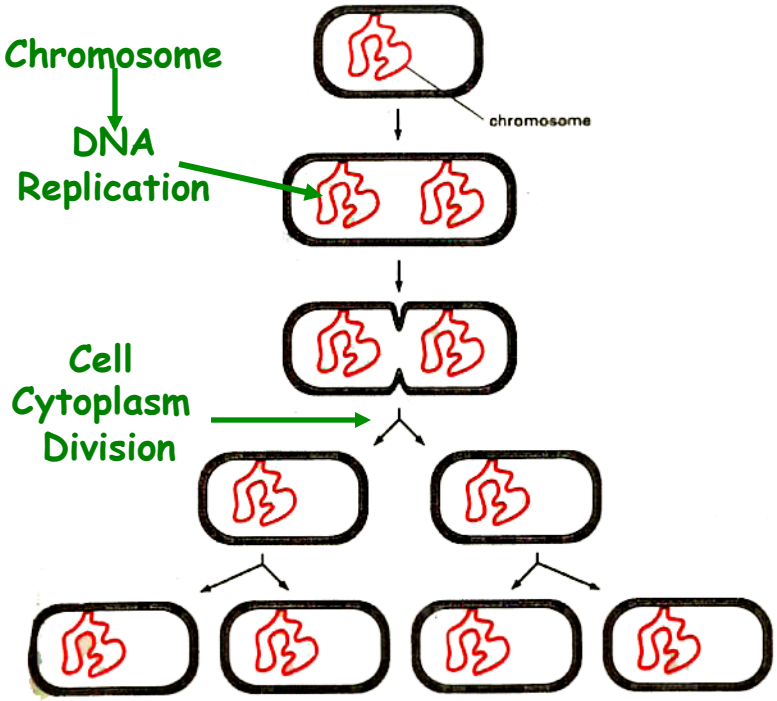


How is the DNA Sequence Copied/ Replicated Each Cell Division?

Pass on Genes to Next Generation Precisely?

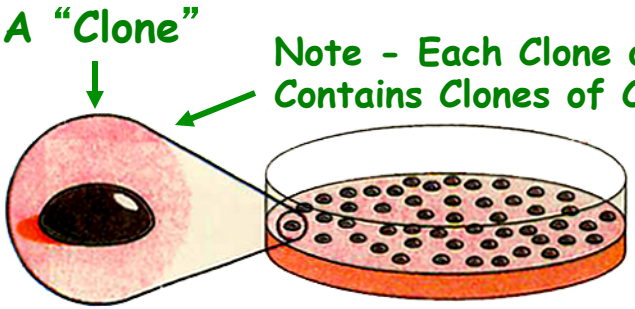
BASIS OF LIFE!

Genes Are Replicated During Each Cell Division



Clones

A Bacterial Colony Contains Many Copies of Same Cell, or Clones, Which are Genetically Identical!



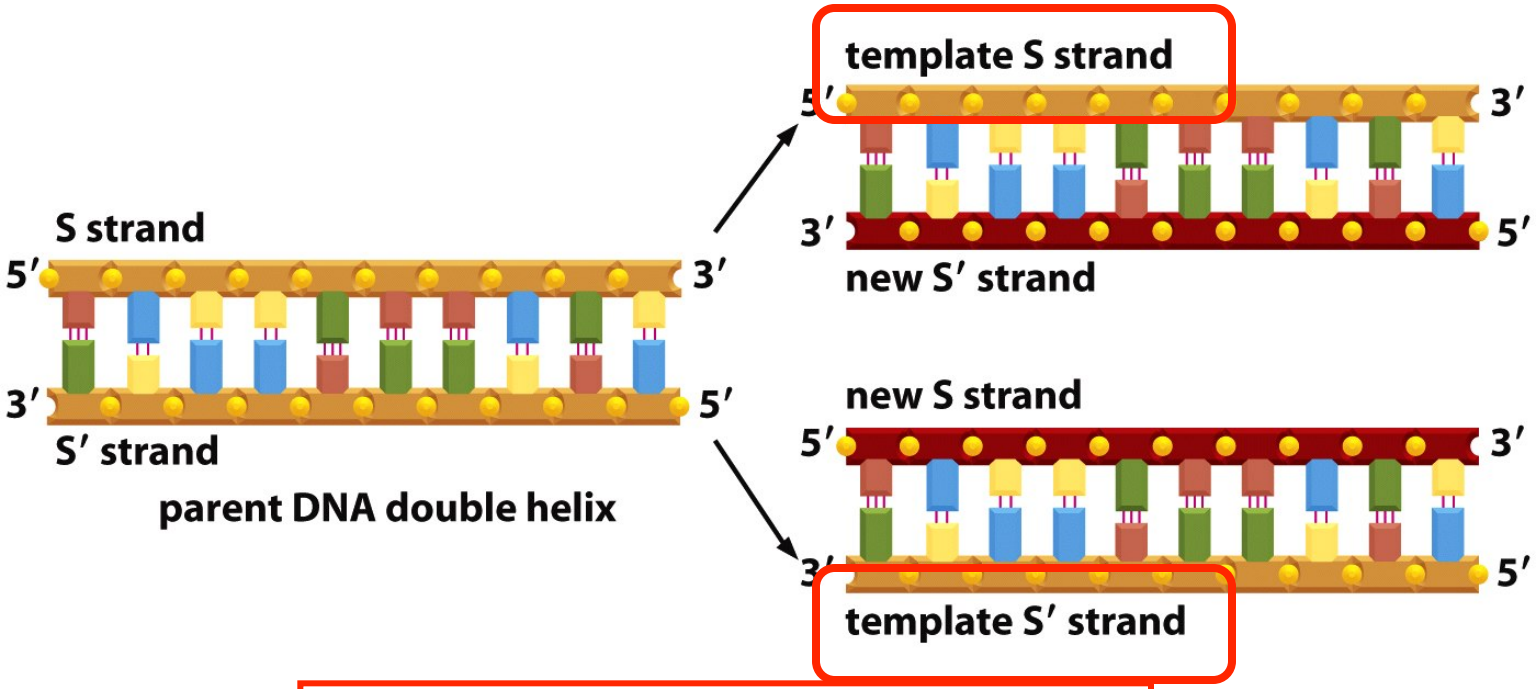
-10^6 cells per colony ~50 colonies per dish

Each Daughter Cell Contains The Same Collection of Genes

Clones!

Major Properties of Genetic Material
Replication, Stability, & All Cells!!

The Sequence of Each DNA Strand Must Be Maintained Division After Division

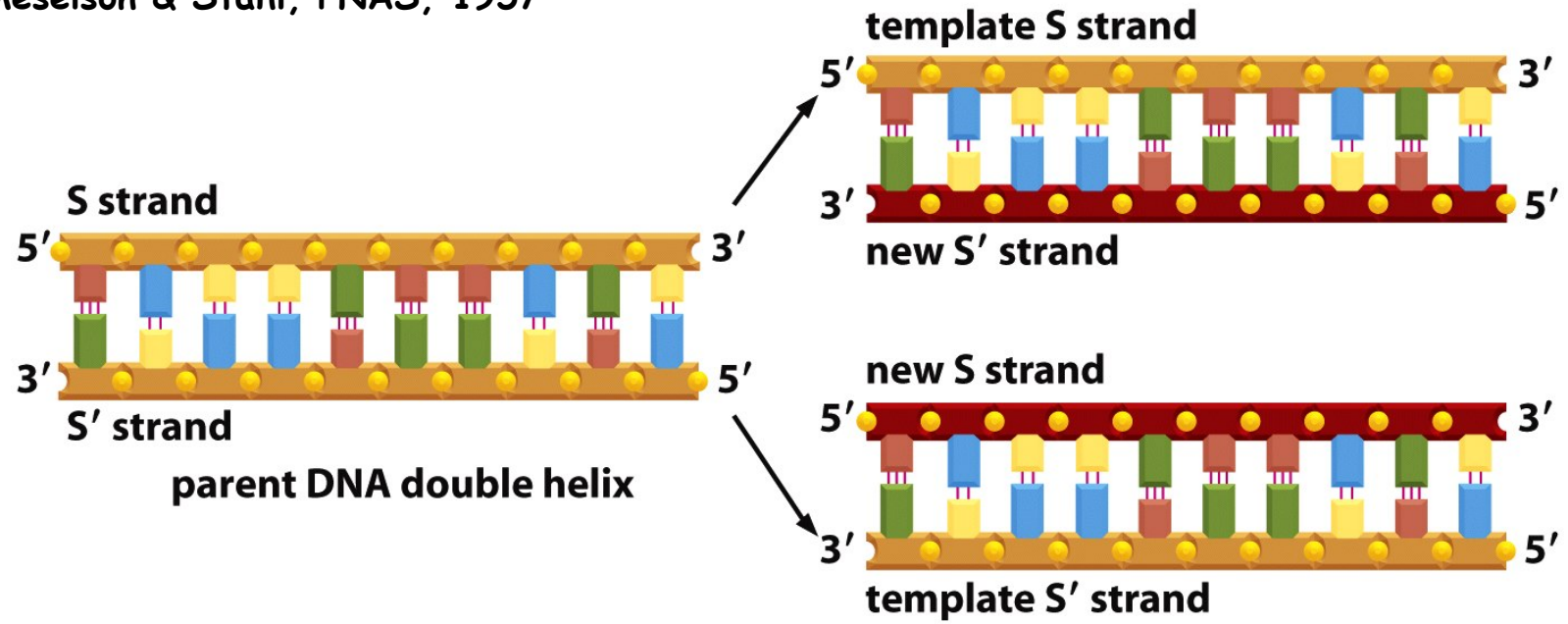


How Does This Occur?
Property of The DNA Molecule

Note → SEQUENCE & POLARITY

DNA Replication Occurs Semi-Conservatively

Meselson & Stahl, PNAS, 1957



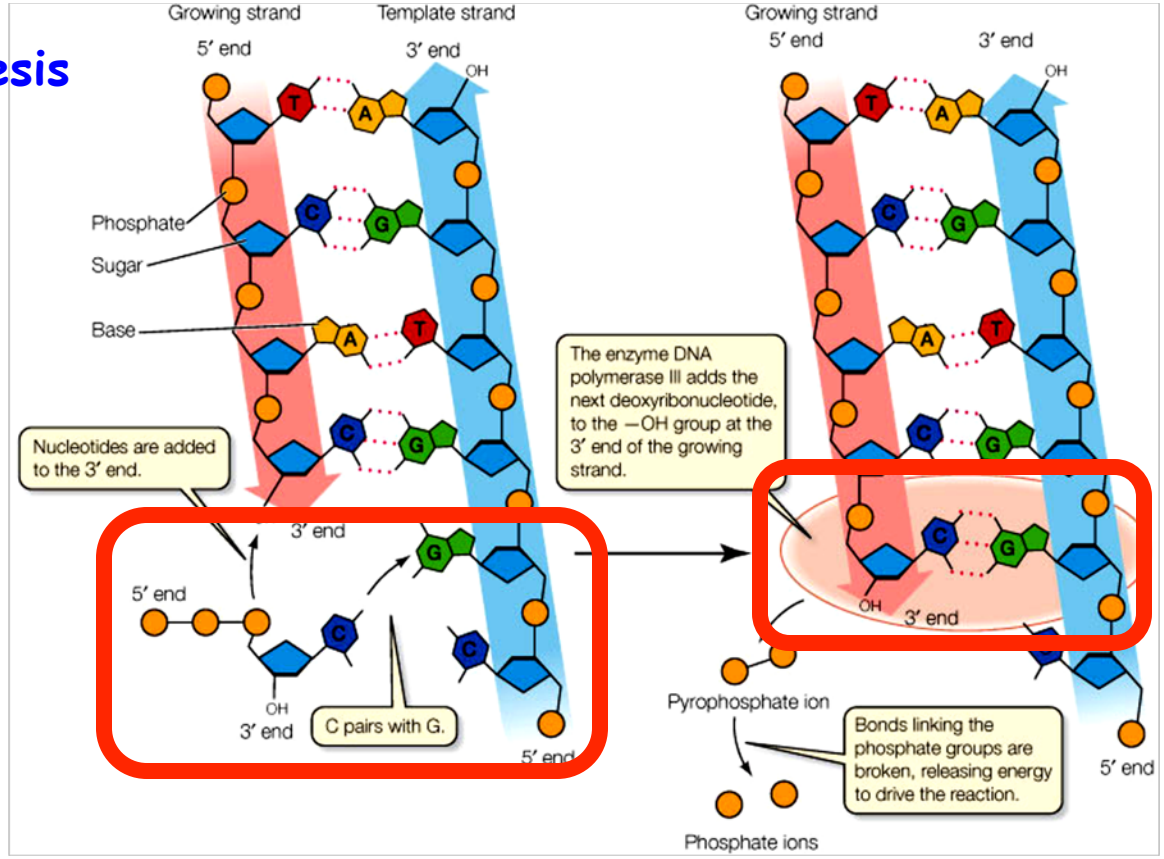
1. DNA Structure Allows DNA Sequence to Be Maintained by Complementary Base Pairing
2. Each Strand Serves as a Template for the Synthesis of a Complementary Strand
3. New DNA Molecules are Precise Copies of Parental DNA - Each Containing One Newly Synthesized Complementary Strand

DNA Sequence of One Strand is A Template For The New Strand

Synthesis

5'

3'



Sequence is Specified by Complementary Bases

Note: 5' (P) & 3' (OH)

5' to 3' Polarity Specifies Sequence

The DNA Sequence is Maintained Generation To Generation

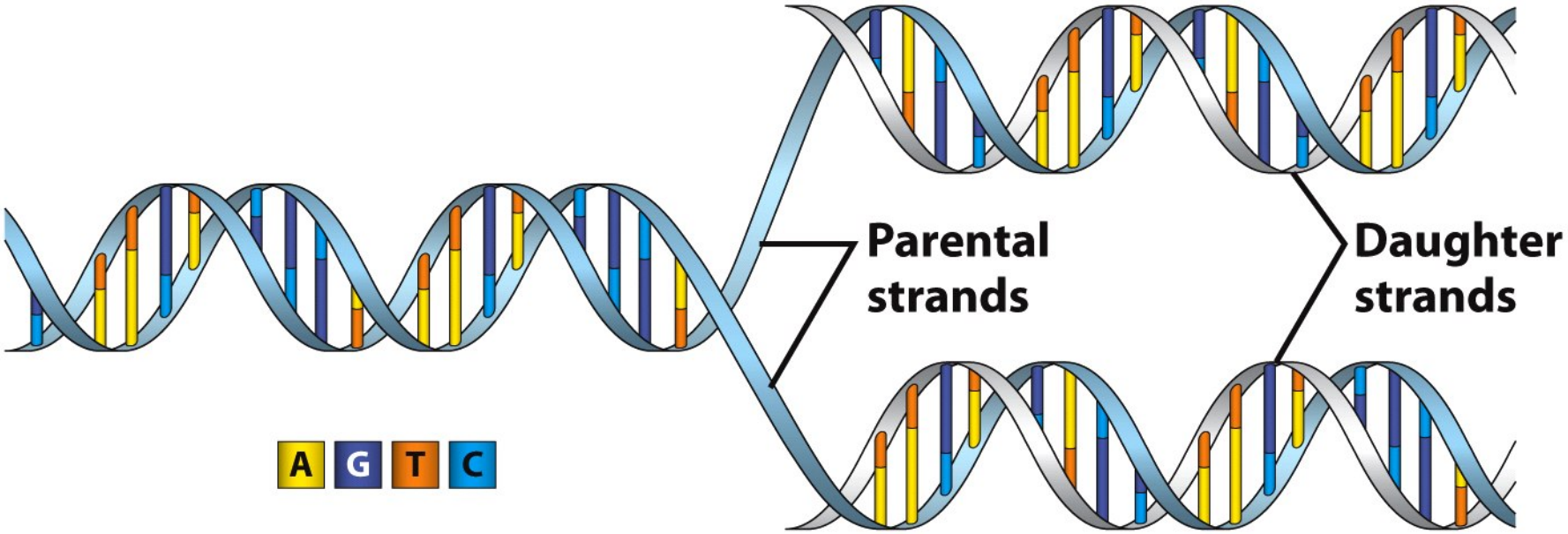


Figure 1-10
Molecular Cell Biology, Sixth Edition

The DNA Sequence "Lives" Forever!

What is Required For DNA Replication to Occur and What Role Does DNA Replication Play in Genetic Engineering?

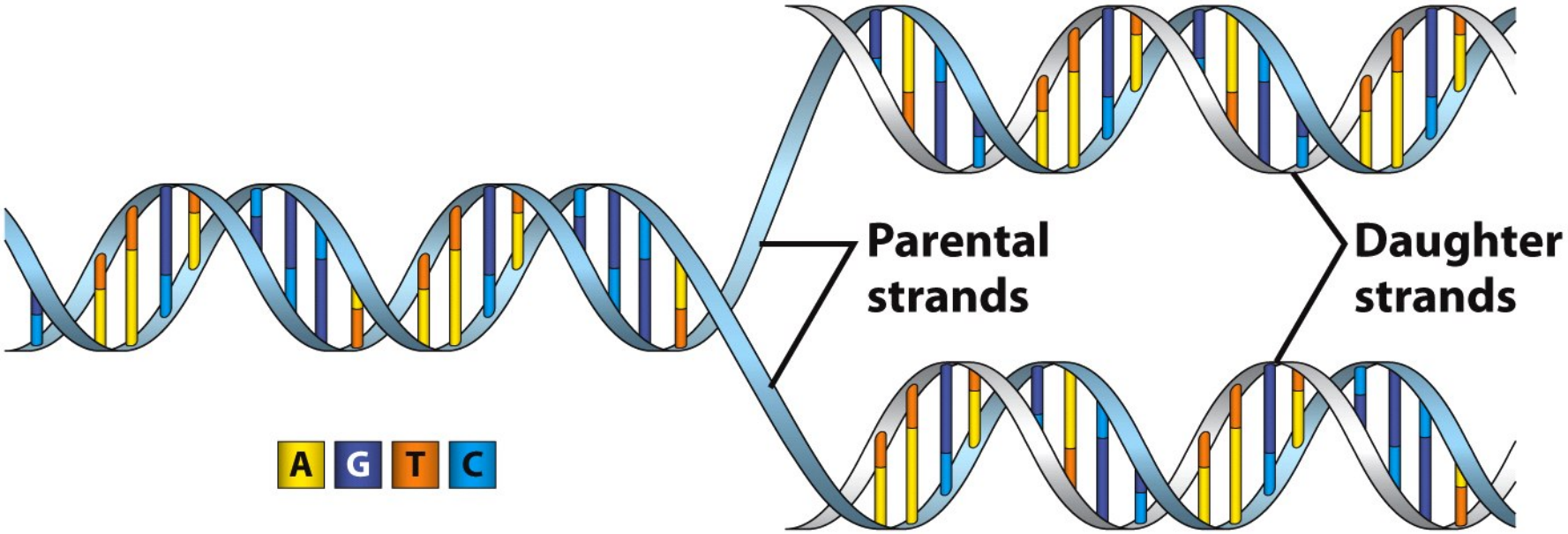
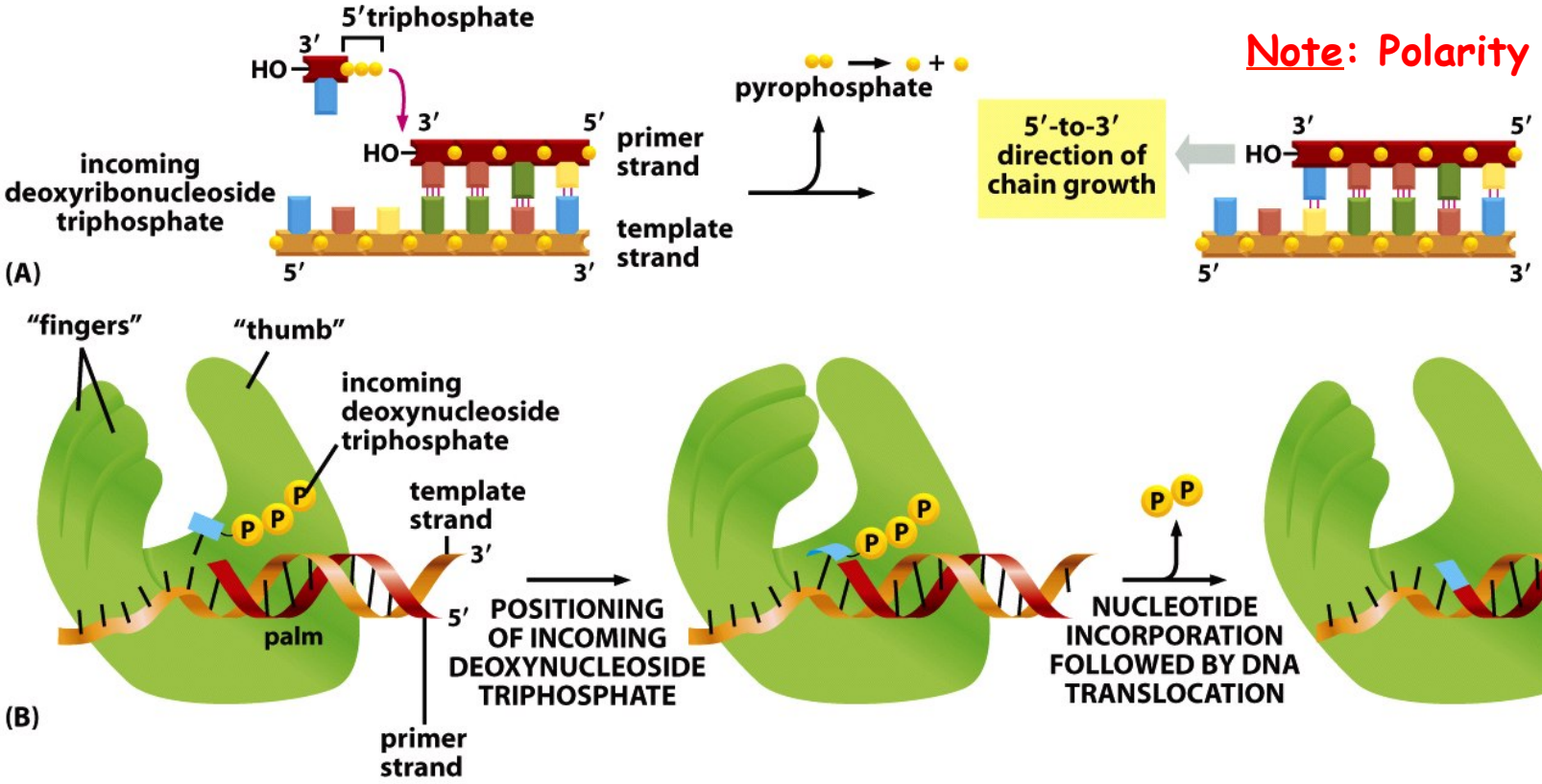


Figure 1-10
Molecular Cell Biology, Sixth Edition

Does a Vector Have the Ability to Replicate Independently?

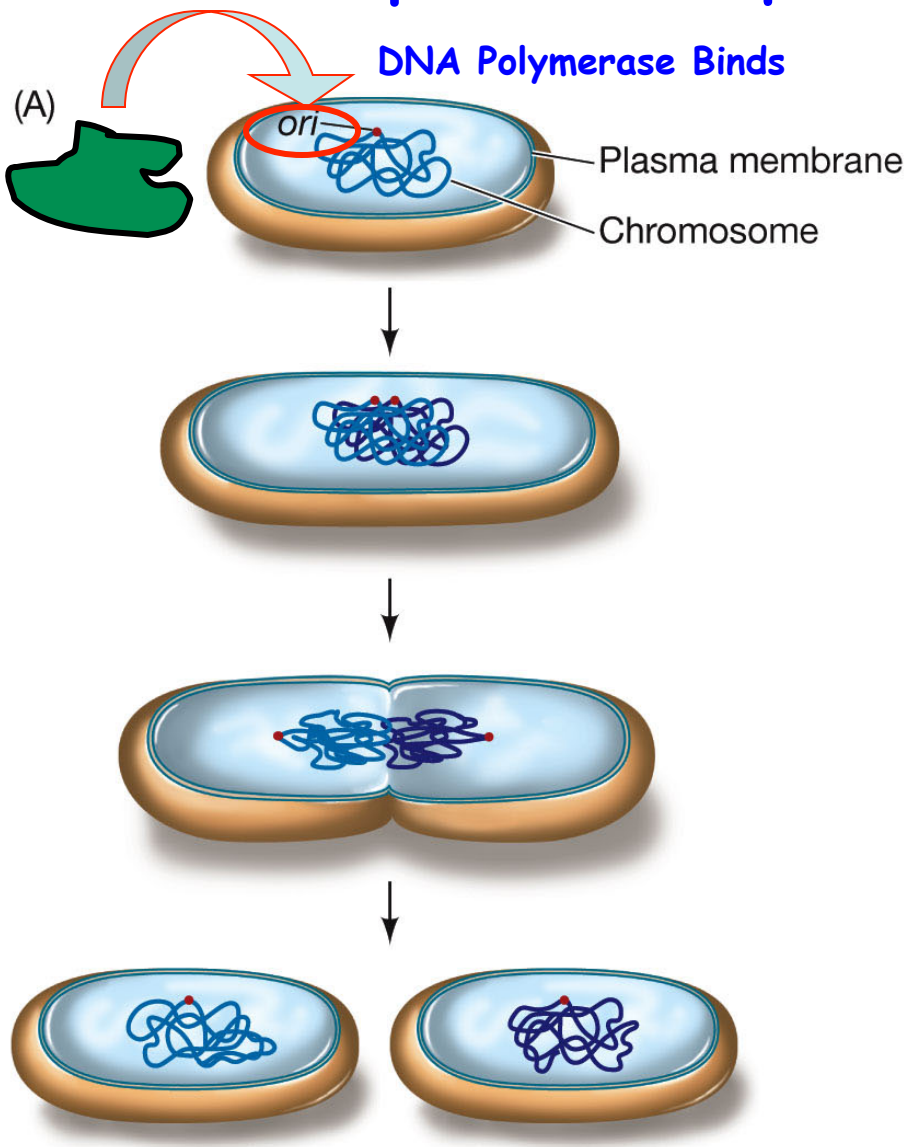
DNA Replication Requires An Enzyme - DNA Polymerase - Which is a Nano Machine!

Note: Nucleotide, Primer, & Template



1. DNA Polymerase Catalyzes 3′-'5' Phosphodiester Bonds & Copies the Template
2. DNA Replication Needs a Primer, Template, DNA Polymerase,& Nucleotides

DNA Replication Requires An Origin of Replication



(b)

DNA Replication Also Requires:

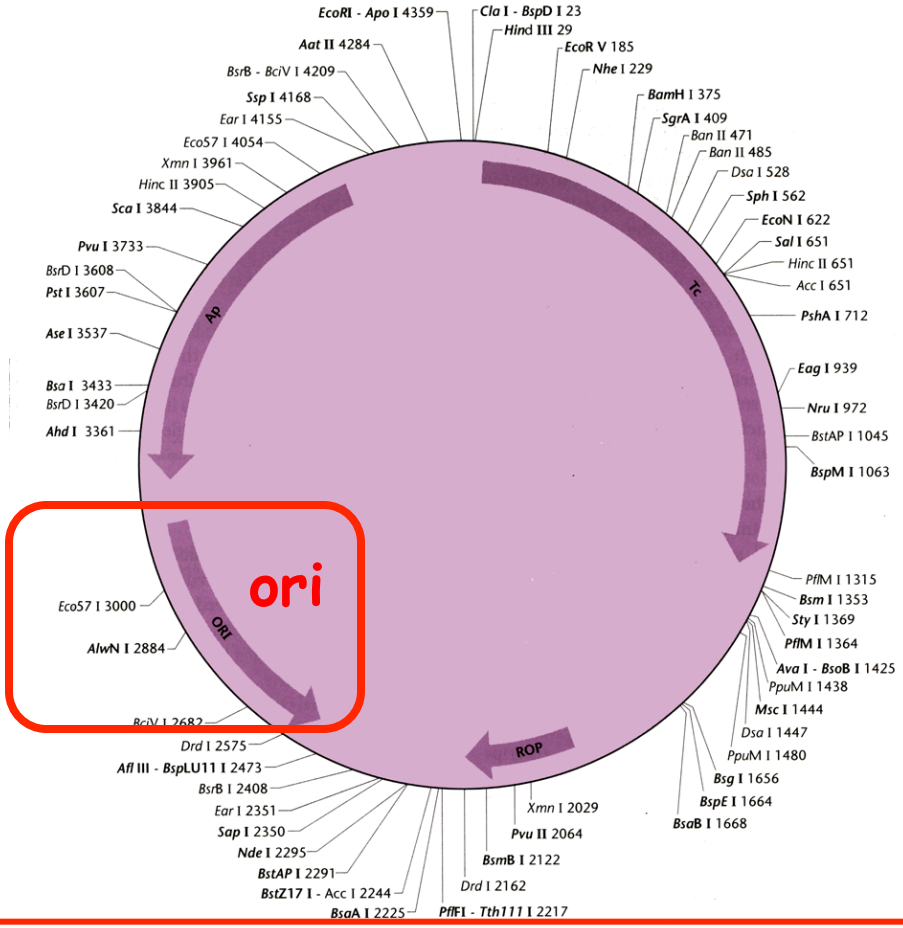
1. Template
2. Nucleotides (deoxribonucleotides)
3. DNA Polymerase (Machine)
4. "Primer" to Start Replication

Two IDENTICAL Cells - Phenotypically & Genotypically - From One Cell

LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 9.2 Prokaryotic Cell Division

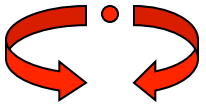
Ori

DNA Replication Starts at The Origin of Replication



DNA Replication is <u>Bidirectional</u> From the Ori!!!

Ori

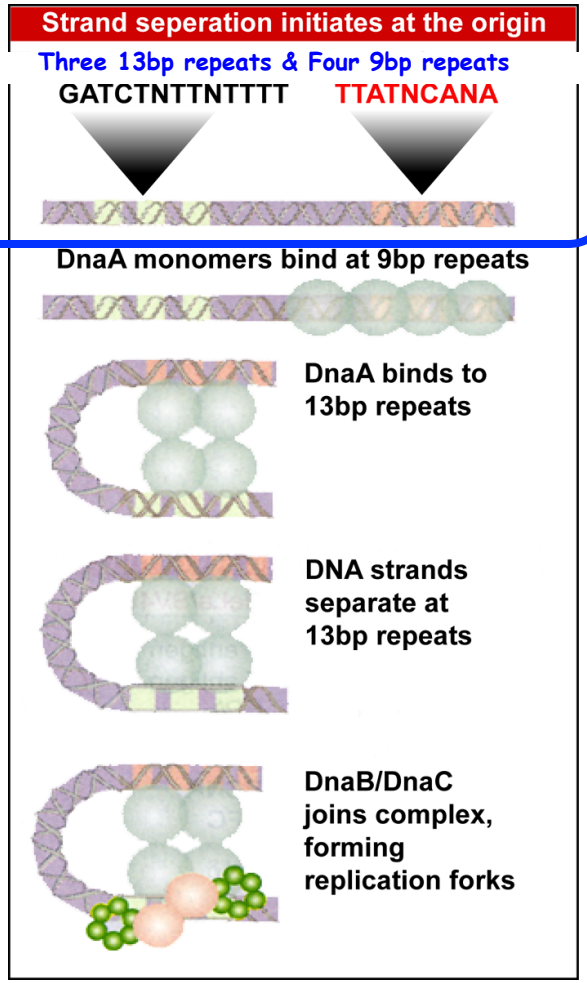


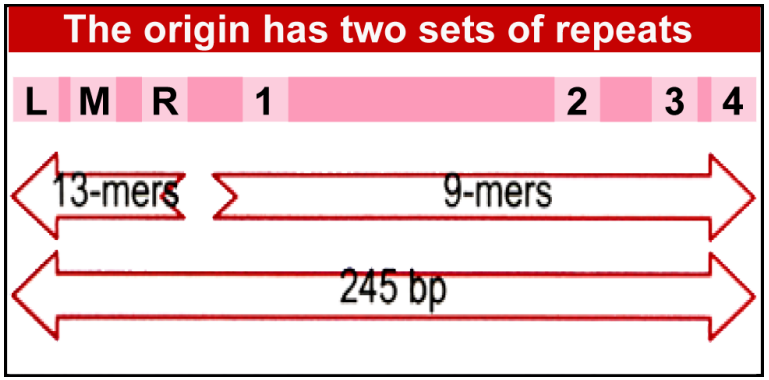
Hypothesis For Two Direction Synthesis?

DNA Polymerase Binds to The Origin of Replication (Ori) to Begin DNA Synthesis

How Control Division?

The Origin of Replication is a Specific Sequence



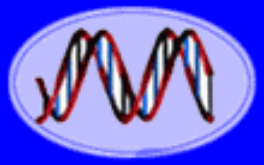


1. How Clone An Origin of Replication?

2. Specific Sequence - What Does This Mean For Genetic Engineering?

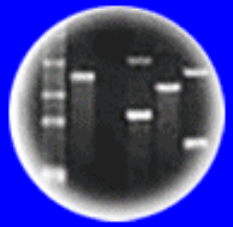
3. What is The Significance For Genetic Engineering?

4. Can Replicating "Chromosomes" Be Made?



DNA
Genetic Code of Life

Entire Genetic Code of a Bacteria



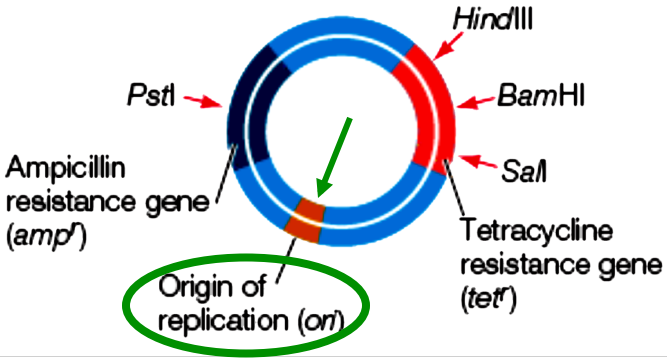
DNA Fingerprinting

Cloning: Ethical Issues and Future Consequences

Plants of Tomorrow

Vectors Are Needed To Replicate Genes In Transformed Cells

(A) Plasmid pBR322
Host: *E. coli*



↓ **Recognition Site for Restriction Enzymes**

1. Ori is a specific sequence
2. Ori is Genome & Organism Specific
3. DNA Polymerases are Specific For Each Organism Therefore need correct Ori to Replicate Gene in a Specific Organism!

Note → Need bacterial Ori to clone human gene in bacteria. Need human Ori to replicate a bacterial gene in human cells.

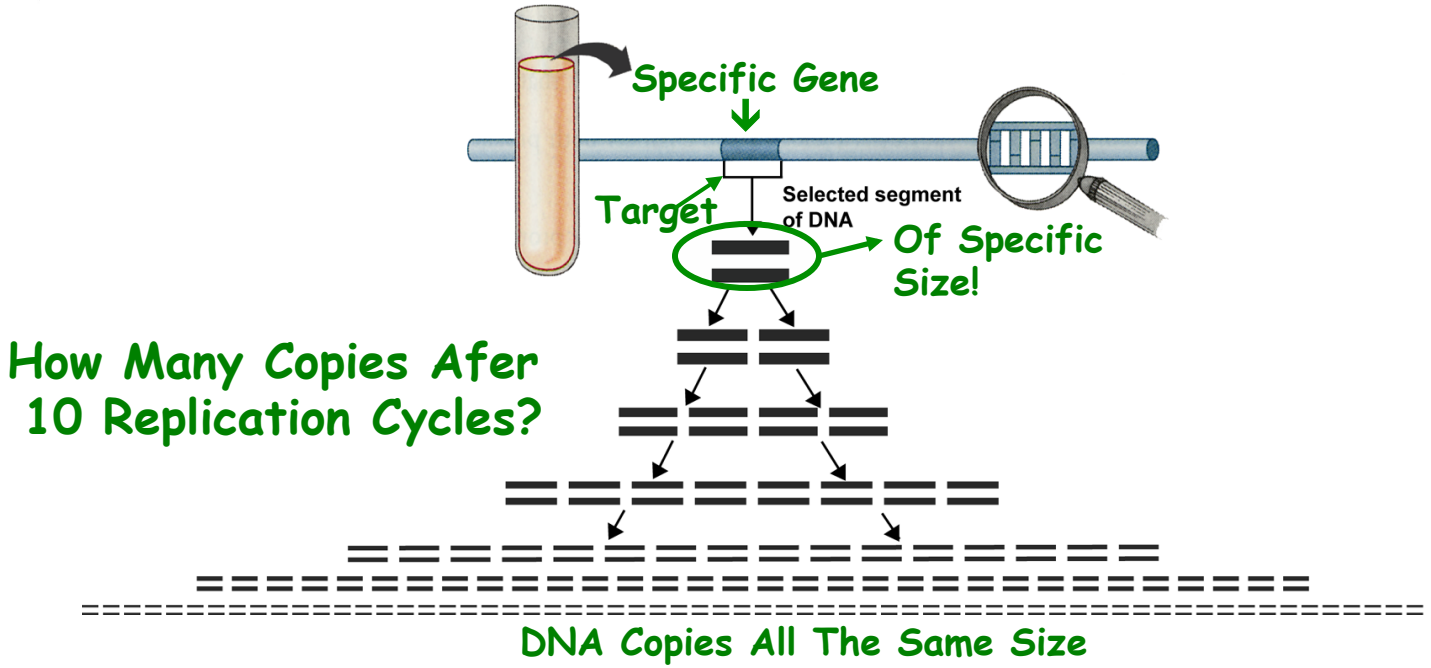
Yo! It's in the Sequence= Function

∴ Vectors can be Engineered!

Ori's can be cloned/synthesized!

MODULAR!!

The Polymerase Chain Reaction or PCR is a Molecular Xerox Machine



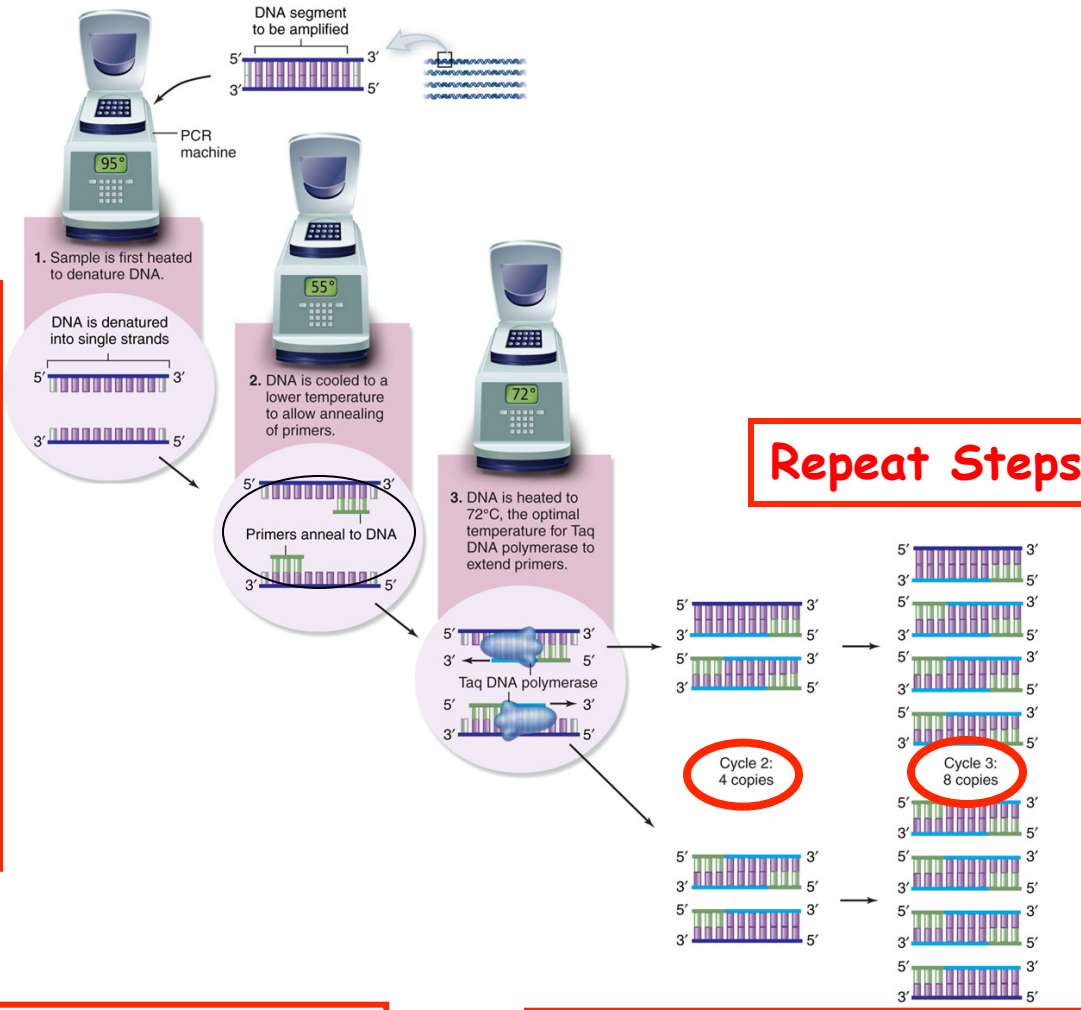
1. PCR Has Revolutionized DNA Analysis!

Specific DNA Sequences/Genes Can Be "Copied" Directly From "Tiny" Amount of DNA!

2. No Cloning Needed!

3. But **Need Sequence!** Therefore - Have to Clone "Gene" First

PCR is A Cyclical Process of DNA Replication



Requires

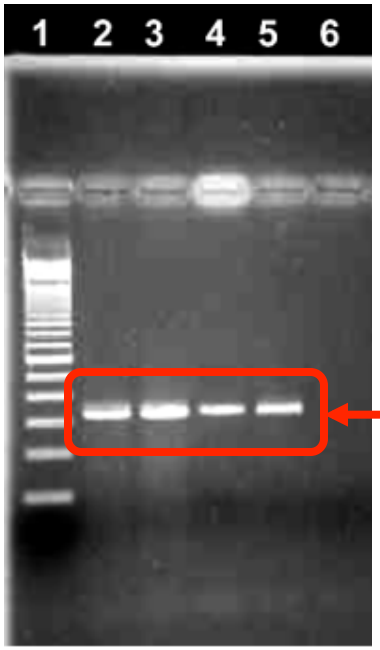
1. Template
2. Primers
3. Knowledge of Specific Sequence
4. Nucleotides
5. Heat-Stable DNA Polymerase
6. Cycler

Repeat Steps or Cycle

2^n Molecules of DNA where n = Number of Cycles

Diagnostic For Amplified DNA Sequence (Between Primers) → **DNA Fragments All The Same Size Primer-Sequence-Primer**

Using Gel Electrophoresis to Visualize PCR Products



Specific Diagnostic DNA Band Unique to DNA Sequence Being Amplified

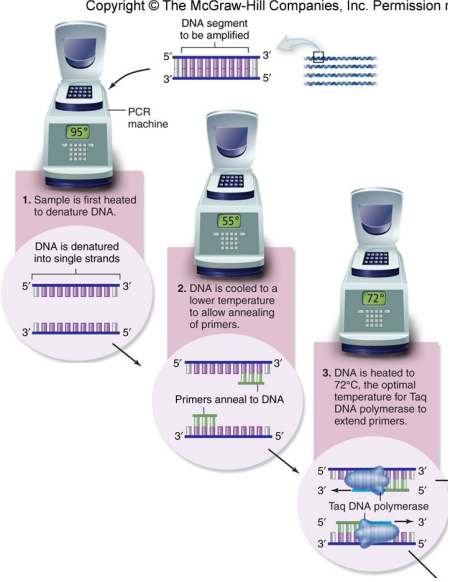
- Target-Specific Band
- Diagnostic For Specific DNA Sequence
- Band Size Unique For Specific Sequence
- Primers "Surround" the Target Sequence

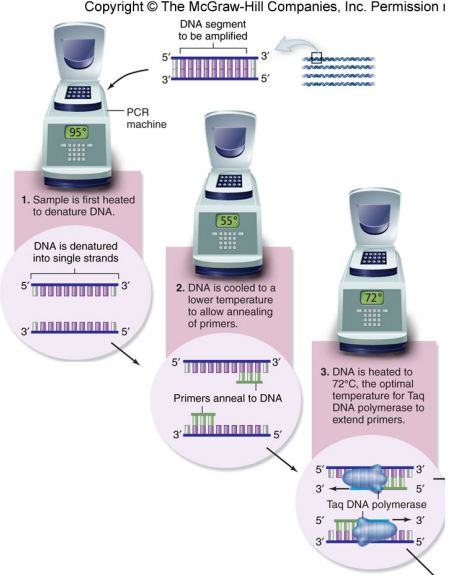
Can Amplify One DNA Sequence From An Entire Genome!!!

Requirements For PCR

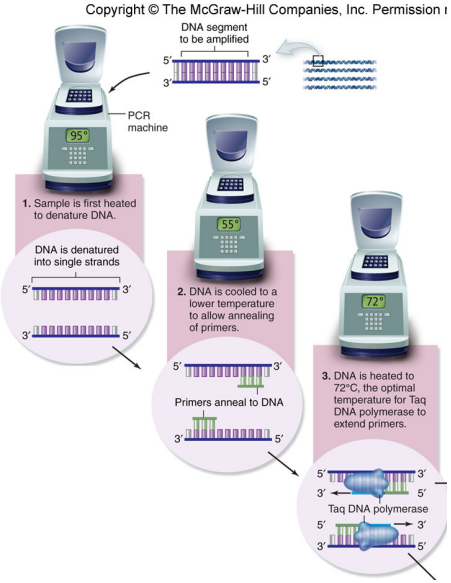
1. Knowledge of a Specific Sequence to Amplify (e.g.,insulin gene)
   a) Must Have First Cloned & Sequenced DNA of Interest the "Old-fashioned Way"
2. Primers That Recognize Specific DNA Sequences & Initiate DNA Synthesis & DNA Polymerase Binding To Template
3. Template (e.g., DNA From Human Cheek Cell)
4. Heat-Stable DNA Polymerase
5. Nucleotides
6. Thermoprogrammer/Cycler To Heat & Cool DNA in Cycles- Separating DNA Strands, Allowing Primers To Bind Complementary Sequences (Anneal), & Permiting New dsDNA Molecules to Form

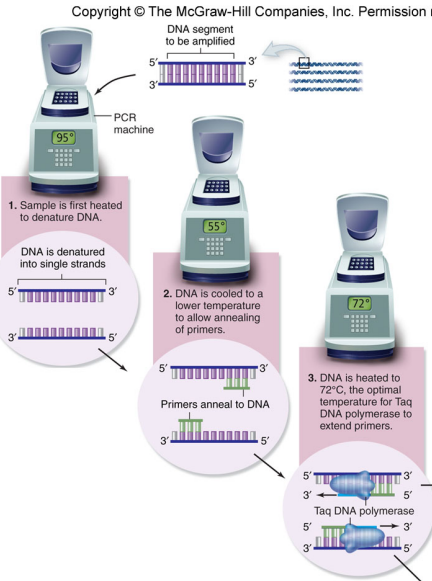
It's All in the DNA Sequences -- Know Sequence & Can Synthesize an Infinite Amount of Specific DNA Sequences. It know Takes One Hour To Do What Used to Take YEARS!

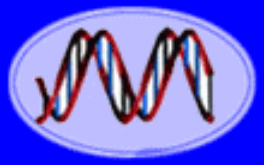




Examples of PCR Applications

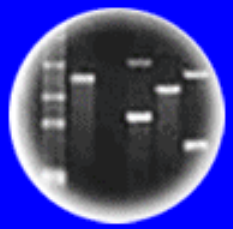






DNA
Genetic Code of Life

Entire Genetic Code of a Bacteria



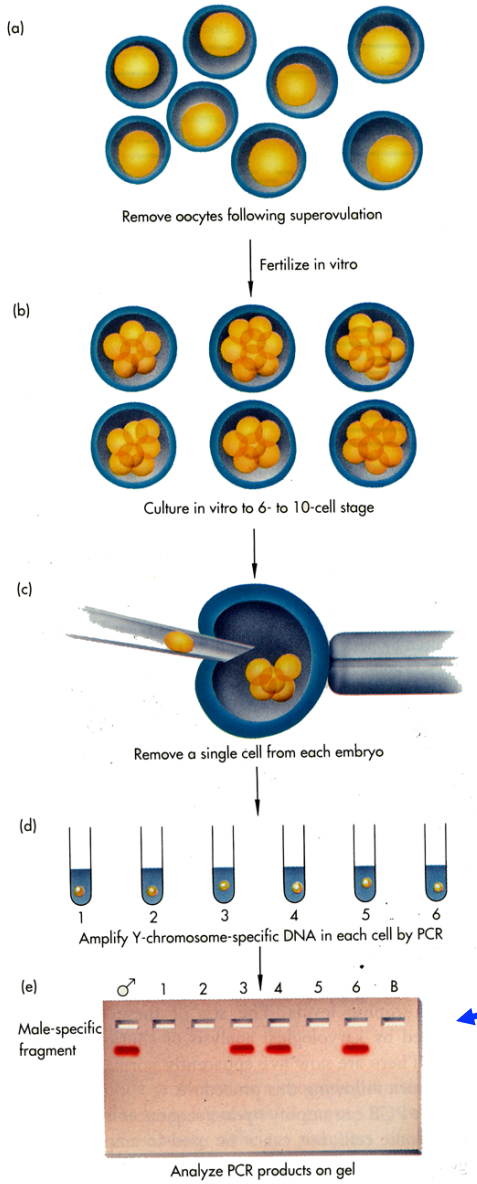
DNA Fingerprinting

Cloning: Ethical Issues and Future Consequences

Plants of Tomorrow

PCR Can Be Used To Analyze Gene in A Single Embryo Cell

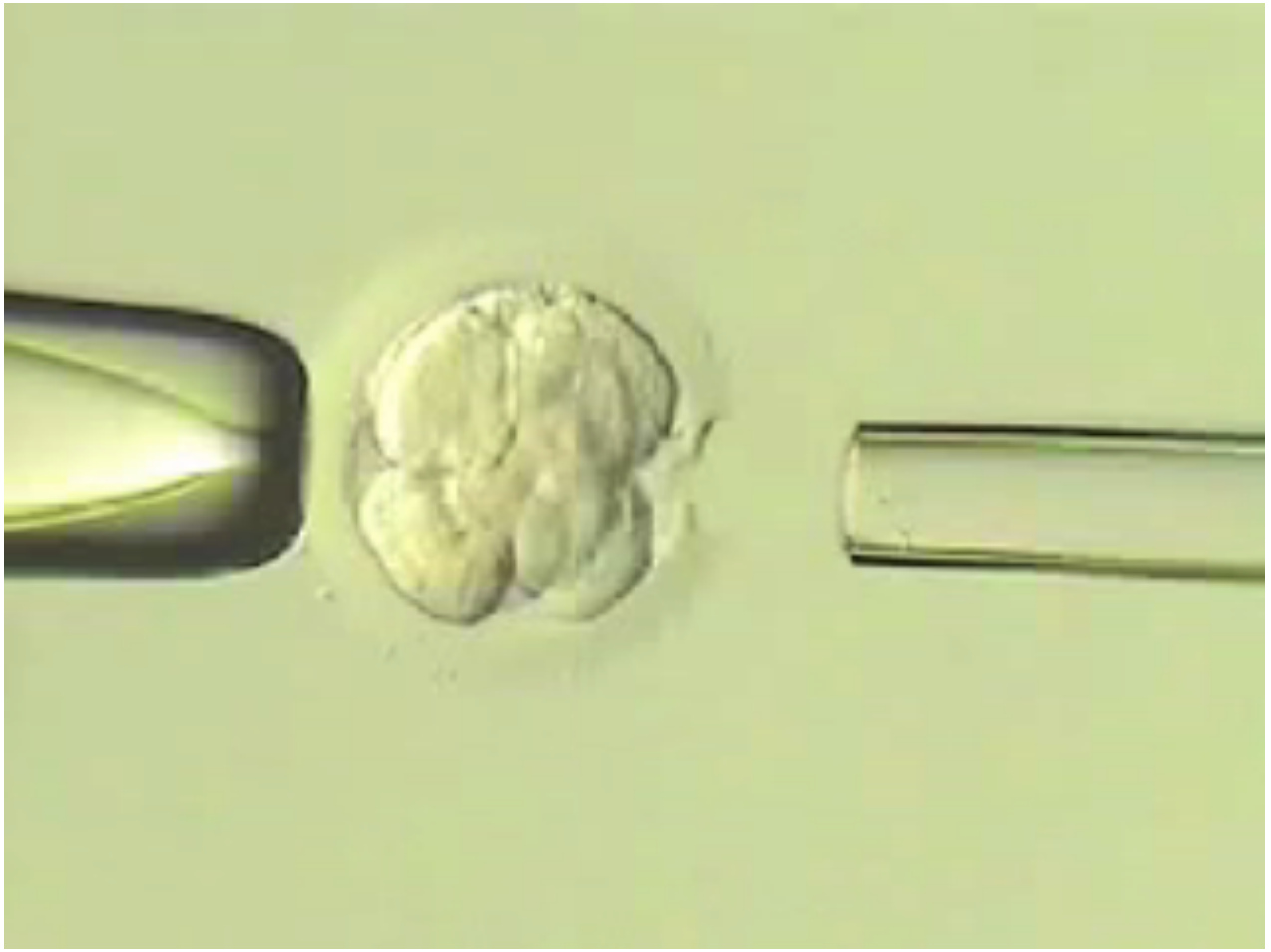
PGD
Pre-Implantation Genetic Diagnosis



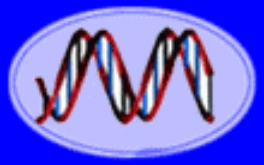
What is The Implication of This Procedure Considering That The Human Genome Has Been Sequenced?

Sex Determination in 8-cell Embryo!

Determining the Genetic Identity of a Human Embryo Before Implantation!

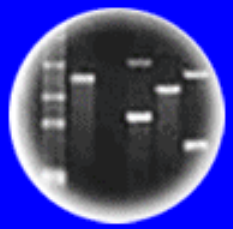


Prenatal Genetic Diagnosis (PGD)



DNA
Genetic Code of Life

Entire Genetic Code of a Bacteria



DNA Fingerprinting

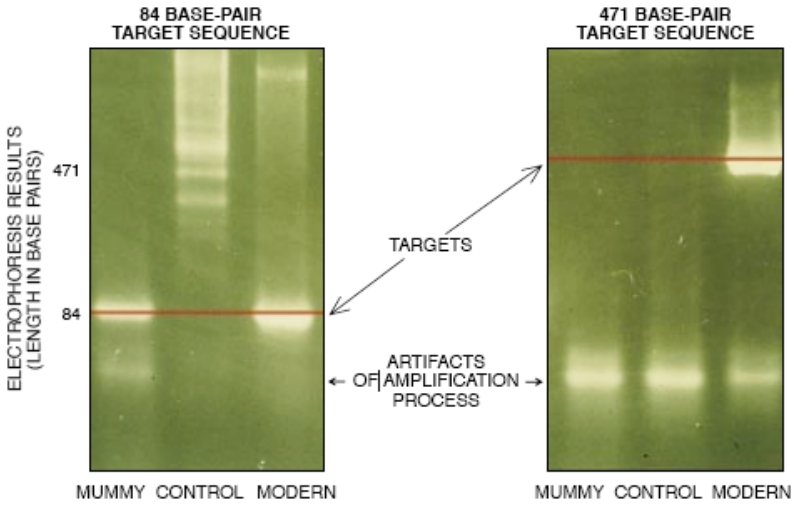
Cloning: Ethical Issues and Future Consequences

Plants of Tomorrow

Parents Should Be Allowed To Use PGD To Test Their Embryos For Gender and Select the Sex of Their Child?

a. Yes
b. No

Using PCR To Detect Genes in Mummy DNA



Sequence to Determine Relationships
For Example – King Tut

Using PCR to Amplify Mammoth DNA From Fossilized Hair & Sequence The Entire Genome!

Nature, November 2008

Sequencing the nuclear genome of the extinct woolly mammoth

Webb Miller[1], Daniela I. Drautz[1], Aakrosh Ratan[1], Barbara Pusey[1], Ji Qi[1], Arthur M. Lesk[1], Lynn P. Tomsho[1], Michael D. Packard[1], Fangqing Zhao[1], Andrei Sher[2]‡, Alexei Tikhonov[3], Brian Raney[4], Nick Patterson[5], Kerstin Lindblad-Toh[5], Eric S. Lander[5], James R. Knight[6], Gerard P. Irzyk[6], Karin M. Fredrikson[7], Timothy T. Harkins[7], Sharon Sheridan[7], Tom Pringle[8] & Stephan C. Schuster[1]

Using PCR to Amplify Neanderthal Bone DNA & Sequence The Entire Genome!

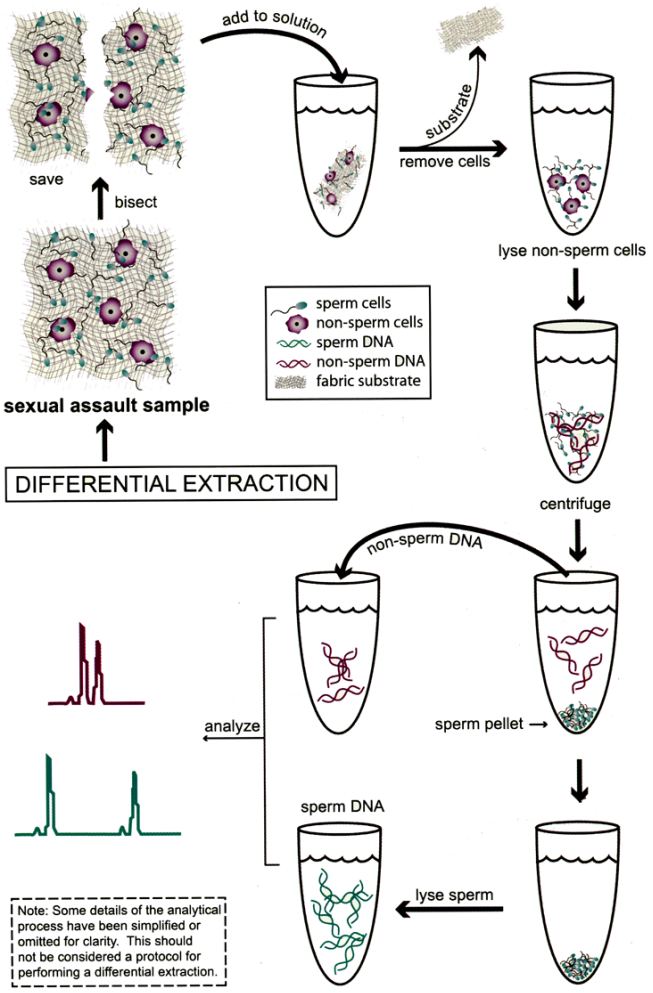
Analysis of one million base pairs of Neanderthal DNA

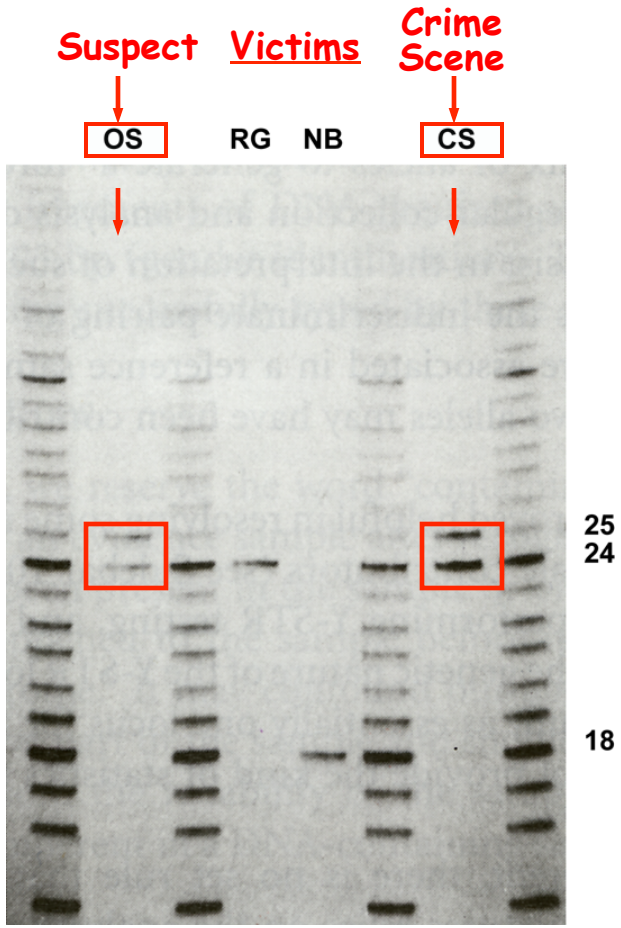
From a 45,000 Year-Old Bone

Richard E. Green[1], Johannes Krause[1], Susan E. Ptak[1], Adrian W. Briggs[1], Michael T. Ronan[2], Jan F. Simons[2], Lei Du[2], Michael Egholm[2], Jonathan M. Rothberg[2], Maja Paunovic[3]‡ & Svante Pääbo[1]

Nature, November, 2006

Using PCR in Crime Scenes





OS = Suspect
CS = Crime Scene
RG & NB = Victims

"Match" What is Probability That This Will Occur by Chance?

DNA Doesn't "Lie" !!

Identifying Victims of 9/11 Using PCR and DNA Fingertinting

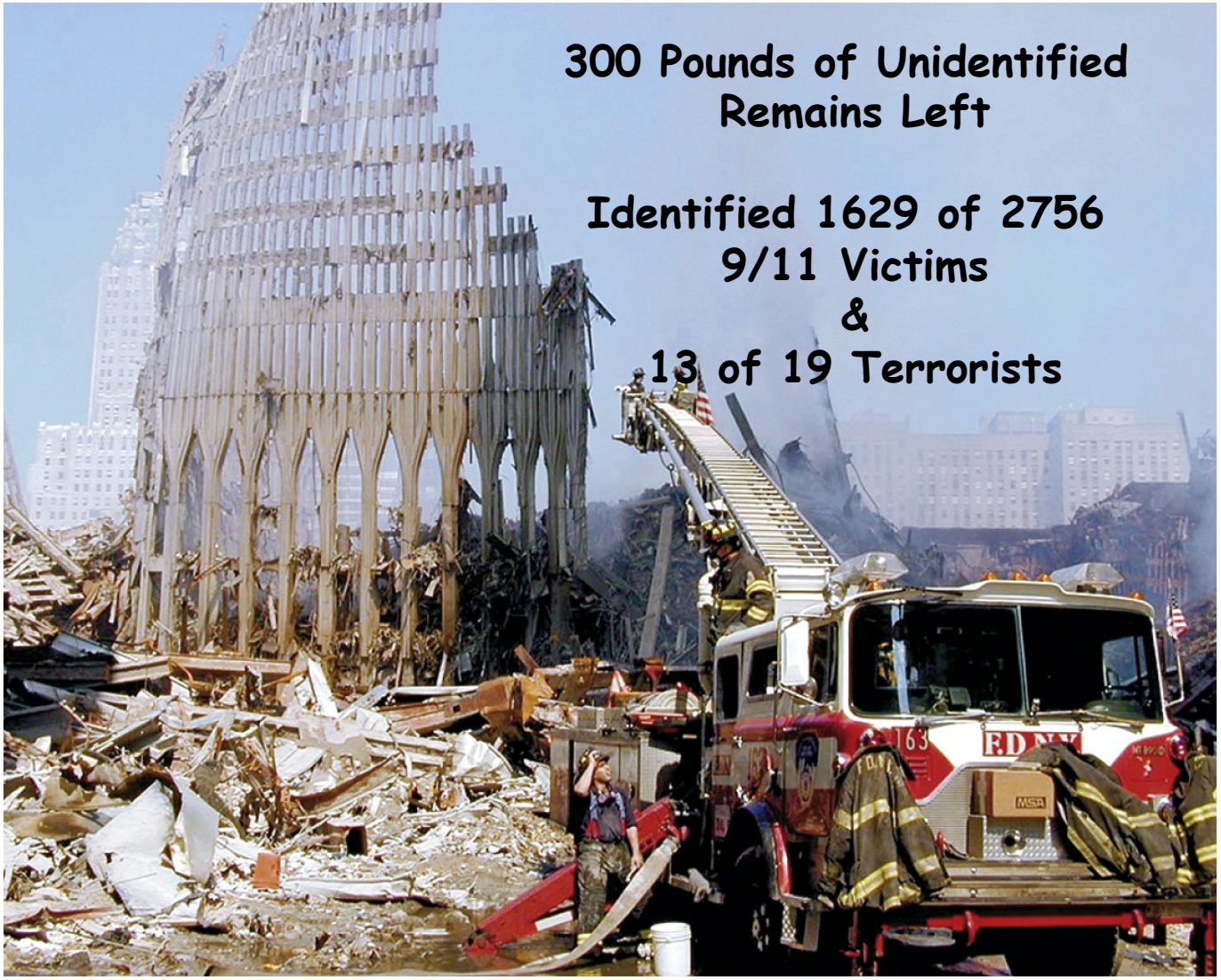
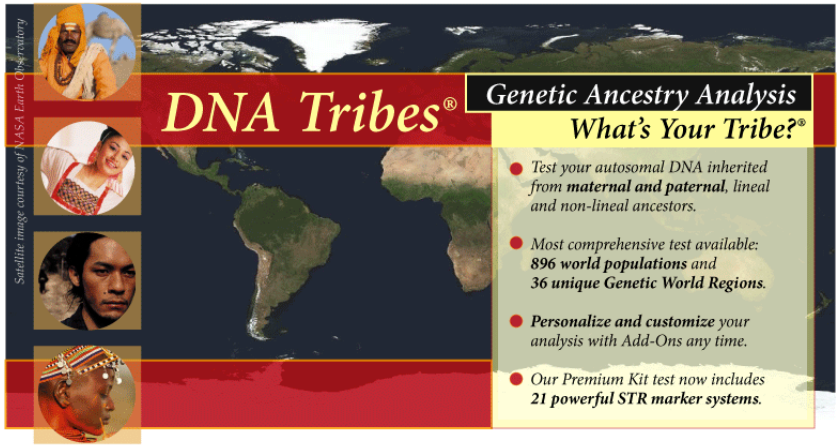


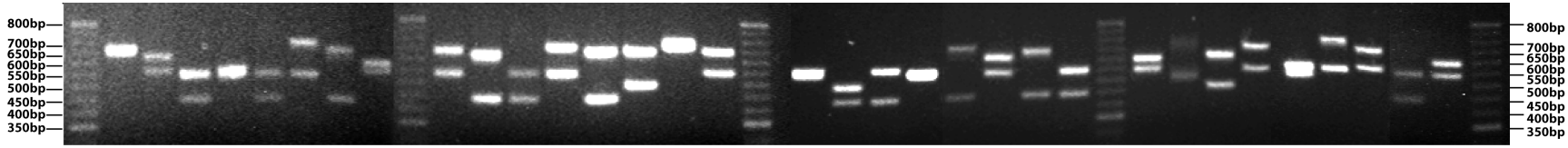
Figure 19-31
Genetics: A Conceptual Approach, Third Edition

Newsweek, January 12, 2009

Using PCR To Determine an Individual's Ancestry



PCR Started a New Industry



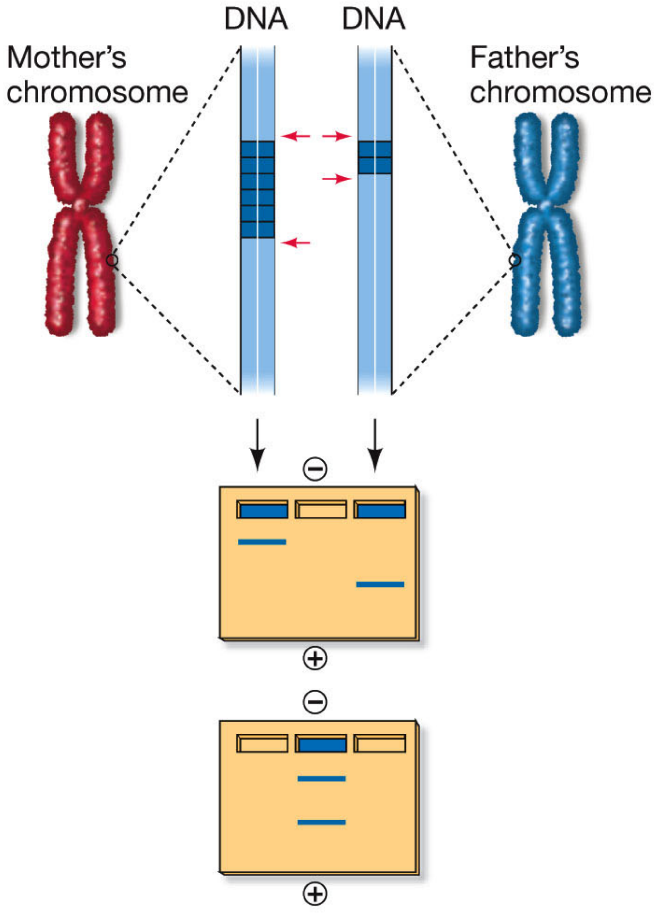
Using PCR to Verify Remains of Russian Royal Family

	Number of repeats	
STR-1	15,16	15,16
STR-2	8,8	7,10
STR-3	3,5	7,7
STR-4	12,13	12,12
STR-5	32,36	11,32

Tsarina Alexandra — Tsar Nicholas II

STR-1	15,16	15,16	15,16
STR-2	8,10	7,8	8,10
STR-3	5,7	5,7	3,7
STR-4	12,13	12,13	12,13
STR-5	11,32	11,36	32,36

VNTRs!



PNAS

Genomic identification in the historical case of the Nicholas II royal family

PNAS, March, 2009

Evgeny I. Rogaev[a,b,c,d,1], Anastasia P. Grigorenko[b,d], Yuri K. Moliaka[b], Guinaz Faskhutdinova[b], Andrey Goltsov[d], Arlene Lahti[e], Curtis Hildebrandt[e], Ellen L. W. Kittler[f], and Irina Morozova[a]

[a]Department of Genomics and Laboratory of Evolutionary Genomics, Vavilov Institute of General Genetics, Russian Academy of Science, Gubkina Street, 3, Moscow, 119991, Russian Federation; [b]Brudnick Neuropsychiatric Research Institute, University of Massachusetts Medical School, 303 Belmont Street, Worcester, MA 01604; [c]Faculty of Bioinformatics and Bioengineering, Lomonosov Moscow State University, Moscow, 119991, Russian Federation; [d]Research Center of Mental Health, Russian Academy of Medical Science, Zagorodnoe Shosse 2/2, Moscow, 113152, Russia; [e]Molecular World, Inc., Thunder Bay, ON, Canada P7B 2T1; and [f]University of Massachusetts Medical School, Center for AIDS Research, Worcester, MA 01605

Communicated by James D. Watson, Cold Spring Harbor Laboratory, Cold Spring Harbor, NY, November 14, 2008 (received for review October 8, 2008)

RESEARCH ARTICLE — OPEN ACCESS

Mystery Solved: The Identification of the Two Missing Romanov Children Using DNA Analysis

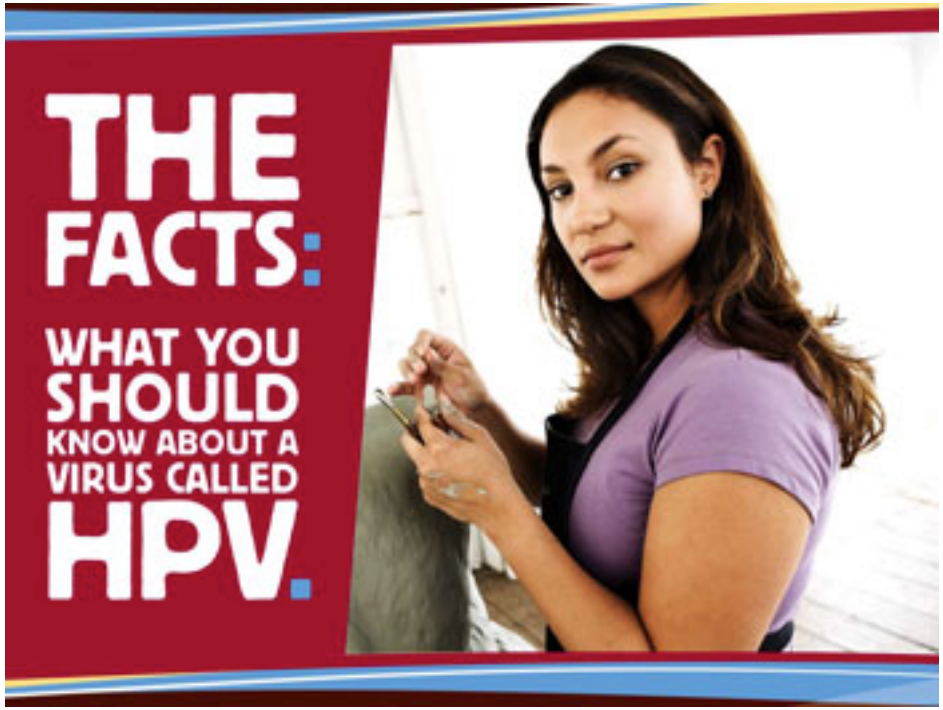
Michael D. Coble[1#*], Odile M. Loreille[1#], Mark J. Wadhams[1], Suni M. Edson[1], Kerry Maynard[1], Carna E. Meyer[1], Harald Niederstätter[2], Cordula Berger[2], Burkhard Berger[2], Anthony B. Falsetti[3], Peter Gill[4,5], Walther Parson[2], Louis N. Finelli[1]

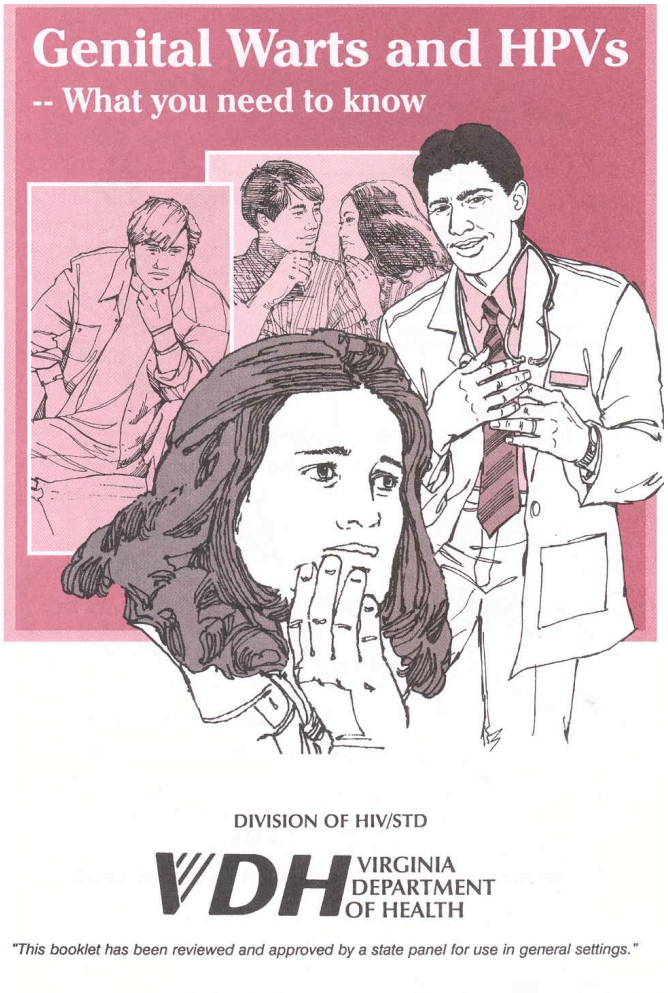
1 Armed Forces DNA Identification Laboratory, Armed Forces Institute of Pathology, Rockville, Maryland, United States of America, **2** Institute of Legal Medicine, Innsbruck Medical University, Innsbruck, Austria, **3** University of Florida, Gainesville, Florida, United States of America, **4** Department of Pure and Applied Chemistry, University of Strathclyde, Glasgow, United Kingdom, **5** Institute of Forensic Medicine, University of Oslo, Oslo, Norway

Download: XML | PDF | Citation
E-mail this Article
Order Reprints
Print this Article
Bookmark this page:

PLOS, March, 2009

Using PCR To Detect Human Pathogens
(Viruses, Fungi, Bacteria)

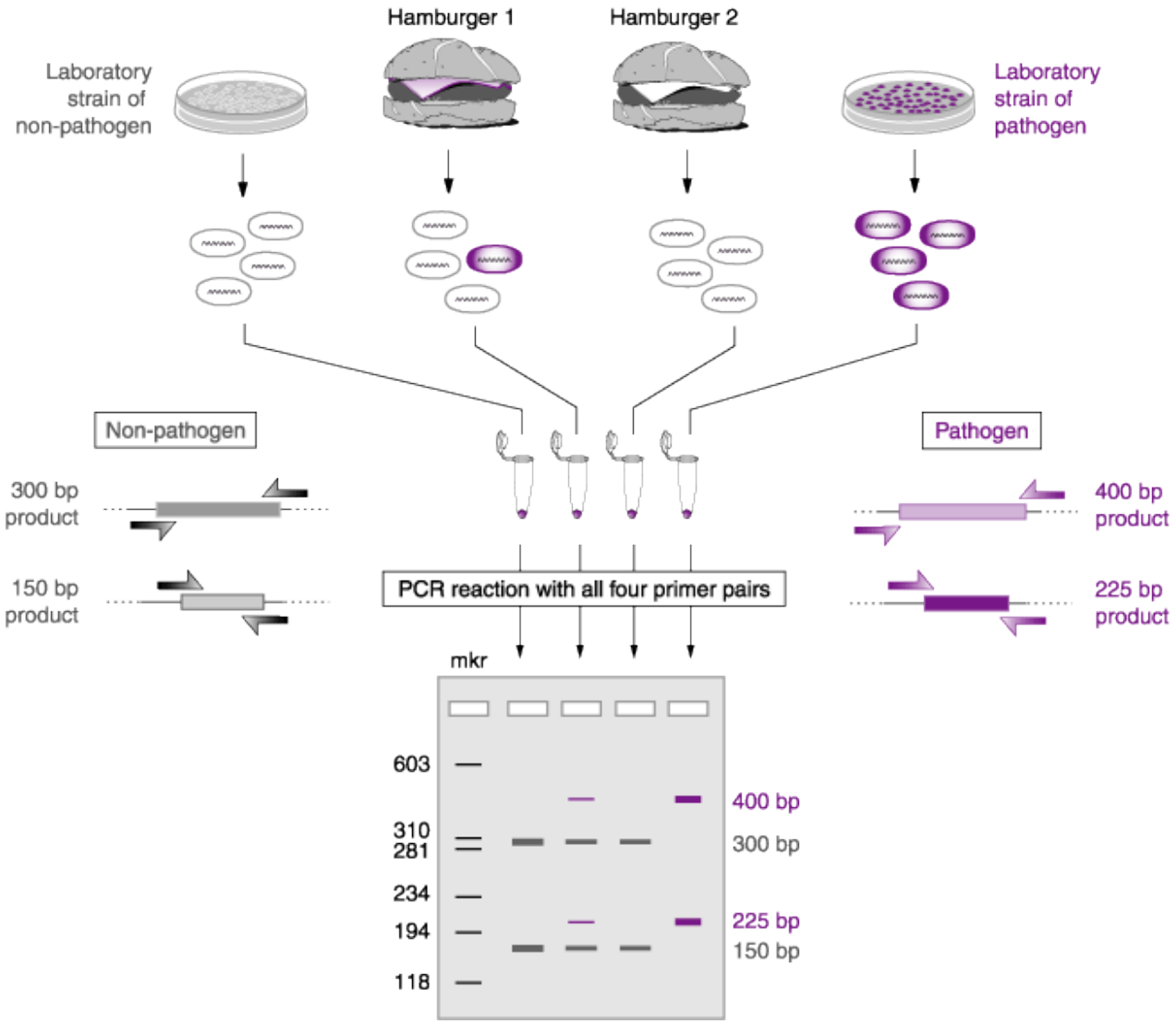




ViroSeq™
HIV-1 Genotyping System

Each Genome Has Specific DNA Sequences That Can Be Used For Screening And Diagnosis Using PCR

Using PCR To Detect Food Pathogens



PCR Has Many Uses, Has Changed Many Fields, and Lead To New Ones That Have Had a Big Impact On Our Lives

1. Amplify Any DNA Sequence, or Gene, From "Tiny" Amounts of DNA or Biological Materials IF ORIGINAL SEQUENCE KNOWN
2. Study DNA From Limited and/or Degraded Sources Such As:
    1. A Single Human Hair or Cheek Cell
    2. An Ancient Fossil (e.g., Neanderthal Bone or Mammoth Hair)
    3. An Ancient Insect Trapped in Amber
    4. Human Remains (e.g., 9/11 Victims)
    5. A Single Human Embryo Cell
    6. Contaminated Meat To Determine the Causal Organism
3. Used In:
    1. DNA Fingerprinting-Individual Identification-Genetic Disease Screening
    2. Forensics (Crime Scenes, Mass Graves, Criminal Suspects, Wrongfully Convicted)
    3. Paternity & Family Relationships (e.g., Immigration, Tracing Lost Children)
    4. Disease Diagnosis & Pathogen Identification (Humans, Animals, & Plants)
    5. Human Origins & Migrations
    6. Ancient Genome Sequences & Evolutionary Studies
    7. Specific mRNA Detection
    8. "Cloning" Specific DNA Sequences
    9. Tracing Plant & Animal Sources (e.g., Poaching Stolen Cattle, Cactus)
4. Need as Little as One Molecule of DNA & Can Replicate an ∞ Amount of Specific Sequences

Revolutionized How To Study & Manipulate DNA

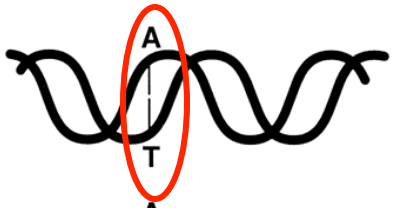

ABCNEWS WASHINGTON
Kerry Mullis and PCR
Nightline March, 1994

DNA Replication is Precise
But Mistakes or Mutations Can Occur!

	DNA	RNA	
pair	A T	A U	pair
pair	G C	G C	pair

BASE PAIR RULES

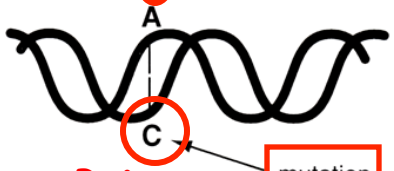
Gene A



ORIGINAL BASE PAIR

Rare Base Mismatch

Replication①



MUTATION DURING REPLICATION

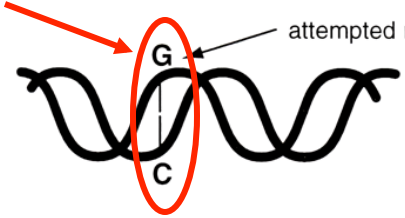
mutation

C mispairs with A

New Base Pair

See Mutation As Change in Phenotype

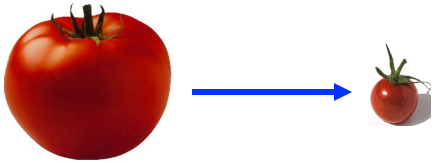
Replication②
Gene A'
Allelic Variant



RESULTING DEFECT

Change DNA Sequence From A = T to G ≡ C

∴ Change Protein Amino Acid Sequence ⇨ Alter Function!



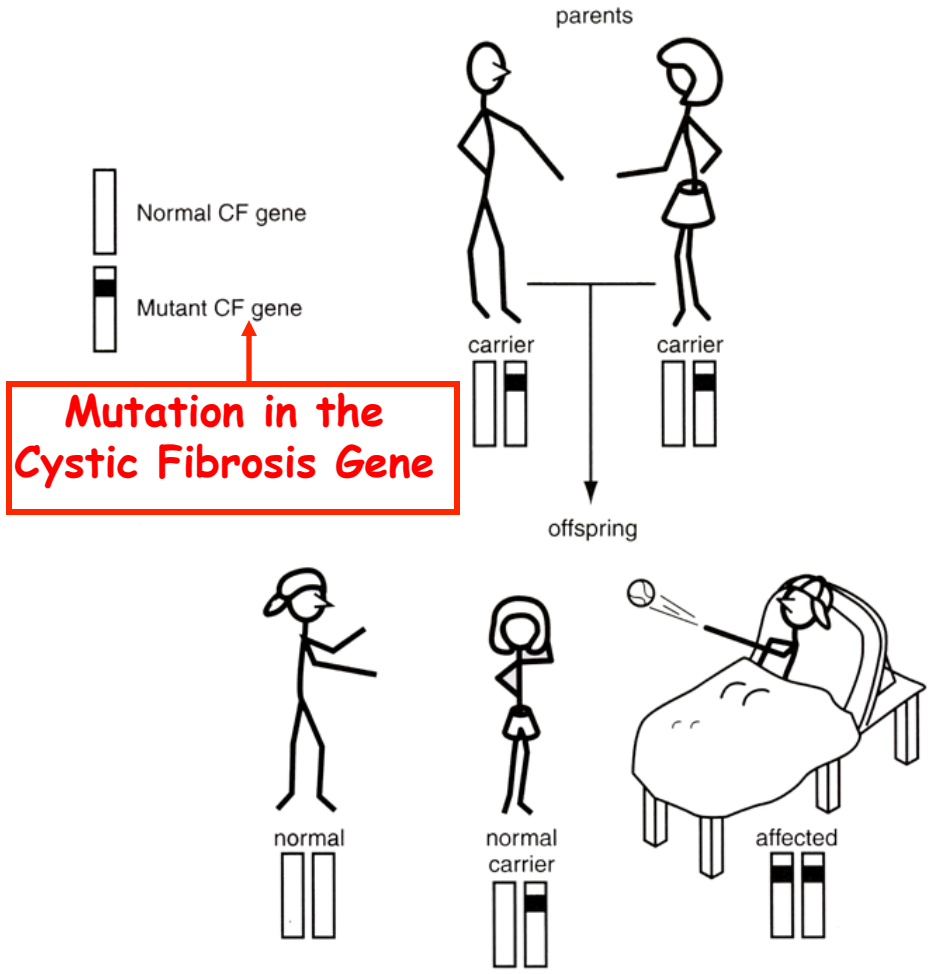
Big Tomato to Small Tomato

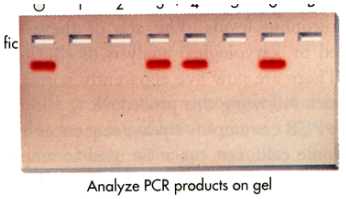
Mutation in Genes Are Rare But Are Inherited

One Gene Per Gamete

♀ + ♂

Two Genes per Somatic Cells



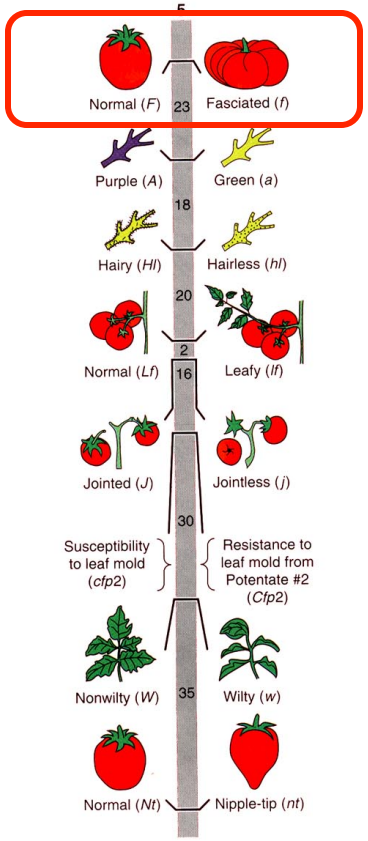


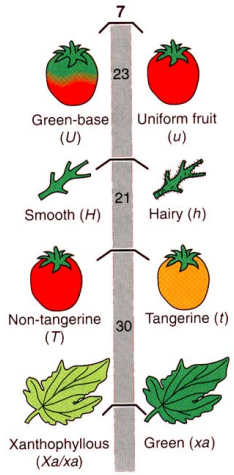
How Follow Inheritance?
What Allows Disease To Be Followed?

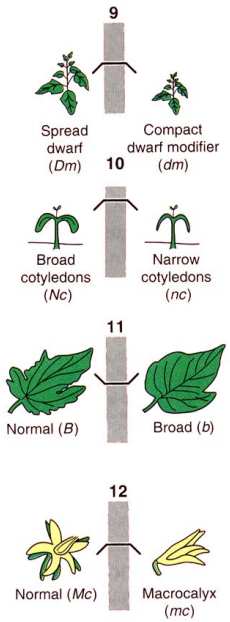
DNA Marker or Fingerprint!

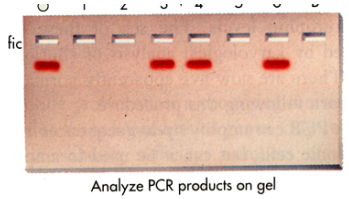
Alternative Forms of the Same Gene Lead to Genetic Diversity

Alleles









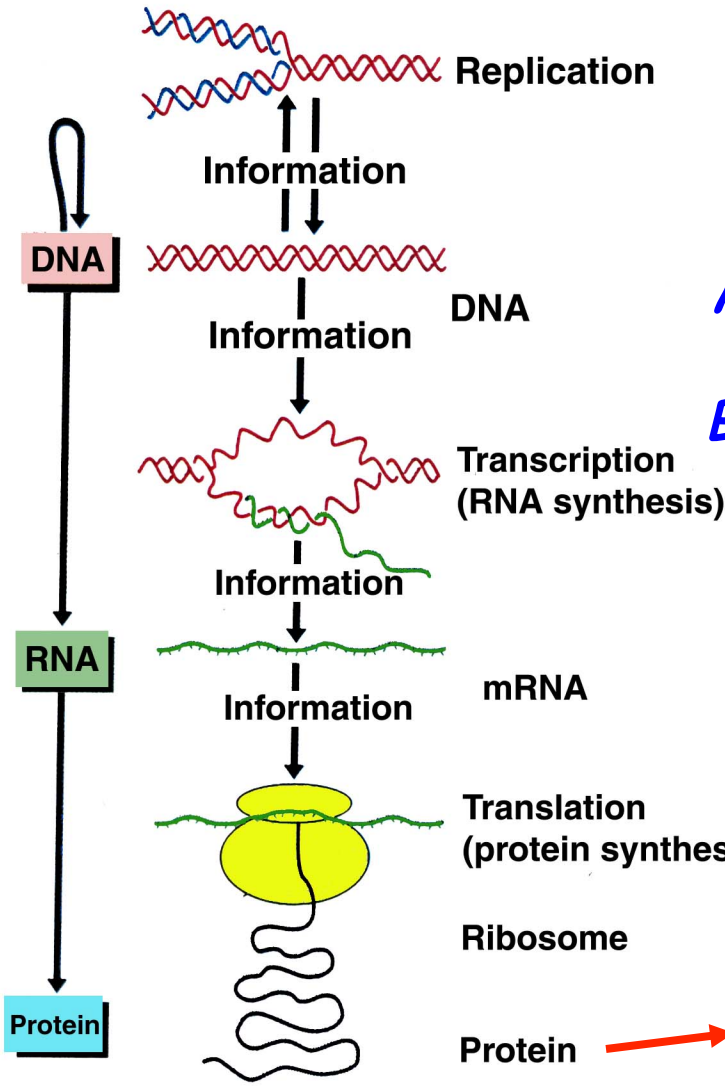
Can Follow These Traits With DNA Markers As Well

mutations result in genetic diversity!!!

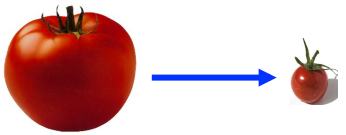
Spontaneous Mutations Give Rise To Alleles, or Different Forms of the Same Gene, And result in Small DNA Sequence Changes (e.g., SNPs or Single Nucleotide Polymorphisms)

Translating The Genetic Code Into Proteins is a Conserved Process

Mutations Are Inherited Because Altered Gene Replicates

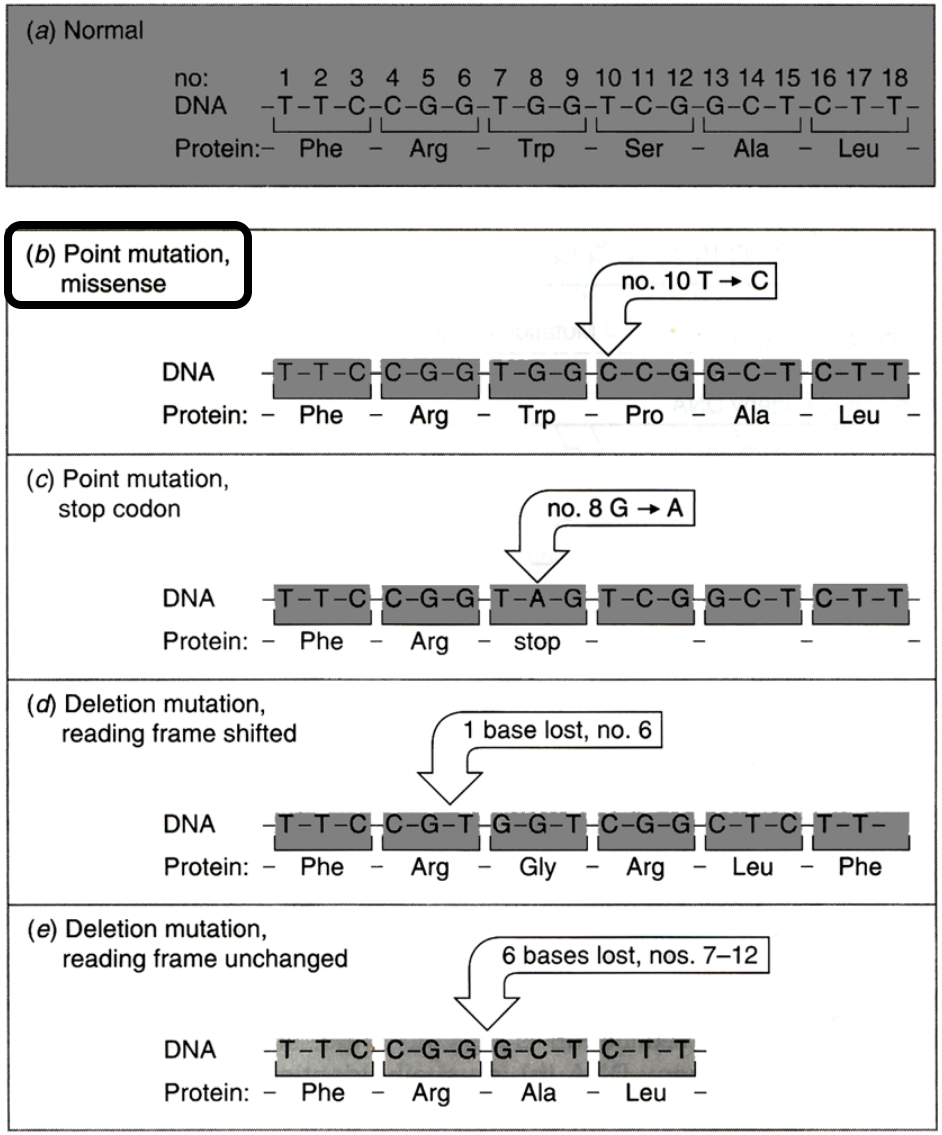


Mutations Lead To Altered Protein Because mRNA and Protein Sequence Encoded By Gene Changes



Mutations Lead to Altered Traits/Phenotype Because Protein Structure Changed

Mutations Can Occur Different Ways



1. Base-Pair Change
2. Insert or Delete Base (Indel)
3. Move Gene, or Part of Gene, to New Location (Switches Change)!

Function of Protein Lost and/or Changed

∴

Phenotype Changes

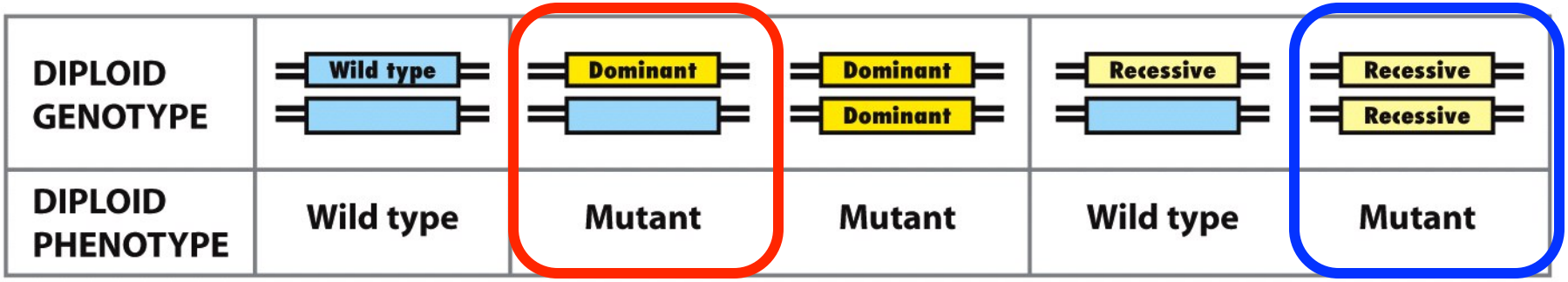
Human Genetic Disorders Occur As a Result of Mutations

TABLE 13.2 Some Important Genetic Disorders

Disorder	Symptom	Defect	Dominant/ Recessive	Frequency Among Human Births
Hemophilia	Blood fails to clot	Defective blood-clotting factor VIII	X-linked recessive	1/10,000 (Caucasian males)
Huntington disease	Brain tissue gradually deteriorates in middle age	Production of an inhibitor of brain cell metabolism	Dominant	1/24,000
Muscular dystrophy (Duchenne)	Muscles waste away	Degradation of myelin coating of nerves stimulating muscles	X-linked recessive	1/3700 (males)
Hypercholesterolemia	Excessive cholesterol levels in blood lead to heart disease	Abnormal form of cholesterol cell surface receptor	Dominant	1/500

Dominant

Recessive

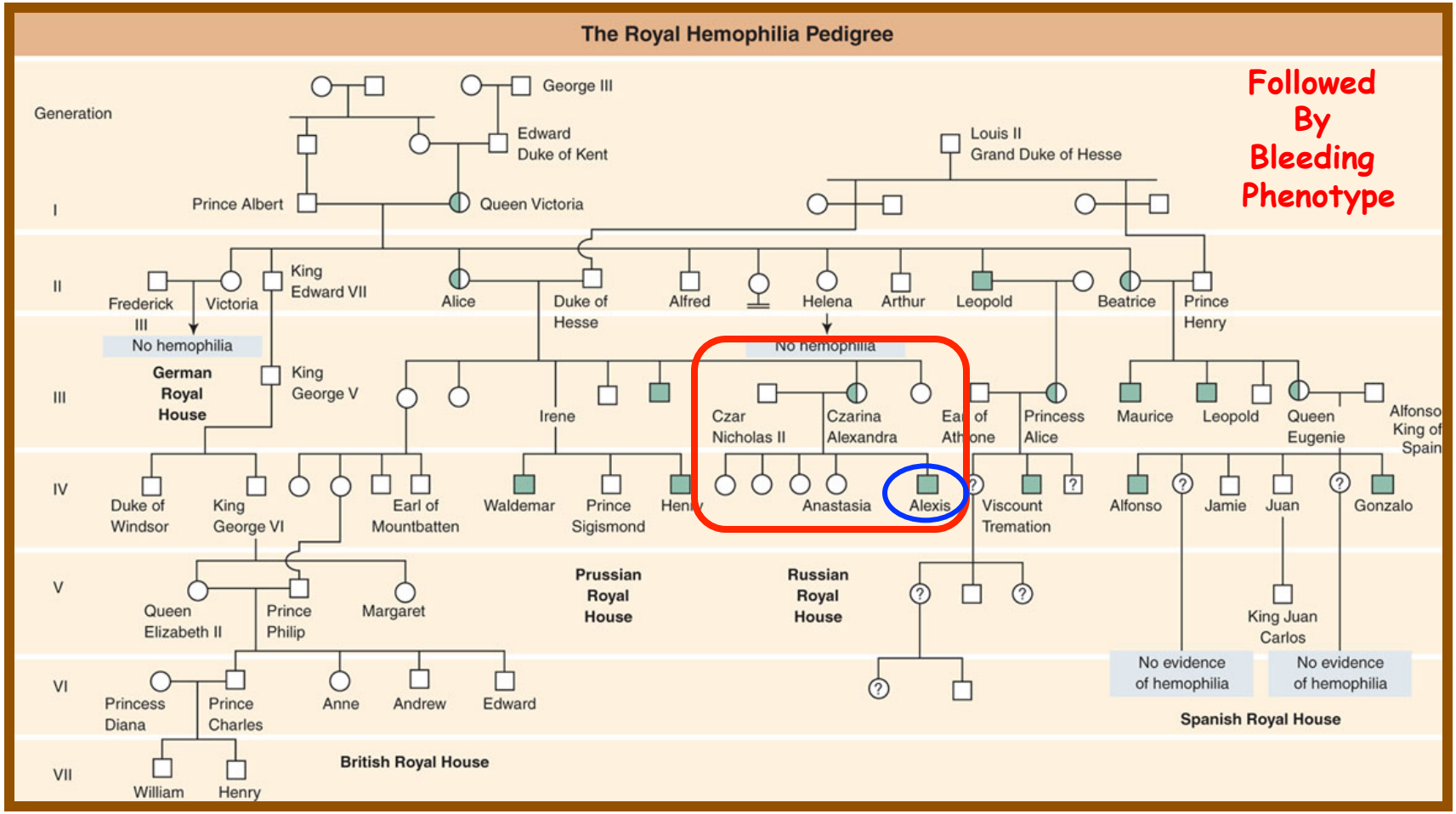


Need One Allele

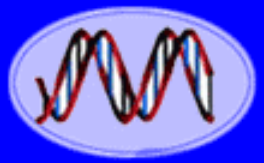
Need Two Alleles

Figure 5-2
Molecular Cell Biology, Sixth Edition

Pedigrees Can Be Used To Follow Disease Genes in Human Families

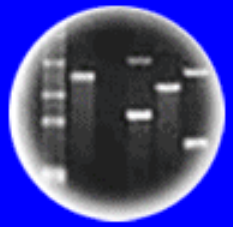


Recessive Sex Linked



DNA
Genetic Code of Life

Entire Genetic Code
of a Bacteria



DNA Fingerprinting

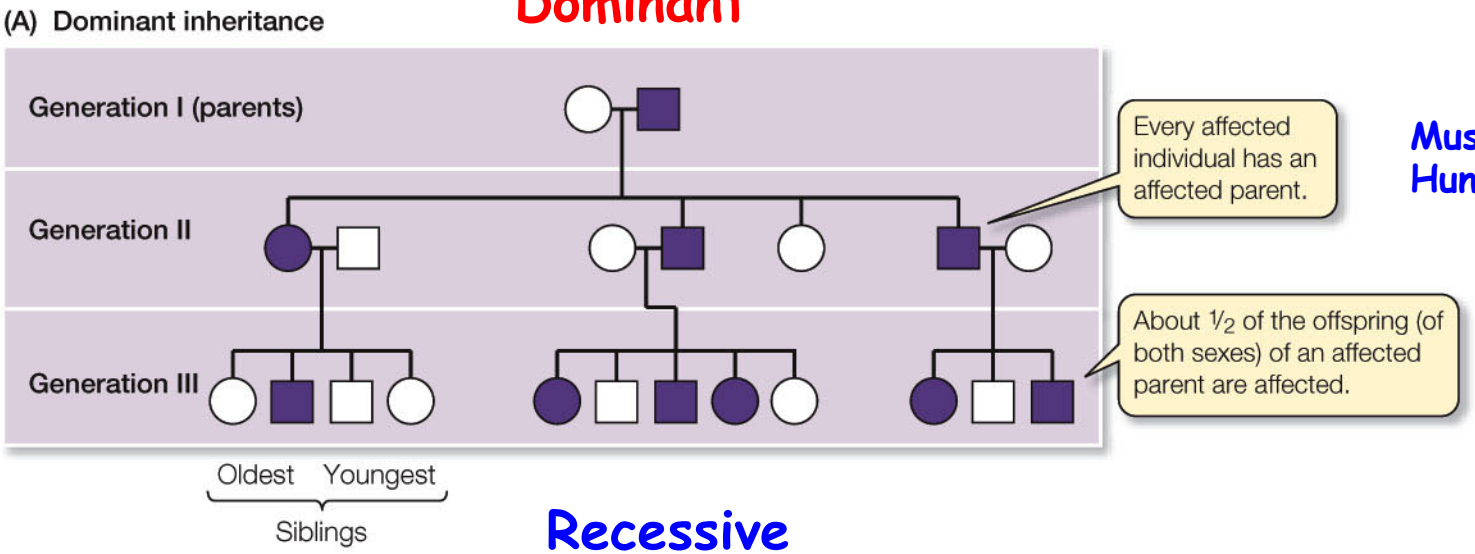
Cloning: Ethical Issues
and Future Consequences

Plants of Tomorrow

Pedigrees Can Be Used To Determine If a Trait is Dominant or Recessive

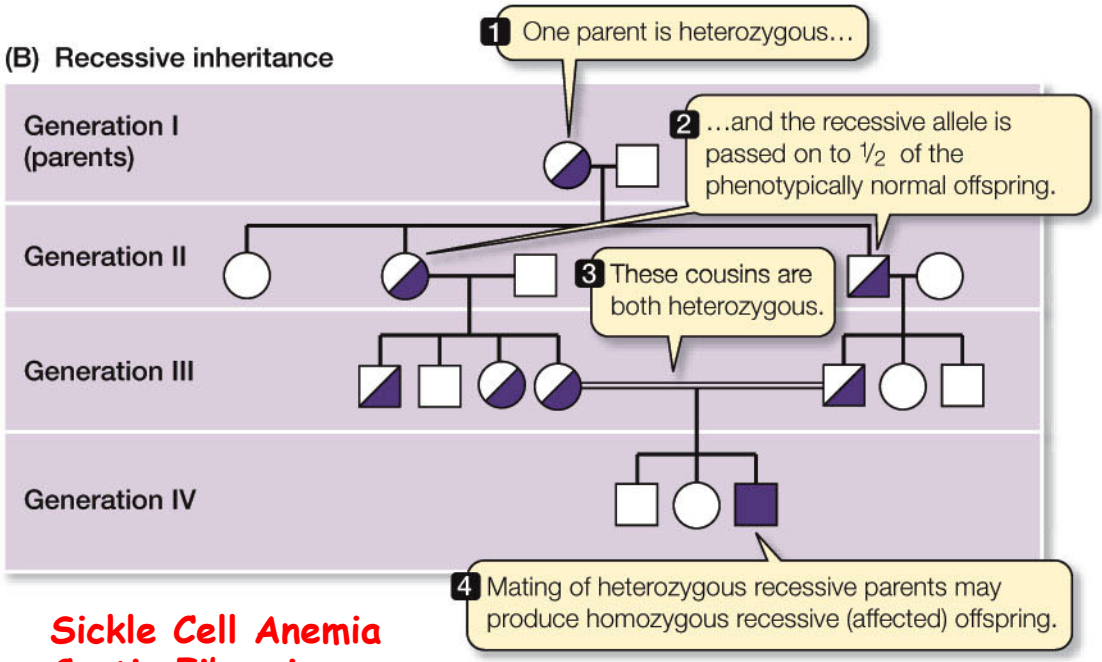
Each Type of Inheritance Predicts Specific Results in Each Generation

Dominant

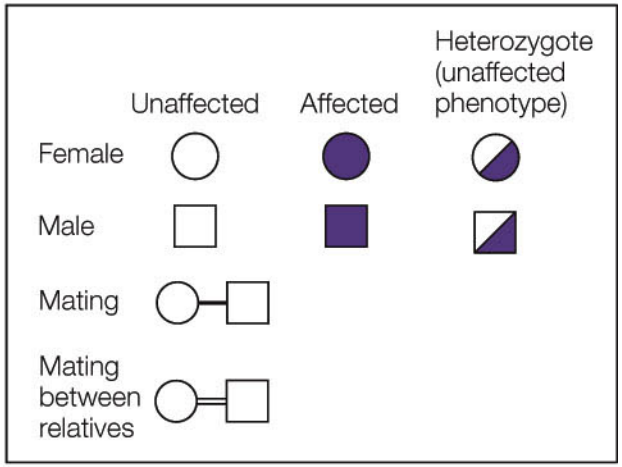


Muscular Dystrophy
Huntington Disease

Recessive

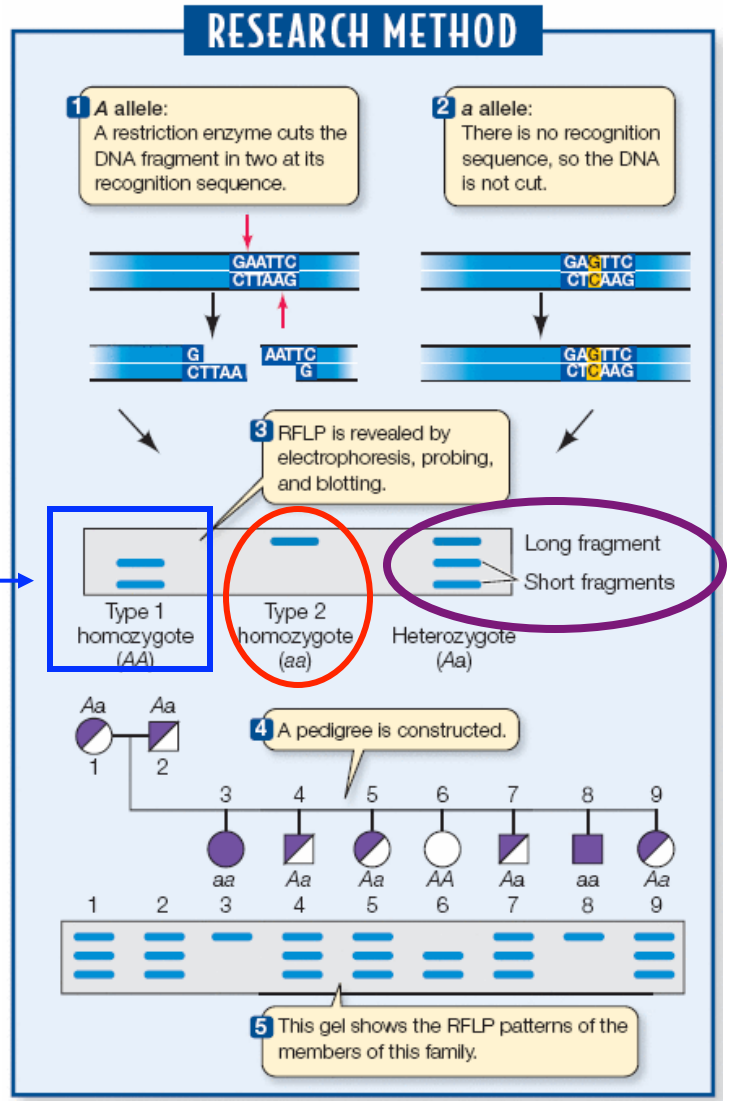


Sickle Cell Anemia
Cystic Fibrosis
Tay-Sachs Disease



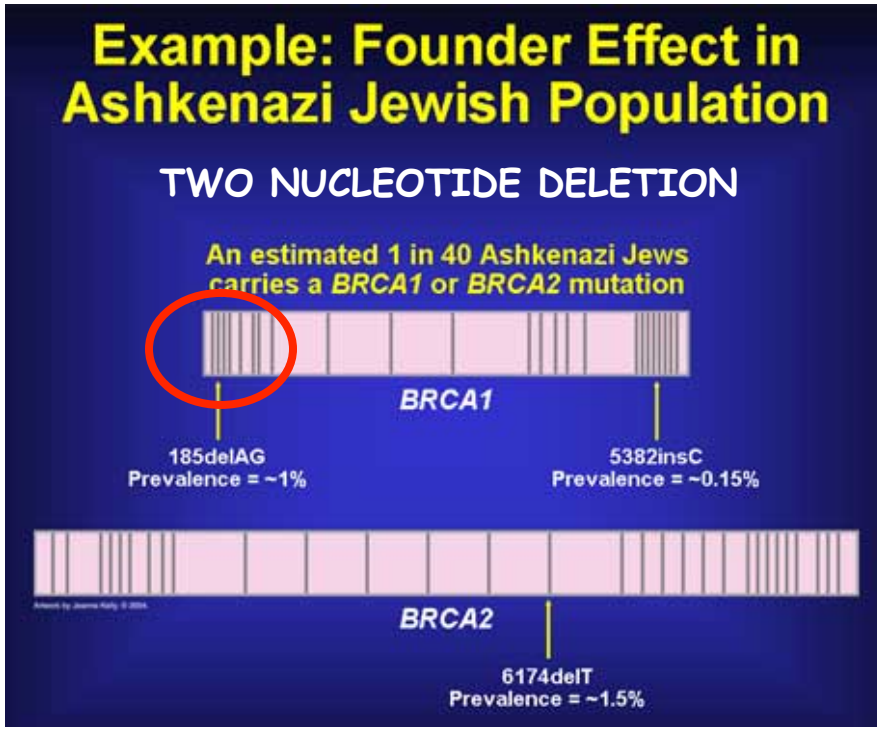
Genetic Diseases Can Be Followed in Families Using Molecular Methods (e.g., DNA Blots or PCR)

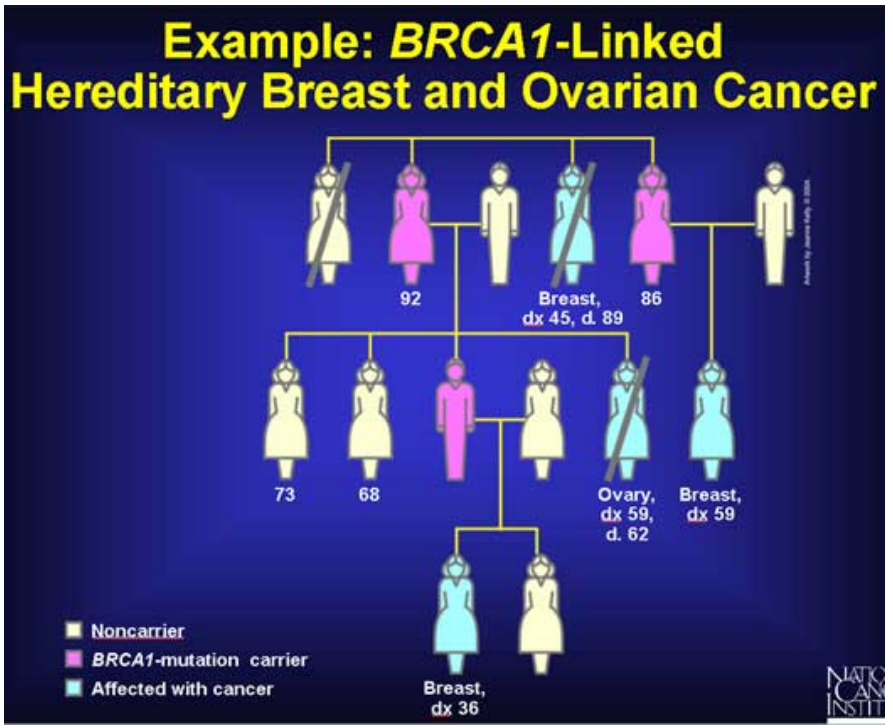
DNA Fingerprints →

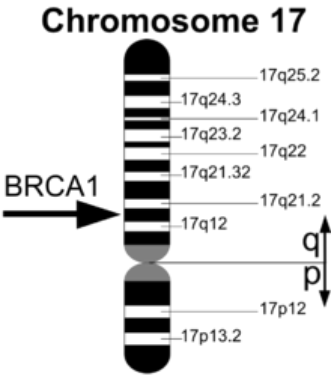


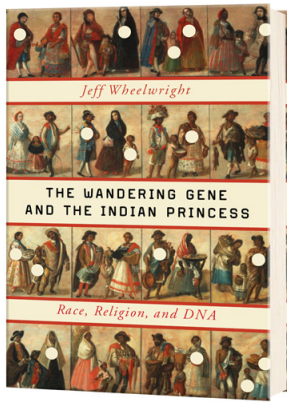
← RFLP –Restriction Fragment Length Polymorphism

Disease Mutations Can Originate in Single Populations and Be Maintained in Population Ancestors

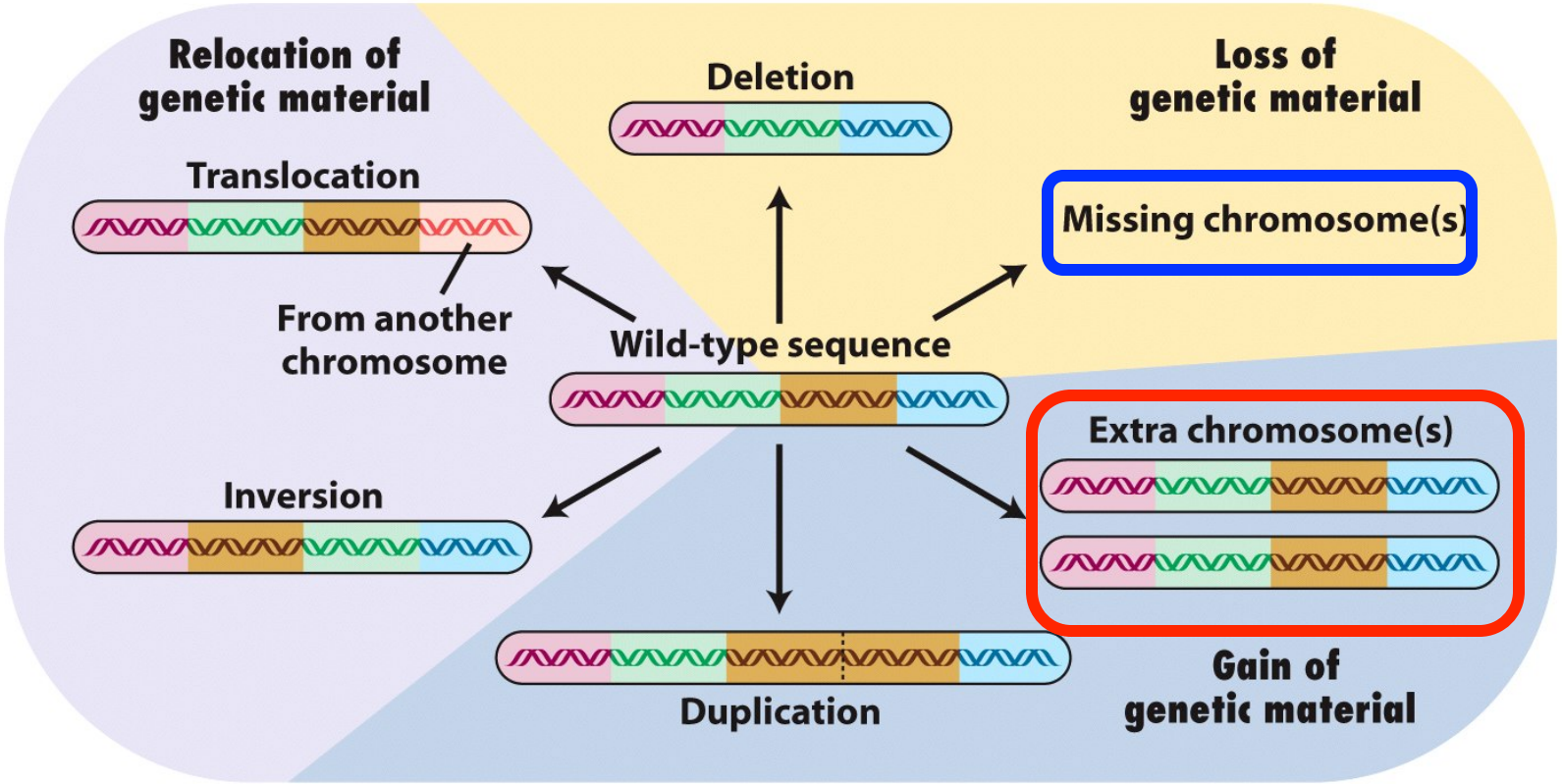








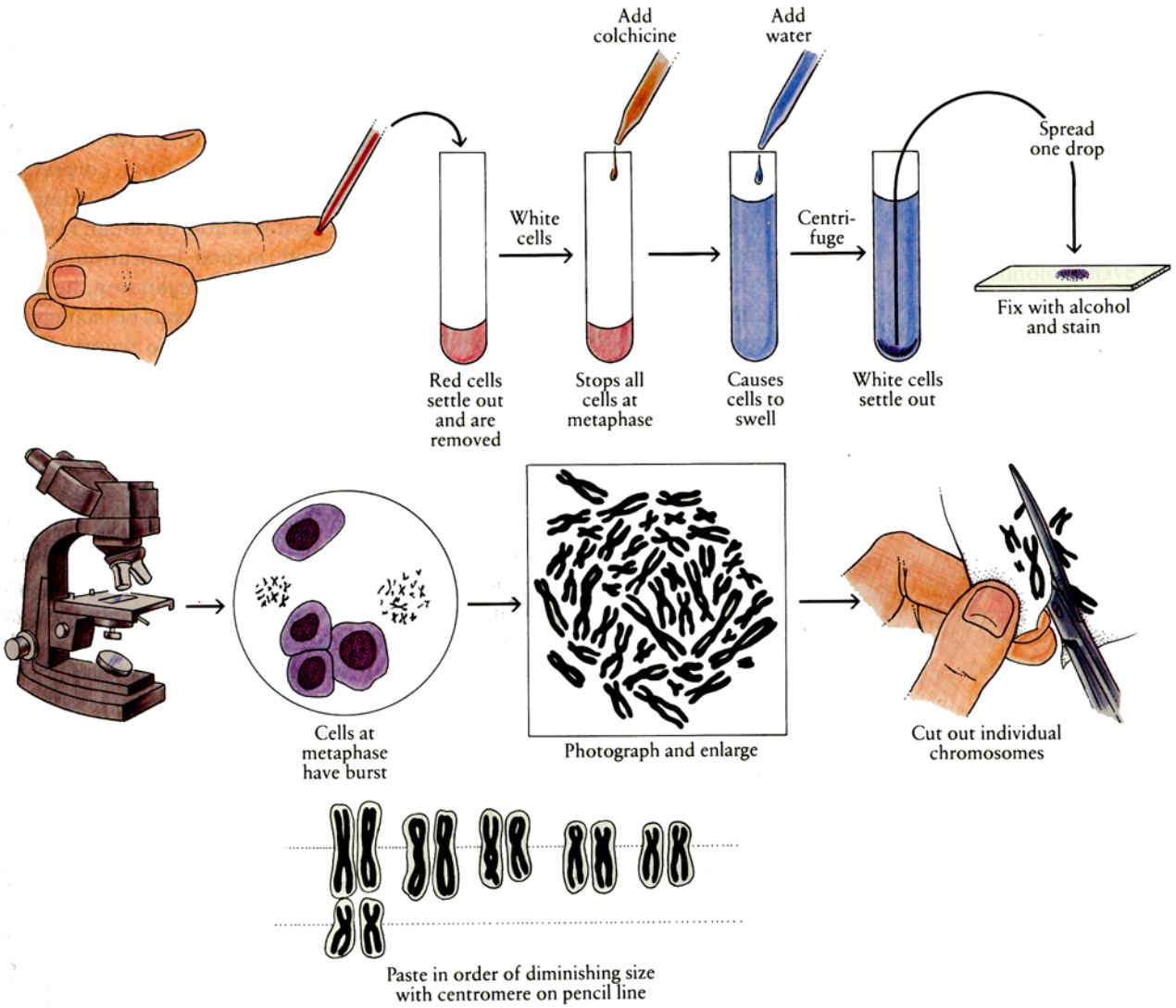
"Mutations" Can Also Occur By Large Chromosomal Changes



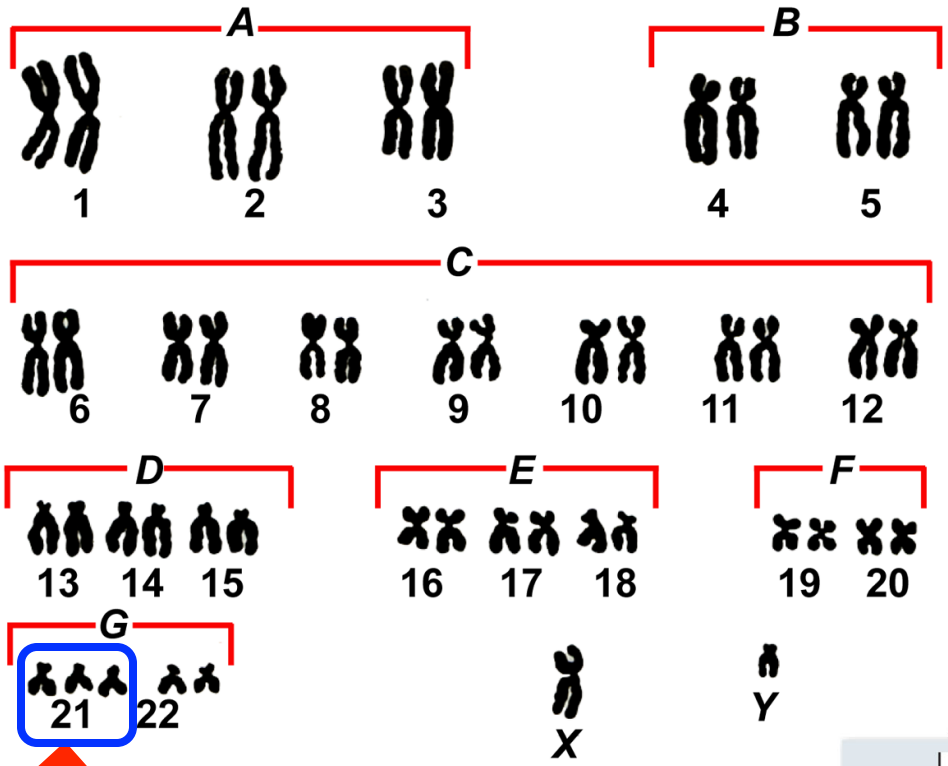
These changes affect many genes!

e.g. Down's Syndrome (3 Chromosome #21s)

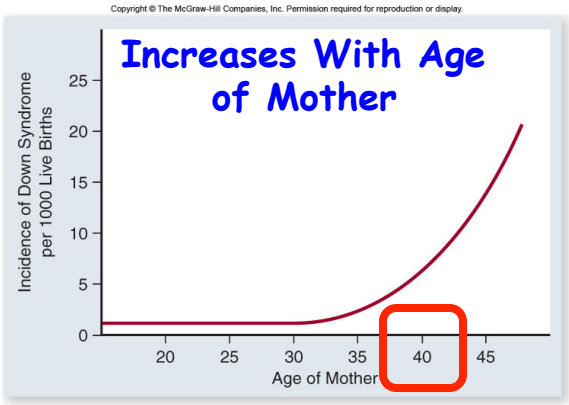
Karyotypes Can Be Used To Detect Changes in Chromosome Structure and Number



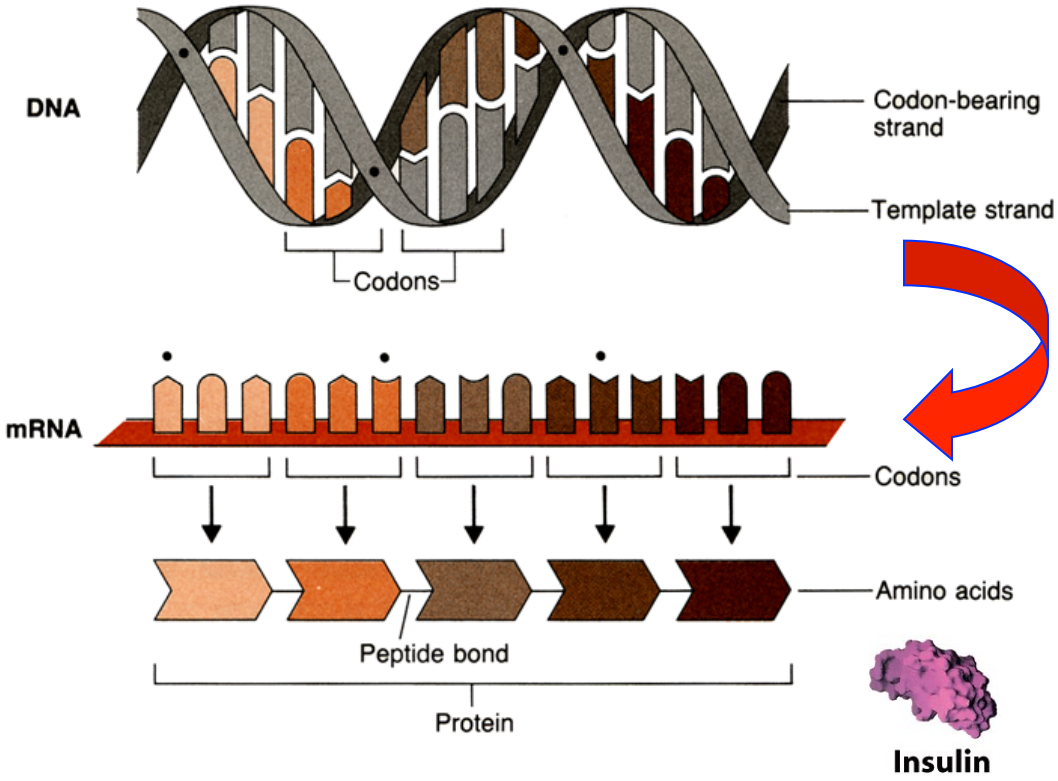
A Down's Syndrome Karyotype



Three Chromosome # 21s



2 How Does A Gene Lead To A Phenotype?



① mRNA Synthesized by Transcription

- Complementary to Transcribed, Non-Sense Strand
- Same Sequence As Sense Strand

② mRNA Translated into Protein by Translation of The Genetic Code

Genetic Code on mRNA Translated to Protein Sequence

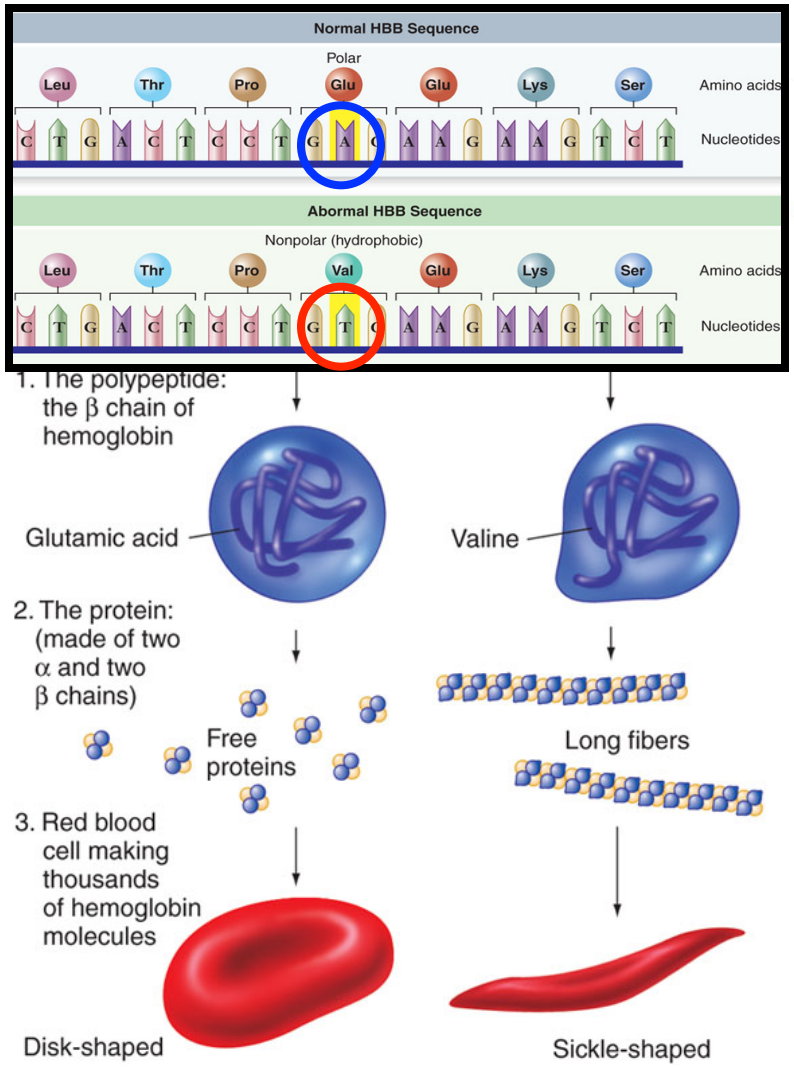
∴ Sequence of Gene
Sequence of mRNA
Sequence of Protein

Colinearity of Sequences!

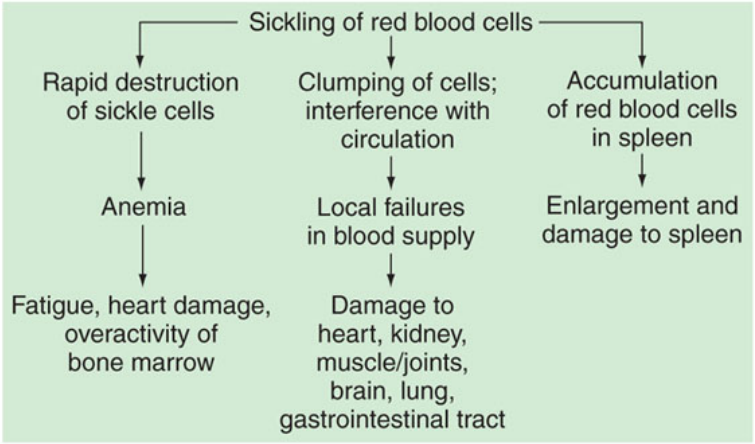
Know Sequence
Know Protein → Engineer New Protein

Human Genetic Disorders Occur As A Result of Mutations

Chromosome 11



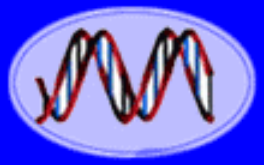
(b) Sickle-cell anemia is pleiotrophic



(c) β-chain substitutions/variants

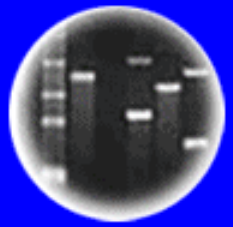
	Amino-acid position									
	1	2	3 ··· 6		7 ··· 26 ··· 63 ··· 67···125···146					
Normal (HbA)	Val	His	Leu	Glu	Glu	Glu	His	Val	Glu	His
HbS	Val	His	Leu	Val	Glu	Glu	His	Val	Glu	His
HbC	Val	His	Leu	Lys	Glu	Glu	His	Val	Glu	His
HbG San Jose	Val	His	Leu	Glu	Gly	Glu	His	Val	Glu	His
HbE	Val	His	Leu	Glu	Glu	Lys	His	Val	Glu	His
HbM Saskatoon	Val	His	Leu	Glu	Glu	Glu	Tyr	Val	Glu	His
Hb Zurich	Val	His	Leu	Glu	Glu	Glu	Arg	Val	Glu	His
HbM Milwaukee 1	Val	His	Leu	Glu	Glu	Glu	His	Glu	Glu	His
HbDβ Punjab	Val	His	Leu	Glu	Glu	Glu	His	Val	Gln	His

Sickle-Cell Anemia



DNA
Genetic Code of Life

Entire Genetic Code
of a Bacteria

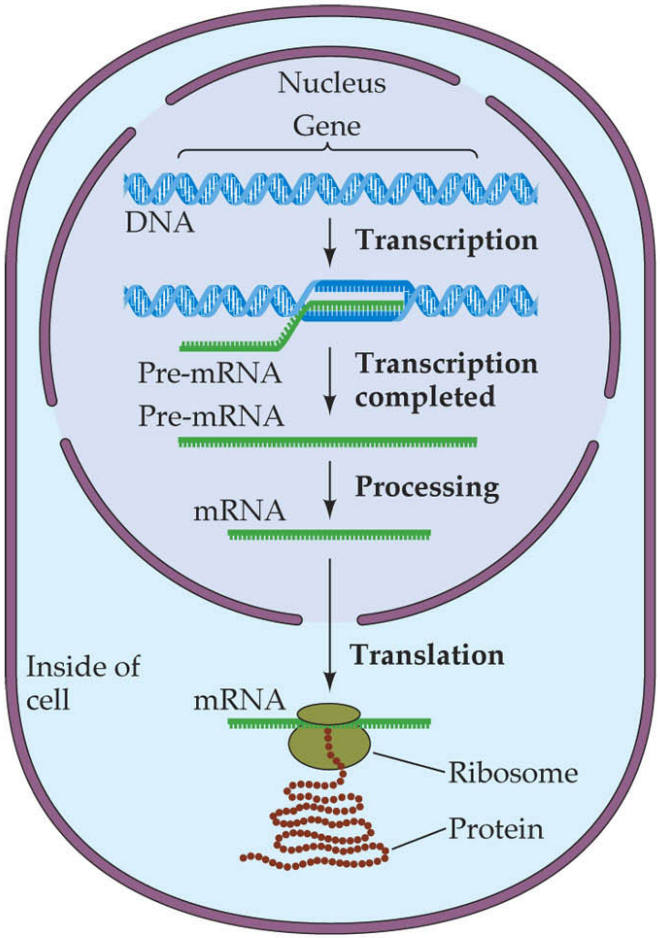


DNA Fingerprinting

Cloning: Ethical Issues
and Future Consequences

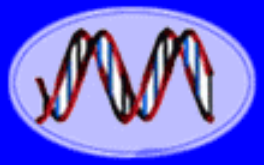
Plants of Tomorrow

An Elaborate Cellular Machinery Requiring Thousands Of Genes is Required To Produce Proteins Encoded By Specific Genes!!



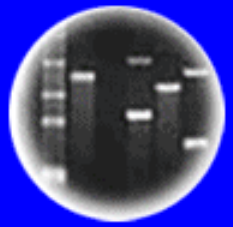
LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 14.1 Eukaryotic mRNA Is Transcribed in the Nucleus but Translated in the Cytoplasm

It takes Genes
to Express
(and Replicate)
A GENE!!!



DNA
Genetic Code of Life

Entire Genetic Code
of a Bacteria



DNA Fingerprinting

Cloning: Ethical Issues
and Future Consequences

Plants of Tomorrow

Unique Proteins Have A Unique Composition & Order of Amino Acids & Have Unique Sizes, Shapes, & Functions

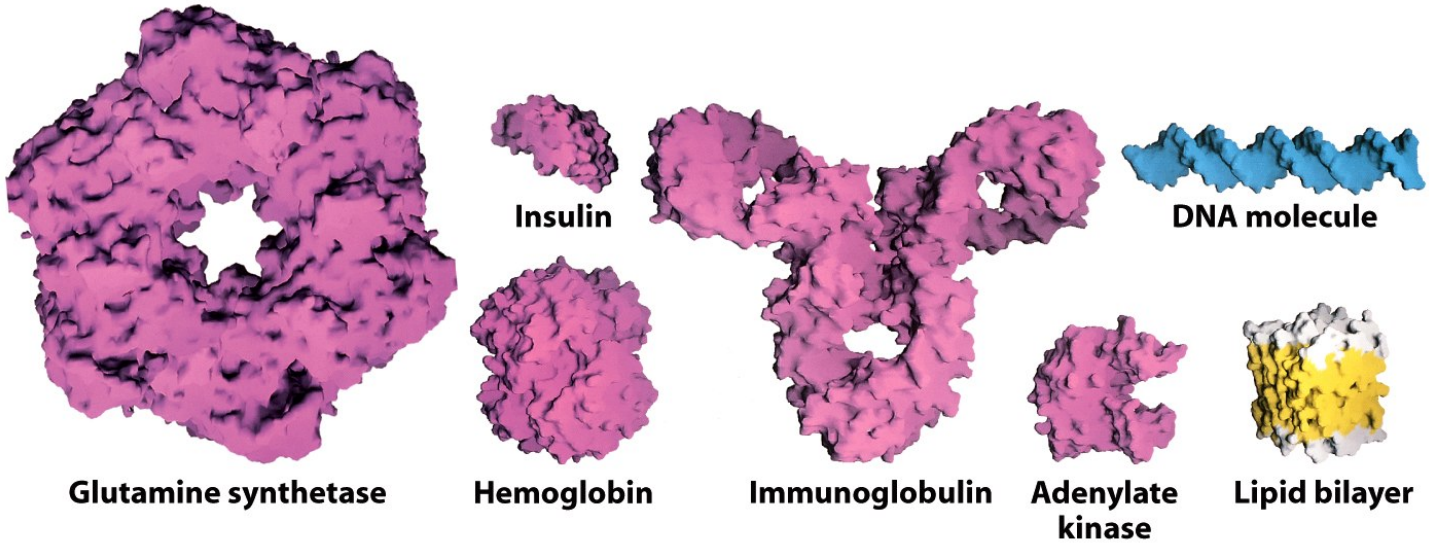
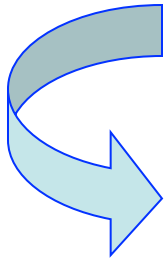
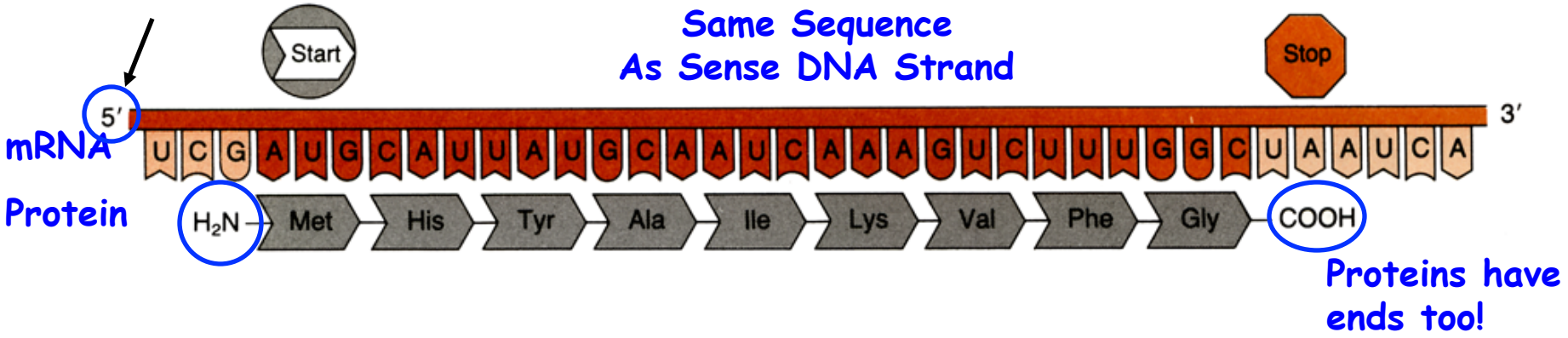


Figure 1-9
Molecular Cell Biology, Sixth Edition



Novel Cell Functions & Phenotypes

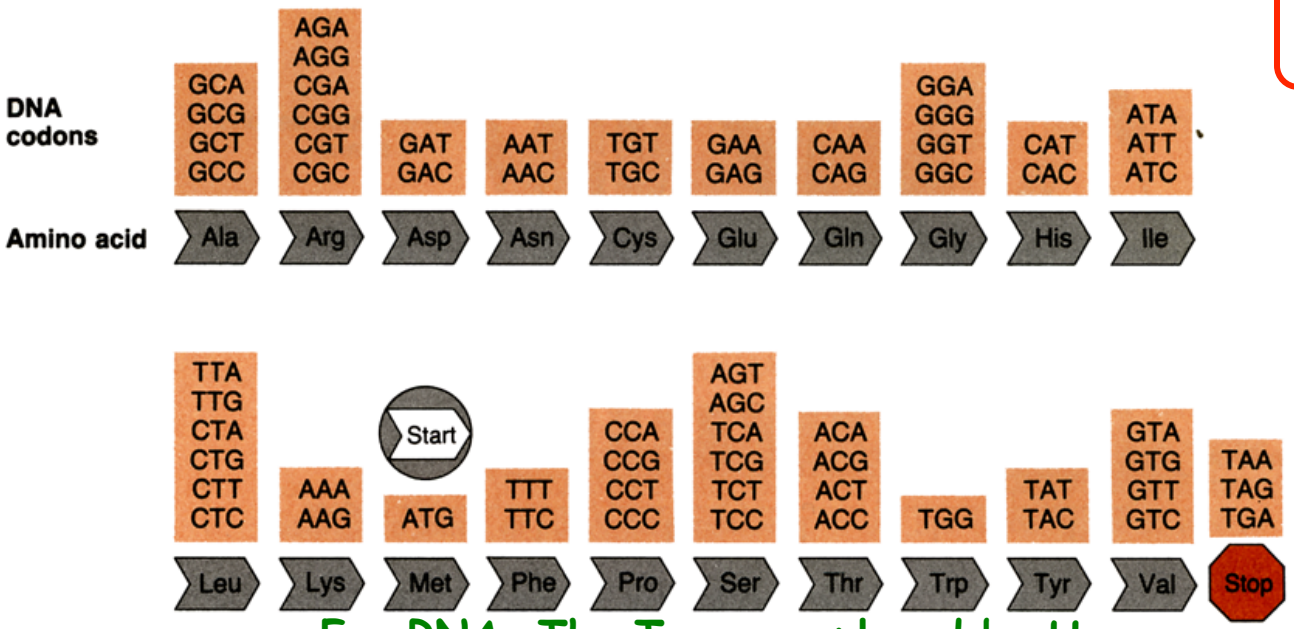
Genetic Code Allows The Sequence of Nucleotides in mRNA/ sense strand of Gene to be Translated into Sequence of Amino Acids in Proteins



Note: Sequence in mRNA (= Sense Gene Strand) is translated 5' →3' (= beginning of sense strand to end) & Protein made in N→C direction therefore order Nts in gene = order amino acid in protein!

The Genetic Code is Universal!

How Know?



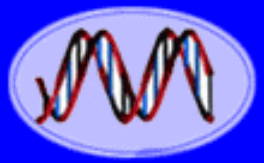
For RNA, The Ts are replaced by Us.

1. Universal
2. Triplet
3. Punctuation
4. Degenerate

Know Sequence of Gene-Know Sequence of Protein Using Genetic Code

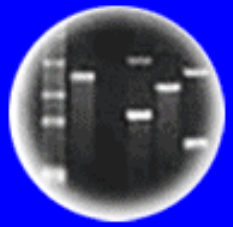
Big Implication For Genetic Engineering! Can Make Genes, Genomes & Specify Proteins Wanted! Can Express Genes From One Organism in Another!

Design An Experiment to Show Code is Universal!



DNA
Genetic Code of Life

Entire Genetic Code
of a Bacteria



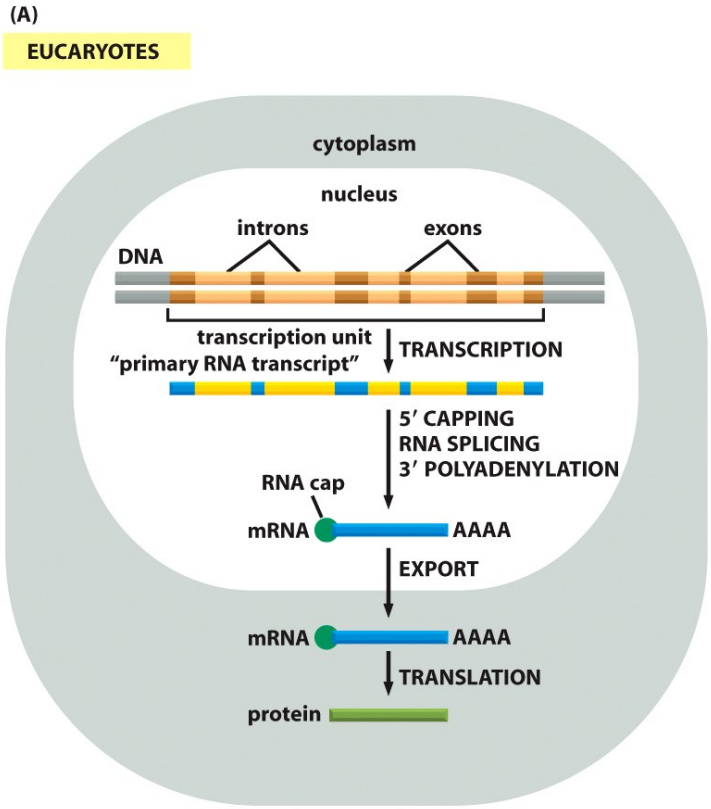
DNA Fingerprinting

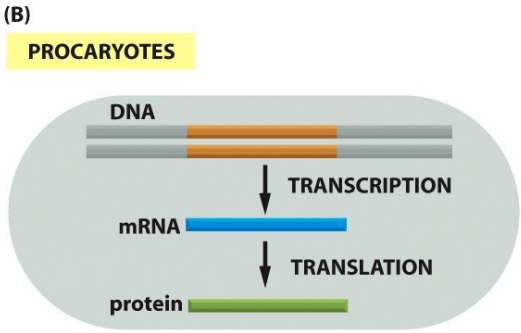
Cloning: Ethical Issues
and Future Consequences

Plants of Tomorrow

Expression of Jellyfish Green Fluorescence Protein (GFP) in Pigs Shows That Genetic Code is Universal!!

Eukaryotic and Prokaryotic Gene Expression Processes Differ Slightly



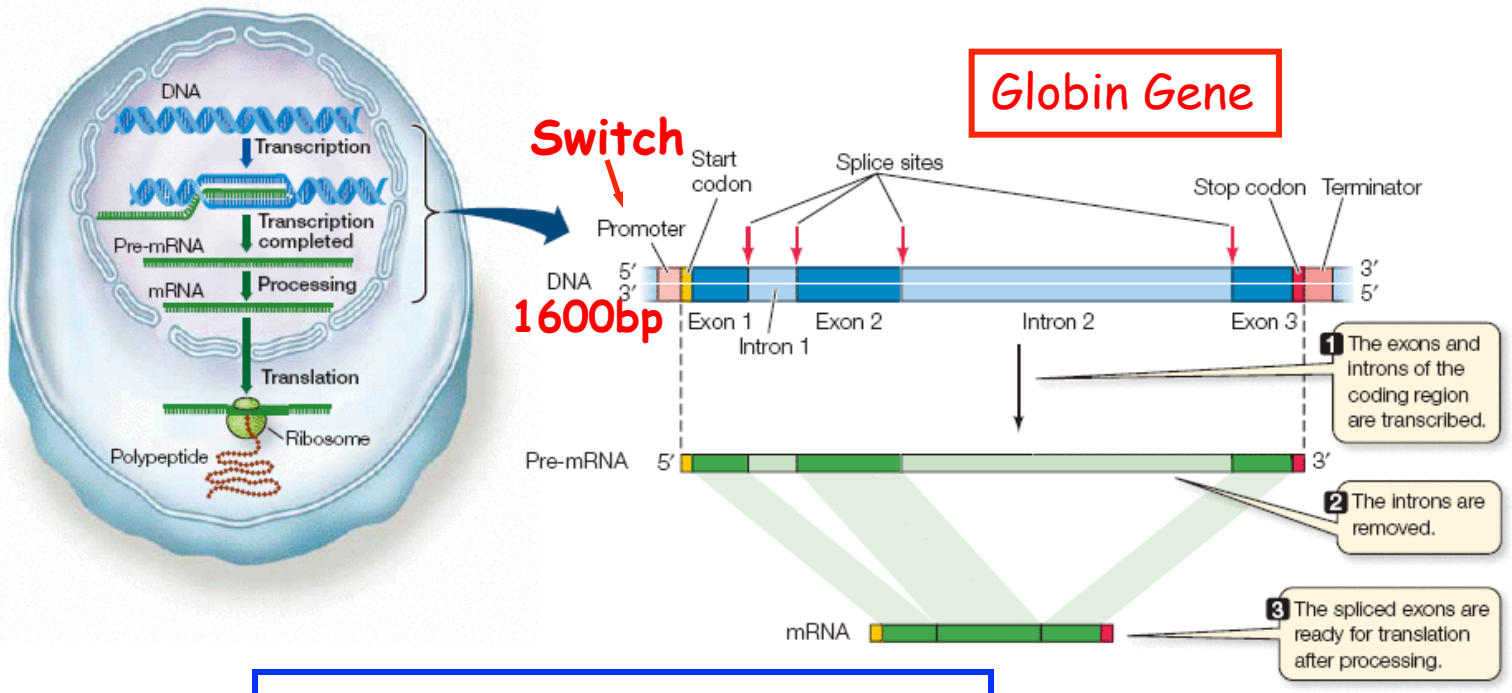


Genes Differ
Switches Differ
Genetic Code the Same
General Processes Same
Eukaryotic Gene Have Introns & Non-Coding Region in Gene!

Eukaryotic Cells Must Remove Non-Coding Region of RNA Before Genetic Code Can Be Translated Continuously!

What Are the Implications For Genetic Engineering?

RNA Splicing- Removing Non-Coding Sequences From Primary Transcripts & Generating Functional mRNAs



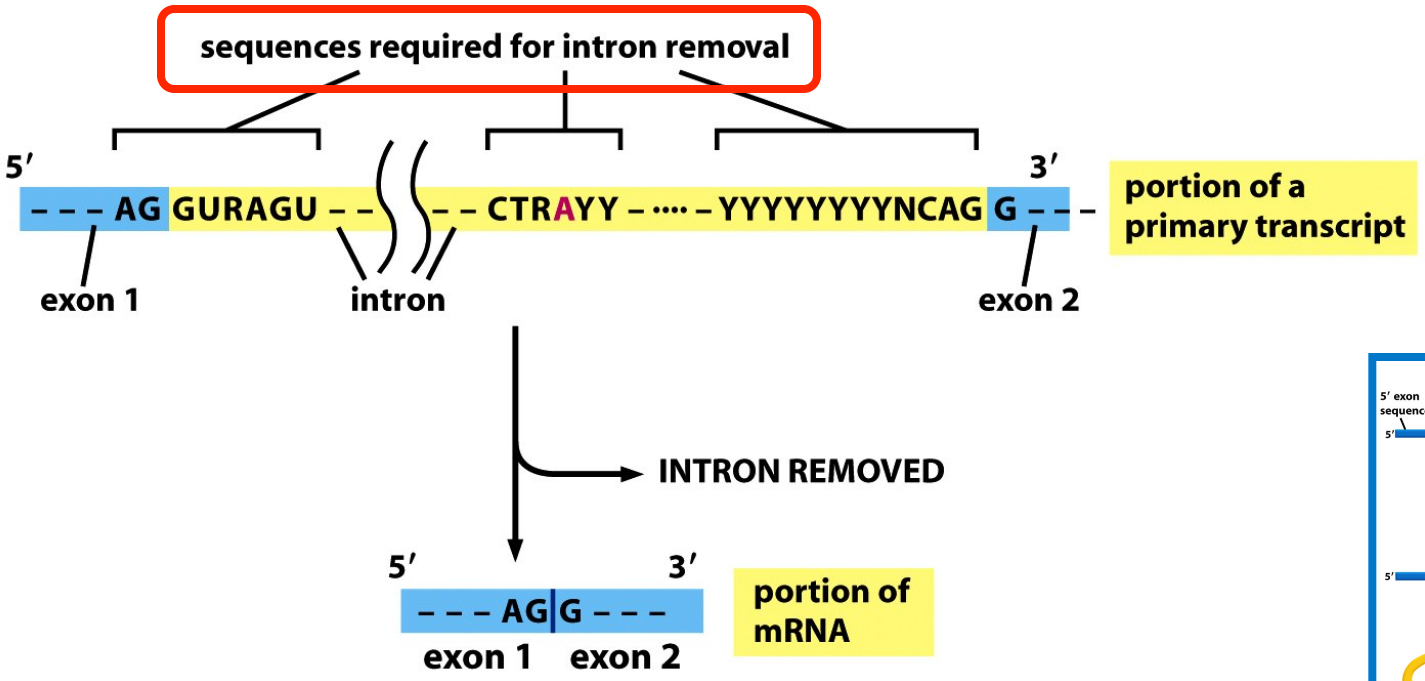
Mutations→ Blood Disorders
Where can these occur?

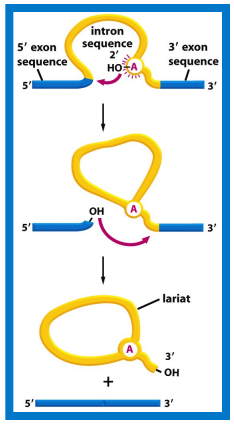
Mutations Can Occur in Coding Region, Switch, & RNA Splice Sites

→ Mutant Phenotype

Implications For Engineering Eukaryotic Gene in Bacterial Cell For Expression?

Yo! It's In The Sequences!

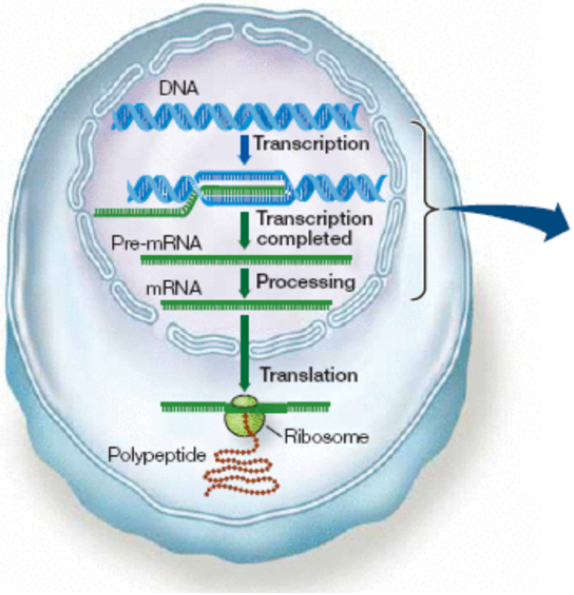




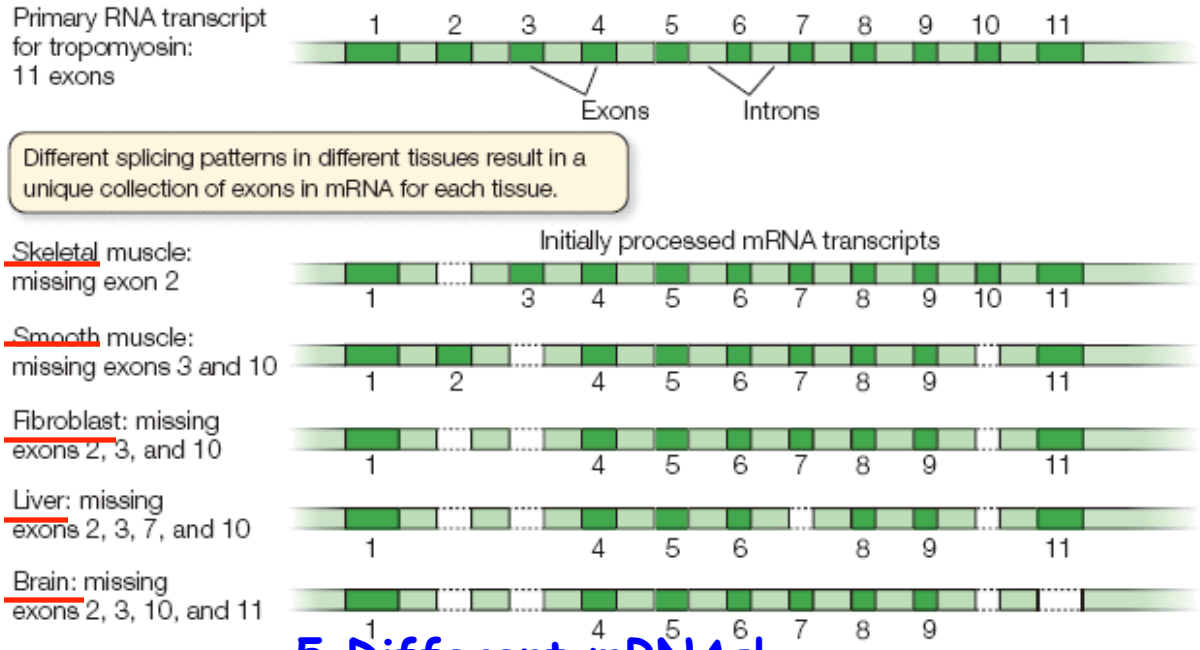
Specific Sequences Required For RNA Splicing!

What Happens If These Sequences Are Mutated in a Gene?

Alternative Splicing- One Gene → Several mRNAs & Proteins



Gene Activity in Varity of Cells, But…..!!!



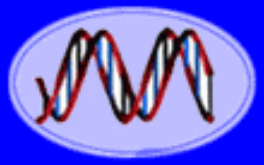
5 Different mRNAs!

Different mRNA = Different Proteins = Different Functions!

Implication- Human Genome Has Only 25,000 Genes But Can Give Rise to Many More Proteins which Are Responsible For Producing the Phenotype

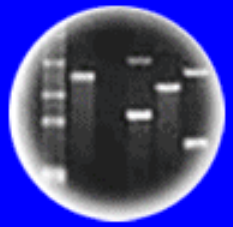
Reason Why Human Genome Can Contain Same Number of Genes as Fly and Plant Genomes!!

Implications for Genetic Engineering? Use Specific cDNA!



DNA
Genetic Code of Life

Entire Genetic Code of a Bacteria



DNA Fingerprinting

Cloning: Ethical Issues and Future Consequences

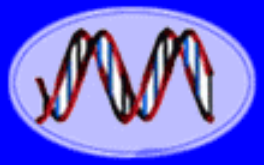
Plants of Tomorrow

Implications For "Yo - Its in The DNA!!"

Modular Organization of Sequences

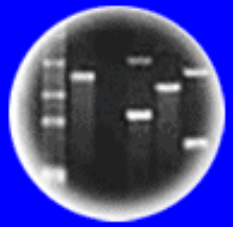
1. DNA Replication
   - Ori
2. Transcription
   - Switch/Regulator
   - Terminator
3. Processing of RNA (Eukaryotes)
   - Splicing Sites
4. Translation
   - Start
   - Stop
   - Genetic Code/Codons
5. Coding Sequence
   - Genetic Code

Modules → Anything You Want To Do Using Genetic Engineering!



DNA
Genetic Code of Life

Entire Genetic Code of a Bacteria



DNA Fingerprinting

Cloning: Ethical Issues and Future Consequences

Plants of Tomorrow

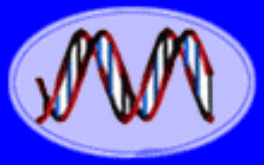
Summary: Engineering Genes Requires:

1. The Gene & Its DNA Sequences
2. A Roadmap of Where Coding Sequence & all Switches Located (Sequence, Restriction Site Map)
3. Transcription Start And Stop Switches
4. Coding Region of Gene (genetic code part)
5. Translation Start And Stop Switches
6. Kingdom-Specific Switches/ Signals

Note: The General Process of Gene→Protein is the same in ALL organisms, but the Specific Switches & Enzymes (e.g., RNA Polymerase) are Kingdom Specific

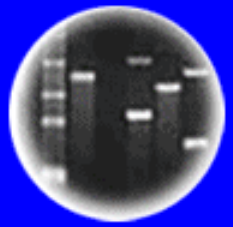
Bacteria Transcription On Switch + Human Insulin Coding Sequence + Bacteria Transcription Off Switch

→ Human Insulin in Bacteria!!



DNA
Genetic Code of Life

Entire Genetic Code of a Bacteria



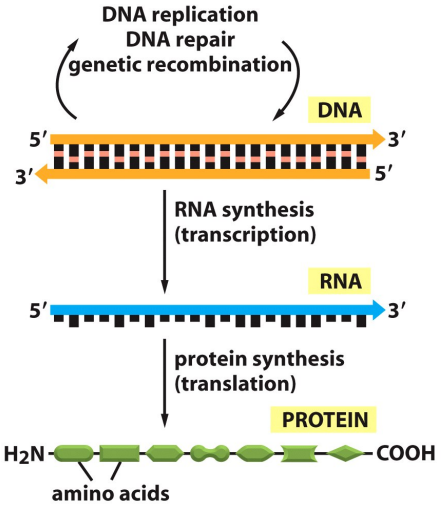
DNA Fingerprinting

Cloning: Ethical Issues and Future Consequences

Plants of Tomorrow

How Do Genes Work & What are Genes in Context of…

Thinking About The Consequences of GMOs



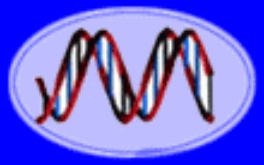
1. What is a Gene?
2. What is the Anatomy of a gene?
3. How Does the Gene Replicate?
4. How Does the Gene Direct Synthesis of a Protein?
5. Does the Gene Work Independently of other Genes?
6. What is the Sequence & Structure of the Protein?
7. How does it work in cell?
8. Does the Protein Structure imply any Potential "Harm"?
9. Does the Gene Change the organism? Fitness?

Need Science-Based Questions & Science-Based Solutions-NOT OPINIONS!

There's NO HOCUS POCUS all hypothesis are testable!!

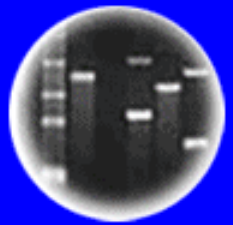
"Behind" All Traits!

Same Processes!



DNA
Genetic Code of Life

Entire Genetic Code
of a Bacteria



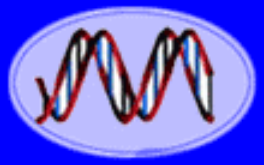
DNA Fingerprinting

Cloning: Ethical Issues
and Future Consequences

Plants of Tomorrow

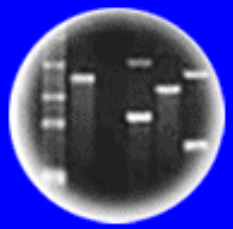
Can Identical Twins Be Different?

"Things Written in Pen You Cannot Change. That's DNA!
Things Written in Pencil You Can. That's Epigenetics"
Geneticist Danielle Reed



DNA
Genetic Code of Life

Entire Genetic Code of a Bacteria

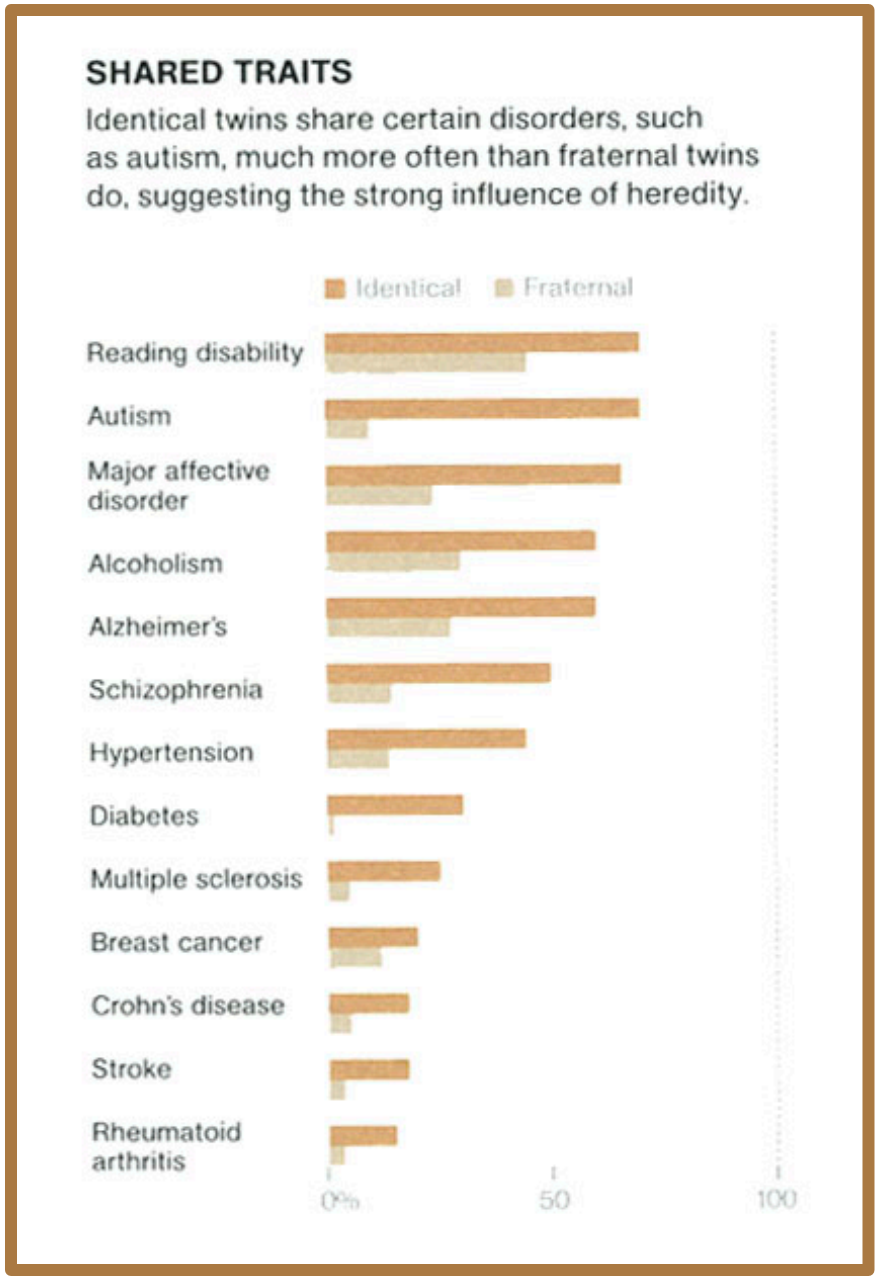


DNA Fingerprinting

Cloning: Ethical Issues and Future Consequences

Plants of Tomorrow

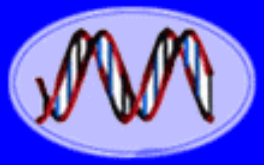
Nature vs. Nurture?



Because Genes Replicate Generation to Generation!

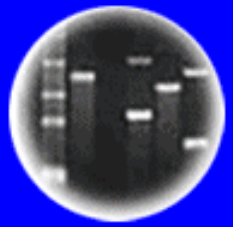
But Environment Can Play a Role

We Are Beginning to Learn Why!



DNA
Genetic Code of Life

Entire Genetic Code of a Bacteria

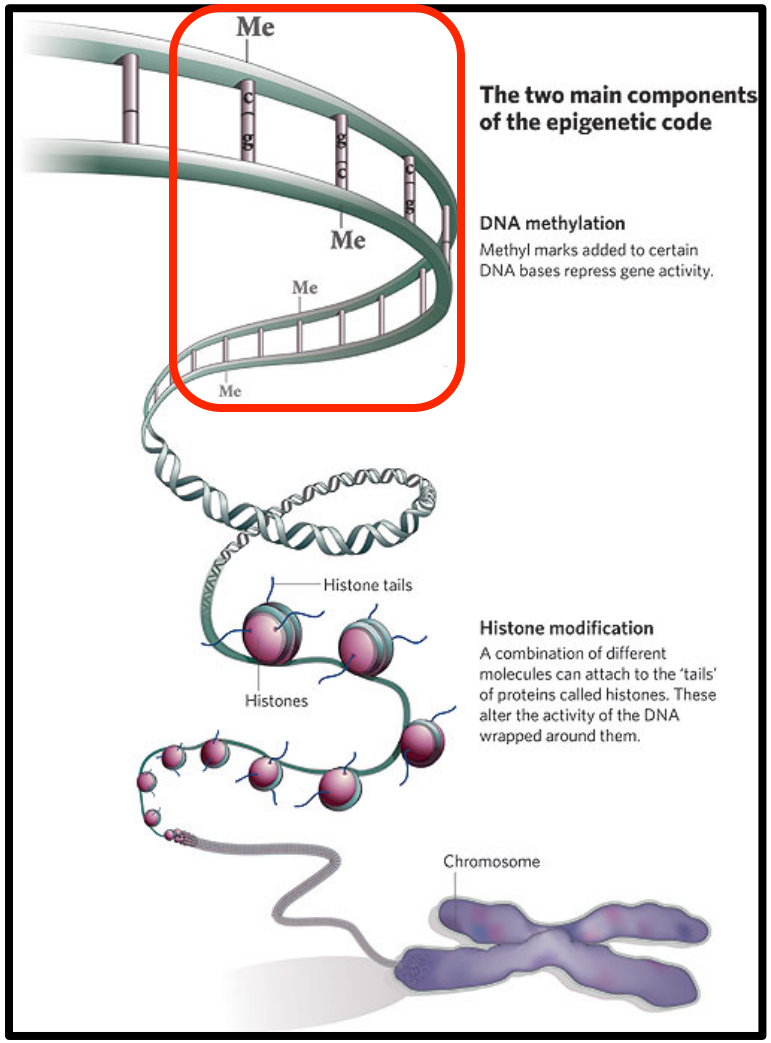


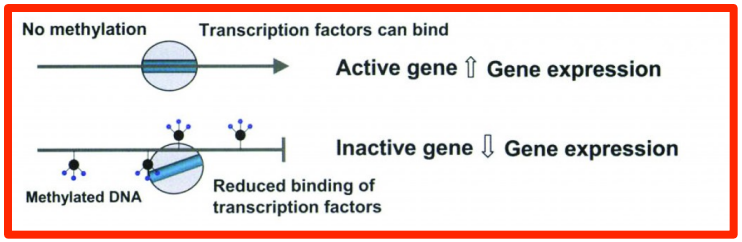
DNA Fingerprinting

Cloning: Ethical Issues and Future Consequences

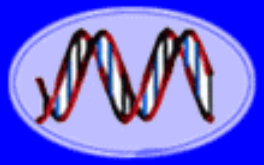
Plants of Tomorrow

Epigenetic Changes, or Chemical Modifications of Switches and Genes, Can Affect Gene Activity!



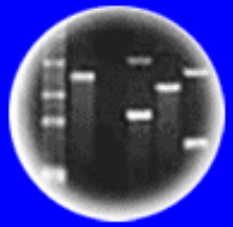


These Changes Are Re-Set Each Generation, but Environmental Factors Can Influence Modification of DNA



DNA
Genetic Code of Life

Entire Genetic Code of a Bacteria

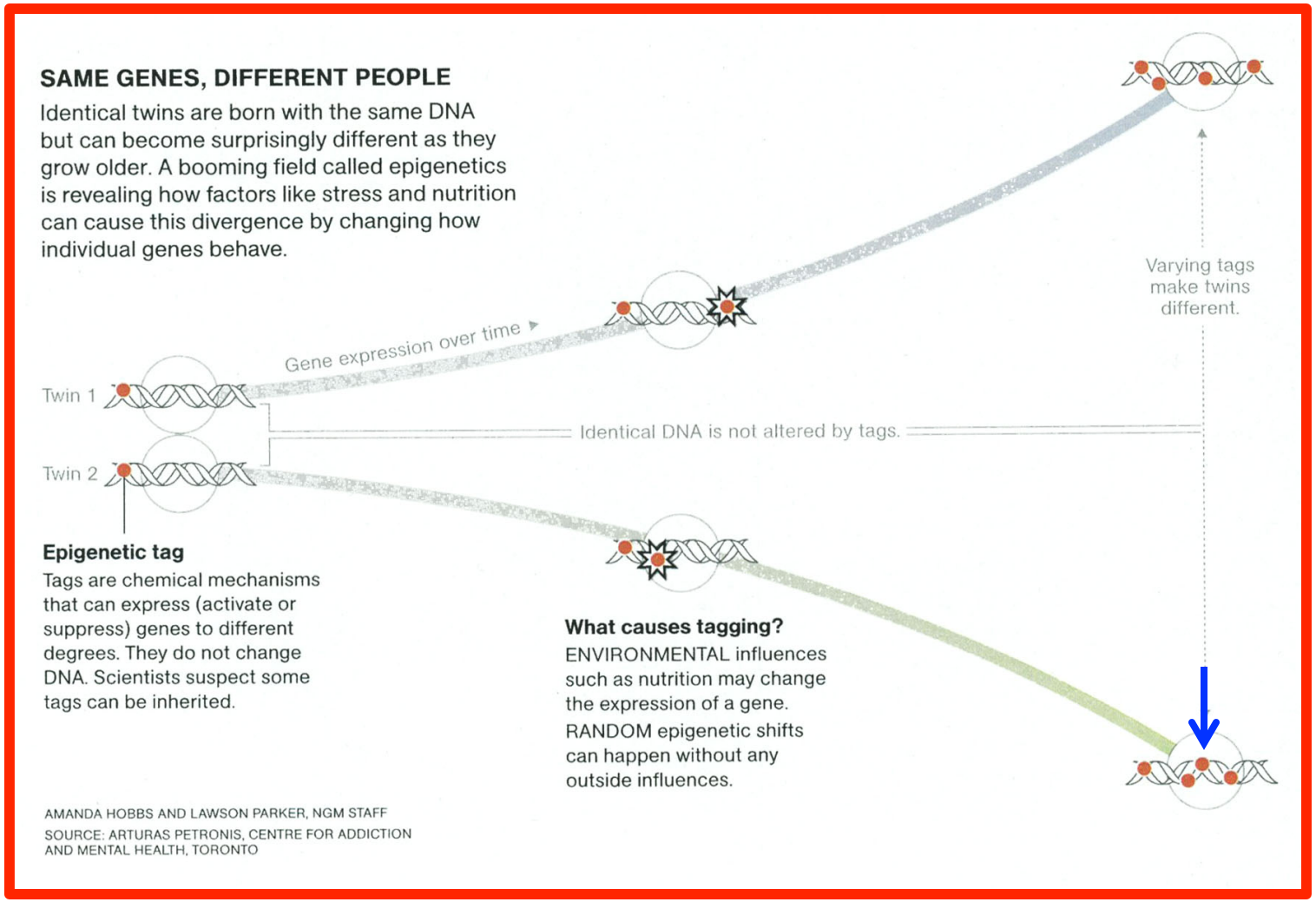


DNA Fingerprinting

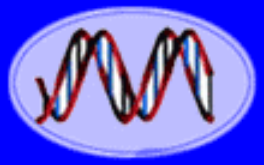
Cloning: Ethical Issues and Future Consequences

Plants of Tomorrow

Nature vs. Nurture?

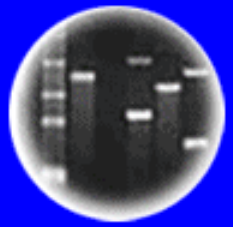


Rare Epigenetic Events Can Affect Individuals Differently!



DNA
Genetic Code of Life

Entire Genetic Code of a Bacteria

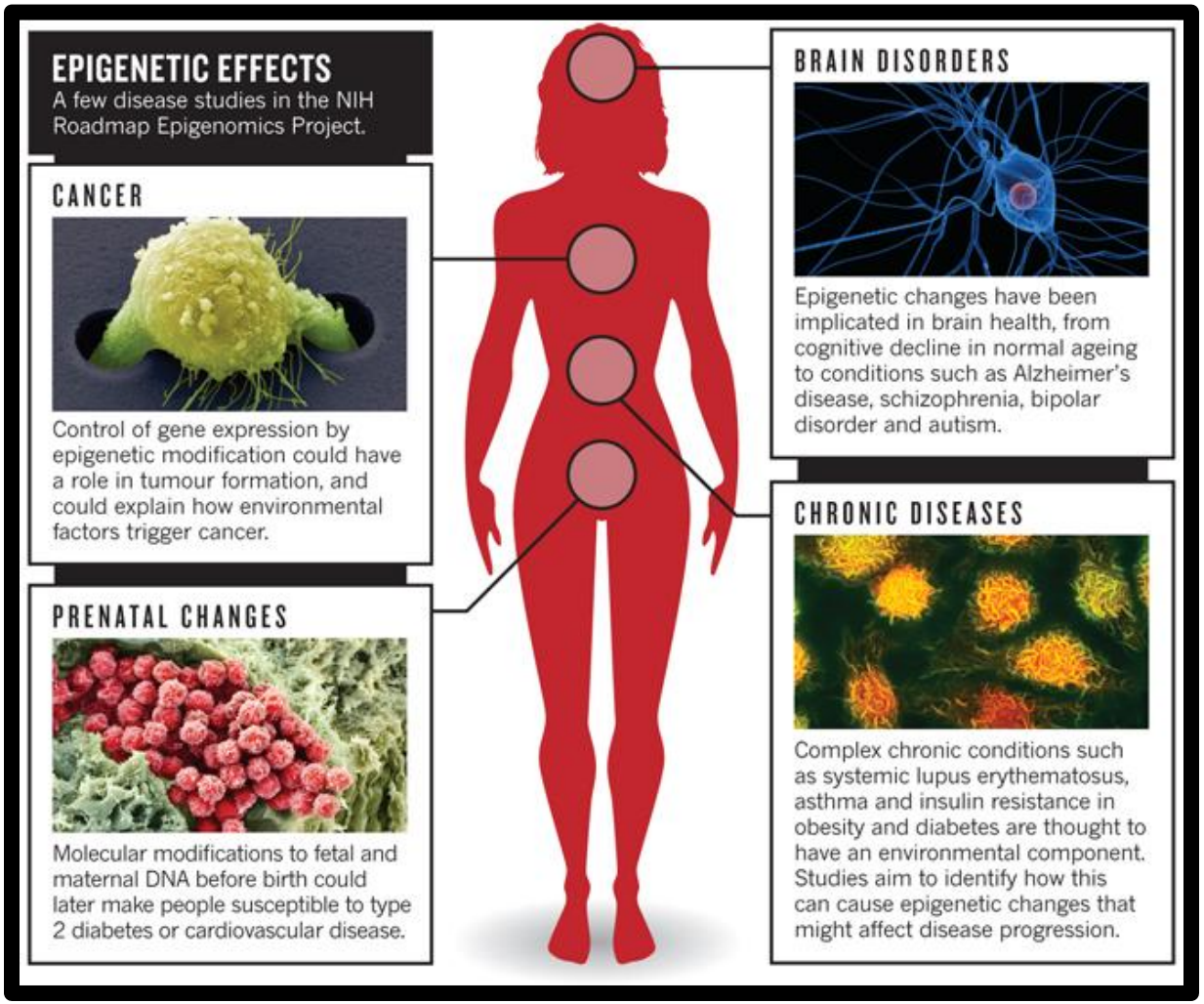


DNA Fingerprinting

Cloning: Ethical Issues and Future Consequences

Plants of Tomorrow

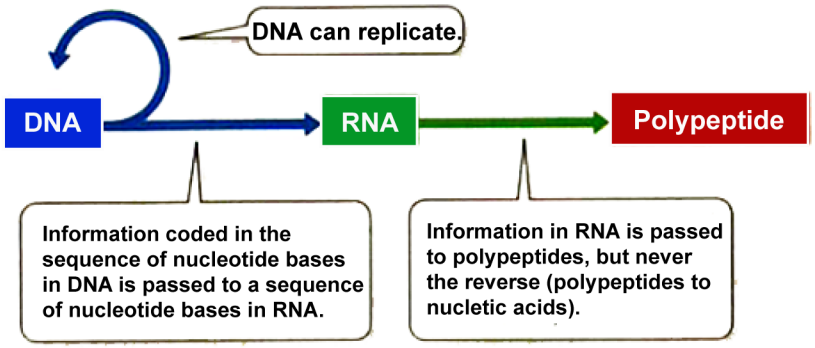
Epigenetic Effects in Disease?



Rare Epigenetic Events Affect Individuals Differently!

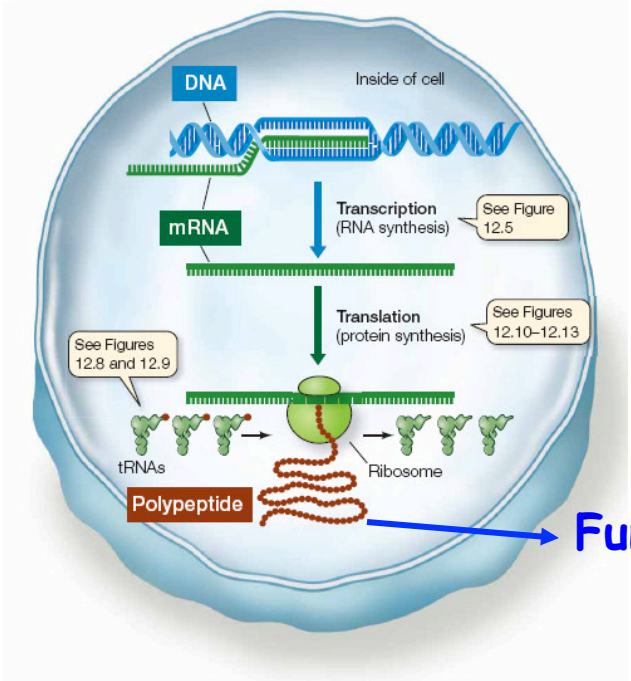
How Do Genes Work-Not As Simple As We Think!

① Replication



② Gene Activity to Function & Phenotype

Gene Activity → Protein → Function → Phenotype (Trait)



Function →

But Precise Cellular Rules Are Followed That We Can Use For Genetic Engineering!