

Genetiikan perusteiden miellekartta: geneettinen triplettikoodi

Translaatiossa mRNA:ssa tarvitaan seuraavat *sanomat* :

m⁷G - pipo

Ehkä internal ribosome entry site **IRES**

poly-A -häntä sirkulaarisen polysomin muodostamiseksi

AUG aloituskodon ensimmäistä metioniinia varten

UAA, UAG tai UGA lopetuskodon RF:ää varten

Sekä ennen AUG-kodonia että STOP-kodonin jälkeen voi olla säätelyyn osallistuvia **UTR**- jaksoja (untranslated region)

UTR koodi **UTR**
m⁷G ---AUG----(IRES) -----AUG -----...-----UAA-----p(AAA)

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UTR koodi UTR
 m^7G ---AUG---(IRES) ---AUG-----...-----UAA-----p(AAA)

Tässä tulikin jo pari triplettikoodin sanaa

Aloitus (= metioniini) **AUG**

STOP: **UAA, UGA** tai **UAG**

Koodin murtaminen oli molekyyligenetiikan historian suuria juttuja: nobelistit Holley (tRNA), Khorana ja Nirenberg ([1968](#))



The Genetic Code

| 1st position (5' end) | 2nd Position | | | | 3rd Position (3' end) |
|--------------------------|--------------|-----|-------------|-------------|--------------------------|
| U | U | C | A | G | |
| | Phe | Ser | Tyr | Cys | U |
| | Phe | Ser | Tyr | Cys | C |
| | Leu | Ser | STOP | STOP | A |
| | Leu | Ser | STOP | Trp | G |
| C | Leu | Pro | His | Arg | U |
| | Leu | Pro | His | Arg | C |
| | Leu | Pro | Gln | Arg | A |
| | Leu | Pro | Gln | Arg | G |
| A | Ile | Thr | Asn | Ser | U |
| | Ile | Thr | Asn | Ser | C |
| | Ile | Thr | Lys | Arg | A |
| | Met | Thr | Lys | Arg | G |
| G | Val | Ala | Asp | Gly | U |
| | Val | Ala | Asp | Gly | C |
| | Val | Ala | Glu | Gly | A |
| | Val | Ala | Glu | Gly | G |

Amino Acids Codons

| | | | |
|---|-----|---------------|-------------------------|
| A | Ala | Alanine | GCA GCC GCG GCU |
| C | Cys | Cysteine | UGC UGU |
| D | Asp | Aspartic acid | GAC GAU |
| E | Glu | Glutamic acid | GAA GAG |
| F | Phe | Phenylalanine | UUC UUU |
| G | Gly | Glycine | GGA GGC GGG GGU |
| H | His | Histidine | CAC CAU |
| I | Ile | Isoleucine | AUA AUC AUU |
| K | Lys | Lysine | AAA AAG |
| L | Leu | Leucine | UUA UUG CUA CUC CUG CUU |
| M | Met | Methionine | AUG |
| N | Asn | Asparagine | AAC AAU |
| P | Pro | Proline | CCA CCC CCG CCU |
| Q | Gln | Glutamine | CAA CAG |
| R | Arg | Arginine | AGA AGG CGA CGC CGG CGU |
| S | Ser | Serine | AGC AGU UCA UCC UCG UCU |
| T | Thr | Threonine | ACA ACC ACG ACU |
| V | Val | Valine | GUA GUC GUG GUU |
| W | Trp | Tryptophan | UGG |
| Y | Tyr | Tyrosine | UAC UAU |

DNA words are three letters long.

22

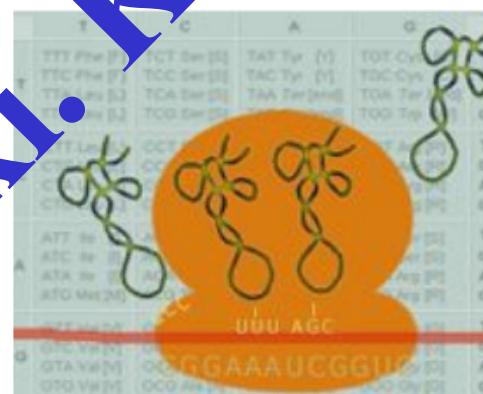
DNA FROM THE BEGINNING



The genetic code had to be a "language" – using the DNA alphabet of A, T, C, and G – that produced enough DNA "words" to specify each of the 20 known amino acids.

Simple math showed that only 16 words are possible from a two-letter combination, but a three-letter code produces 64 words. Operating on the principle that the simplest solution is often correct, researchers assumed a three-letter code called a codon.

Research teams at University of British Columbia and the National Institutes of Health laboriously synthesized different RNA molecules, each a long strand composed of a single repeated codon. Then, each type of synthetic RNA was added to a cell-free translation system containing ribosomes, transfer RNAs, and amino acids. As predicted, each type of synthetic RNA produced a polypeptide chain composed of repeated units of a single amino acid. Several codons are "stop" signals and many amino acids are specified by several different codons, accounting for all 64 three-letter combinations.



- 20 [A half DNA ladder is a template for copying the whole.](#)
- 21 [RNA is an intermediary between DNA and protein.](#)
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- GENETIC ORGANIZATION AND CONTROL** 
- 29 [DNA is packaged in a chromosome.](#)
- 30 [Higher cells incorporate an ancient chromosome.](#)
- 31 [Some DNA does not encode protein.](#)
- 32 [Some DNA can jump.](#)
- 33 [Genes can be turned on and off.](#)
- 34 [Genes can be moved between species.](#)
- 35 [DNA responds to signals from outside the cell.](#)
- 36 [Different genes are active in different kinds of cells.](#)
- 37 [Master genes control basic body plans.](#)
- 38 [Development balances cell growth and death.](#)
- 39 [A genome is an entire set of genes.](#)
- 40 [Living things share common genes.](#)
- 41 [DNA is only the beginning for understanding the human genome.](#)



DNA words are three letters long.

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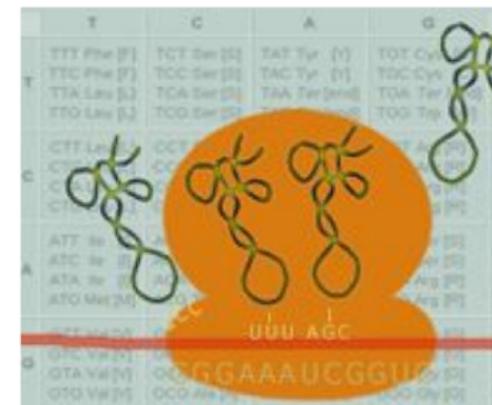
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- 6 Genes are real things.
 - 7 All cells arise from pre-existing cells.
 - 8 Sex cells have one set of chromosomes; body cells have two.
 - 9 Specialized chromosomes determine gender.
 - 10 Chromosomes carry genes.
 - 11 Genes get shuffled when chromosomes exchange pieces.
 - 12 Evolution begins with the inheritance of gene variations.
 - 13 Mendelian laws apply to human beings.
 - 14 Mendelian genetics cannot fully explain human health and behavior.

MOLECULES
OF GENETICS

- 15 DNA and proteins are key molecules of the cell nucleus.
 - 16 One gene makes one protein.
 - 17 A gene is made of DNA.
 - 18 Bacteria and viruses have DNA too.
 - 19 The DNA molecule is shaped like a twisted ladder.
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GENETIC ORGANIZATION AND CONTROL

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Address http://www.dnabtb.org/dnabtb/22/concept/index.html

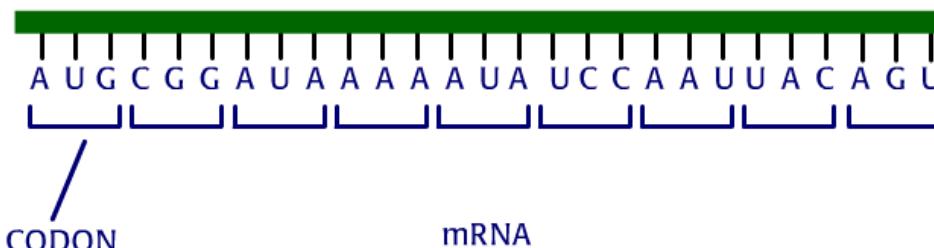
DNA words are three letters long.

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DNA FROM THE BEGINNING



I'm Marshall Nirenberg. Har Khorana's group and mine "cracked" the genetic code. We figured out how the nucleotide language of mRNA is "translated" into the amino acid language of proteins. Genetic data from Crick and others showed that three nucleotides form a "codon" – an mRNA word that specifies one amino acid.



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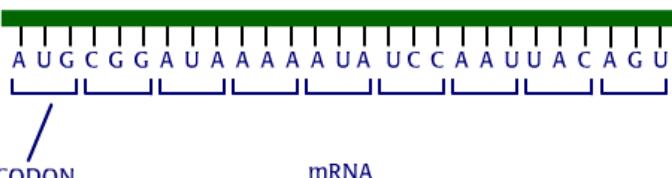
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DNA FROM THE BEGINNING



This made sense, because a codon made from only one or two nucleotides would not produce enough combinations (words) to code for all 20 of the known amino acids.



1 NUCLEOTIDE = 4 POSSIBLE CODONS

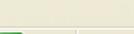
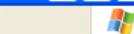
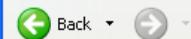
2 NUCLEOTIDES = 4 X 4 POSSIBLE CODONS



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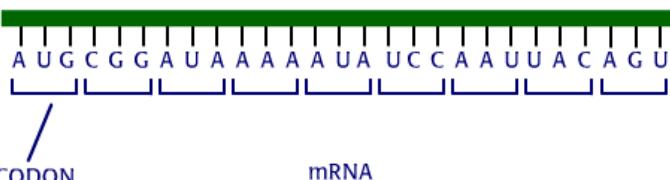
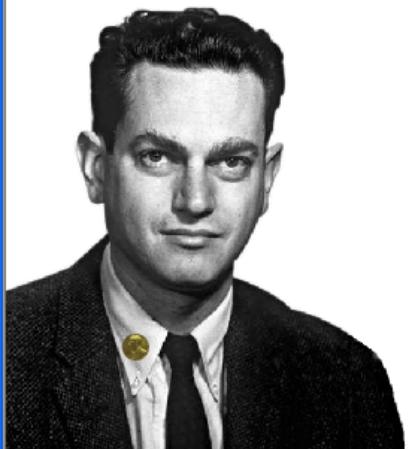
DNA words are three letters long.

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DNA FROM THE BEGINNING



However, a three-nucleotide codon produces 64 combinations. This would produce a redundant, or degenerate, code where several different codons specify the same amino acid. The parsimony principle – that the simplest solution is often right – ruled out a four-nucleotide codon.



3 NUCLEOTIDES = 4 X 4 X 4 POSSIBLE CODONS

3 NUCLEOTIDES = 64 codons for 20 amino acids



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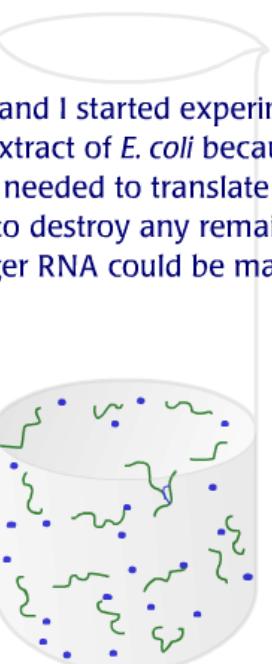
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DNA FROM THE BEGINNING



In 1961, Heinrich Matthaei, a visiting post-doc, and I started experiments to test the triplet codon hypothesis. We used a cell-free extract of *E. coli* because we believed that this extract should contain all the components needed to translate mRNA into proteins. The extract was treated with DNase to destroy any remaining *E. coli* DNA — so there was no template from which messenger RNA could be made.



CELL-FREE EXTRACT



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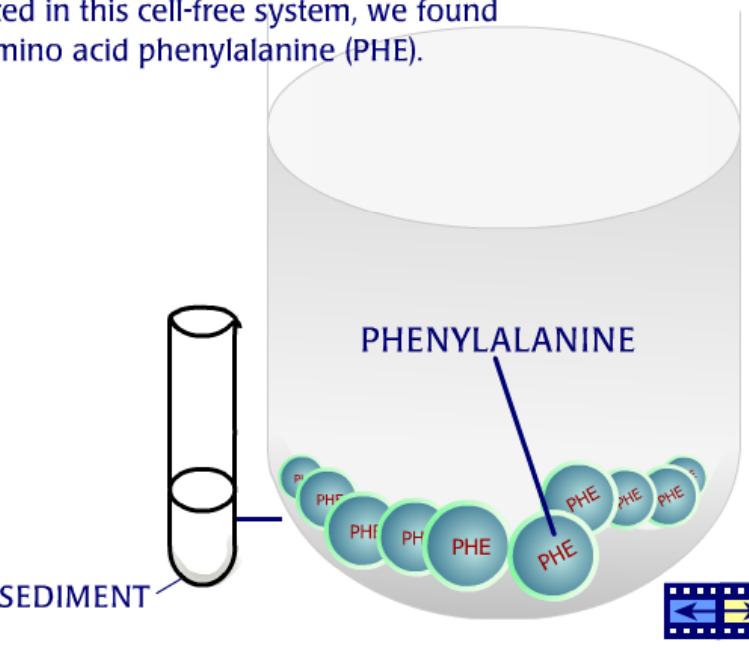
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DNA FROM THE BEGINNING



When we examined the products produced in this cell-free system, we found polypeptides composed entirely of the amino acid phenylalanine (PHE).



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CONCEPT

ANIMATION

GALLERY

AUDIO/VIDEO

BIO

PROBLEM

LINKS



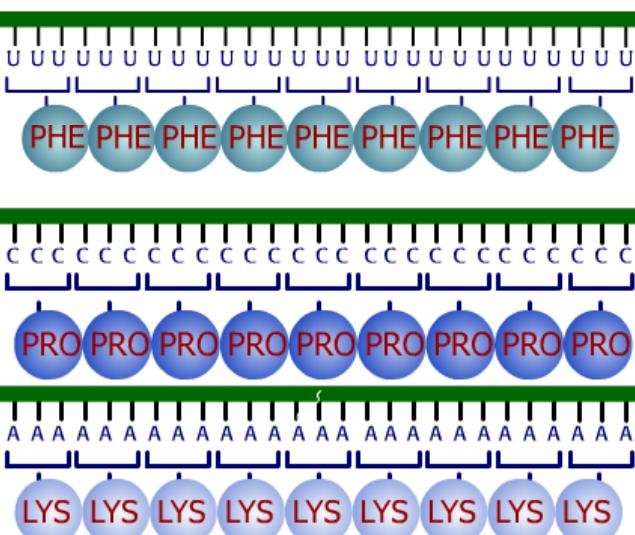
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DNA FROM THE BEGINNING



Matthaei and I tried other polynucleotide chains. Poly-C made a proline (PRO) chain; poly-A made a lysine (LYS) chain. Interestingly, no protein was made with the poly-G chain.



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RNA words are three letters long. - Microsoft Internet Explorer

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DNA words are three letters long.

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DNA FROM THE BEGINNING

Other researchers and I quickly recognized the power of this approach. Using RNA templates containing different nucleotide combinations, we assigned amino acids to about 50 triplet codons.



| SECOND LETTER | | | | THIRD LETTER | |
|---------------|--|--|--|--|------------------|
| FIRST LETTER | U | C | A | | G |
| U | UUU UUC UUA UUG  | UCU UCC UCA  UCG  | UAU UAC ?  ?  | UGU ?  UGG ?  | U C A G |
| C | CUU CUC ?  ?  | CCU CCC CCA CCG  | CAU CAC CAA ?  ?  | CGU CGC CGA ?  ?  | U C A G |
| A | AUU AUC ?  ?  | ACU ACC ACA ?  ?  | AAU AAC AAA ?  ?  ?  | AGC AGA AGA ?  ?  ?  | U C A G |
| G | GUU GUA ?  ?  | GCU GCC GCA ?  ?  ?  | GAU GAC GAA ?  ?  ?  | GGU GGC GGA ?  ?  ?  | U C A G |

 CONCEPT  ANIMATION  GALLERY  AUDIO/VIDEO  BIO  PROBLEM  LINKS

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Internet



DNA words are three letters long.

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DNA FROM THE BEGINNING



Hi, I'm Phil Leder. I helped Marshall Nirenberg with the rest of the genetic code.



| | | SECOND LETTER | | | | | | |
|--------------|---|--|--|--|--|------------------|--|--|
| | | U | C | A | G | | | |
| FIRST LETTER | U | U U U } PHE U U C U U A } LEU U U G | U C U } SER U C C U C G U C A ? | U A U } TYR U A C ? ? | U G U - CYS U G C ? U G G - TRP | U C A G | | |
| | C | C U U } LEU C U C C U A } ? C U G | C C U C C C C C A } PRO C C G | C A U } HIS C A C C A A - GLN C A G ? | C G U } C G C } ARG C G A } | U C A G | | |
| | A | A U U } ILE A U C A U A A U G - MET | A C U A C C A C A A C G ? | A A U } ASN A A C A A A - LYS A A G ? | A G U ? A G C - SER A G A - ARG A G G ? | U C A G | | |
| | G | G U U } VAL G U A G U C G U G ? | G C U } G C C } ALA G C A G C G ? | G A U } ASP G A C G A A - GLU G A G ? | G G U } G G C } GLY G G A G G G ? | U C A G | | |



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- 13 Mendelian laws apply to human beings.
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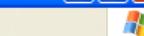
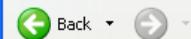
MOLECULES OF GENETICS

- 15 DNA and proteins are key molecules of the cell nucleus.
- 16 One gene makes one protein.
- 17 A gene is made of DNA.
- 18 Bacteria and viruses have DNA too.
- 19 The DNA molecule is shaped like a twisted ladder.
- 20 A half DNA ladder is a template for copying the whole.
- 21 RNA is an intermediary between DNA and protein.
- 22 DNA words are three letters long.
- 23 A gene is a discrete sequence of DNA nucleotides.
- 24 The RNA message is sometimes edited.
- 25 Some viruses store genetic information in RNA.
- 26 RNA was the first genetic molecule.
- 27 Mutations are changes in genetic information.
- 28 Some types of mutations are automatically repaired.

GENETIC ORGANIZATION AND CONTROL

- 29 DNA is packaged in a chromosome.
- 30 Higher cells incorporate an ancient chromosome.
- 31 Some DNA does not encode protein.
- 32 Some DNA can jump.
- 33 Genes can be turned on and off.
- 34 Genes can be moved between species.
- 35 DNA responds to signals from outside the cell.





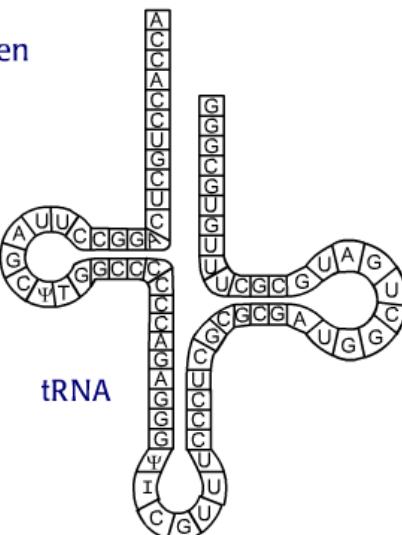
DNA words are three letters long.

22

DNA FROM THE BEGINNING



tRNA is the molecule that carries amino acids to the ribosomes for protein synthesis. In 1962, Robert Holley solved the structure of tRNA. Although tRNA is single stranded, stretches of complementary nucleotides hydrogen bond to form short double-stranded regions, which bend the tRNA into a characteristic cloverleaf shape.



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DNA FROM THE BEGINNING



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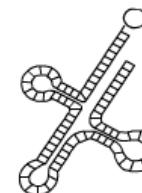
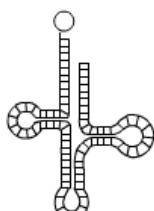
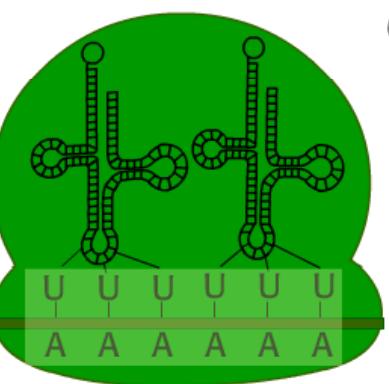
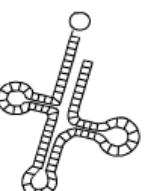
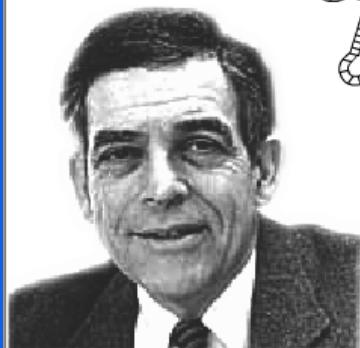
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DNA words are three letters long.

22

I first made short RNA chains composed of three or six nucleotides. When added to a cell-free extract, an activated tRNA will read these trinucleotide or hexanucleotide sequences.





DNA words are three letters long.

22

DNA FROM THE BEGINNING



After that, all I had to do was make specific trinucleotide and hexanucleotide chains to confirm the genetic code.



| SECOND LETTER | | | | |
|---------------|--|---------------------------------------|--|--|
| | U | C | A | |
| U | UUU } PHE UUC UUA } LEU UUG | UCU UCC UCA } | UAU } TYR UAC | UGU } CYS UGC UGG } TRP |
| C | CUU CUC CUA } LEU CUG | CCU CCC CCA } PRO CCG | CAU } HIS CAC CAA } CYN CAG | CGU CGC CGA } ARG CGG |
| A | AUU AUC } ILE AUA AUG } MET | ACU ACC ACA } THR ACG | AAU } ASN AAC AAA } LYS AAG | AGU } SER AGC AGA } ARG AGG |
| G | GUU GUA GUC } VAL GUG | GCU GCC GCA } ALA GGC | GAU } ASP GAC GAA } GLU GAG | GGU GGC GGA } GLY GGG |

GENETIC CODE TABLE



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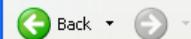
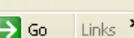
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Address <http://www.dnabtb.org/dnabtb/22/concept/index.html>

DNA words are three letters long.

22

DNA FROM THE BEGINNING



We also found that translation starts with a specific codon AUG – the only unique codon – and there are stop codons that end translation. So, in addition to words, the genetic code also has punctuation points.



| | | SECOND LETTER | | | | | |
|--------------|---|--|---|---|--|---|---|
| | | U | C | A | G | | |
| FIRST LETTER | U | U U U } PHE U U C } U U A } LEU U U G } | U C U } U C C } U C G } SER U C A } | U A U } TYR U A C } U A A } STOP U A G } | U G U } CYS U G C } U G A } STOP U G G } TRP | U | C |
| | C | C U U } C U C } LEU C U A } C U G } | C C U } C C C } C C G } PRO C C G } | C A U } HIS C A C } C A A } GLN C A G } | C G U } C G C } C G A } ARG C G G } | U | C |
| | A | A U U } A U C } ILE A U A } A U G } MET | A C U } A C C } A C A } THR A C G } | A A U } ASN A A C } A A A } LYS A A G } | A G U } A G C } A G A } A G G } | U | C |
| | G | G U U } G U A } G U C } VAL G U G } | G C U } G C C } G C A } ALA G C G } | G A U } G A C } ASP G A A } GLU G A G } | G G U } G G C } G G A } GLY G G G } | U | C |

GENETIC CODE TABLE
(Mouseover table to enlarge)



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Geneettinen koodi ja avoimet lukukehykset: polypeptidiä koodaavan geenin “ennustamisen” päätävälineet

On tapana kirjoittaa ja tallettaa geenipankkiin vain toinen juoste, alkaen 5' päästä, esimerkiksi näin:

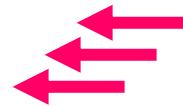
5' -TTATTTATTTCGATAATTGACCTTAAACGCGAAACTCACTTAAC- 3'

Geenin viesti voi kumminkin olla kummassa tahansa juosteessa, ja sen jako tripleteihin voi alkaa molemmissa kolmesta eri paikasta

Tässä voisi siis olla peräti kuusi erilaista lukutapaa, joista vain yksi lienee oikea (aloituskodonia ei etsitään, vaan pelkästään stoppeja)



5' - TTATTTCGATAATTGACCTAAACGCGAAACTTCACTAAC - 3'
3' - AATAAAAATAAGCTATTAAGCTGGAATTGCGCTTGAAAGTGAATTG - 5'



Ensimmäinen *kodoni* voi siis olla

>>> UUA, UAU tai AUU >> TEMPLAATTINA ALEMPI JUOSTE
tai

<<<GUU, UUA tai UAA <<< TEMPLAATTINA YLEMPI JUOSTE

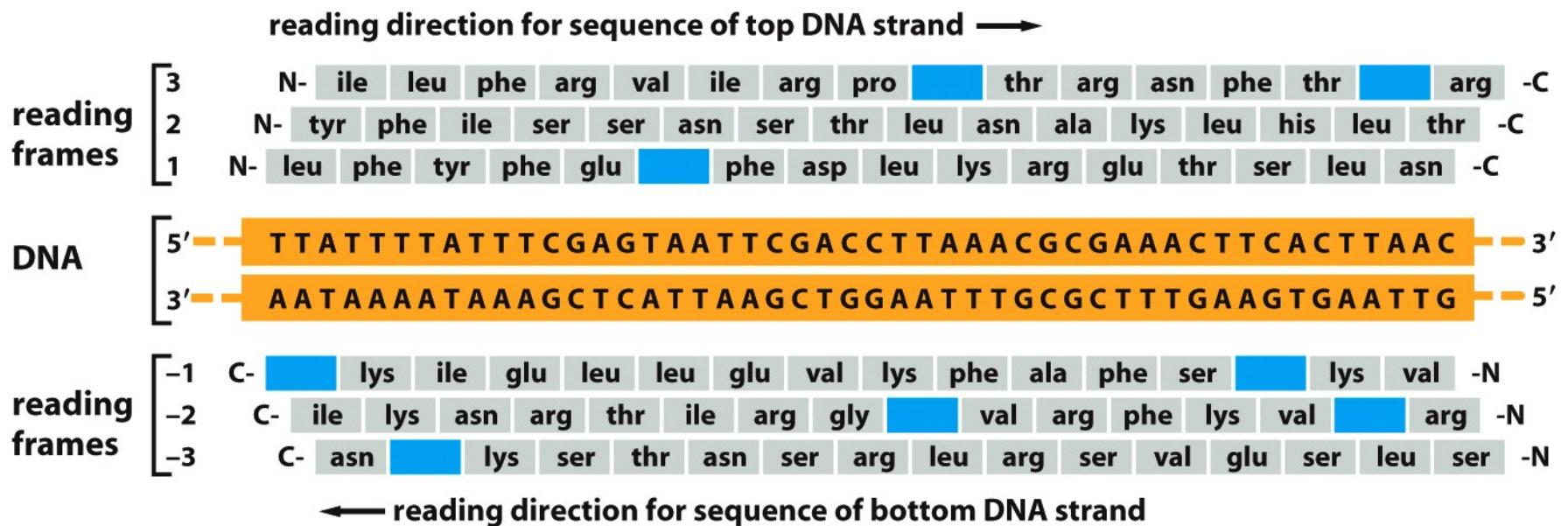


Figure 8-52a Molecular Biology of the Cell 5/e (© Garland Science 2008)

STOP on merkitty sinisellä laatikolla (UAA, UAG, UGA).

Avain lukemiseen:

leu UUA, UUG, CUU, CUC, CUA, CUG

Mikä siis on geeni? Alempi vai ylempi juoste?

CELL 550

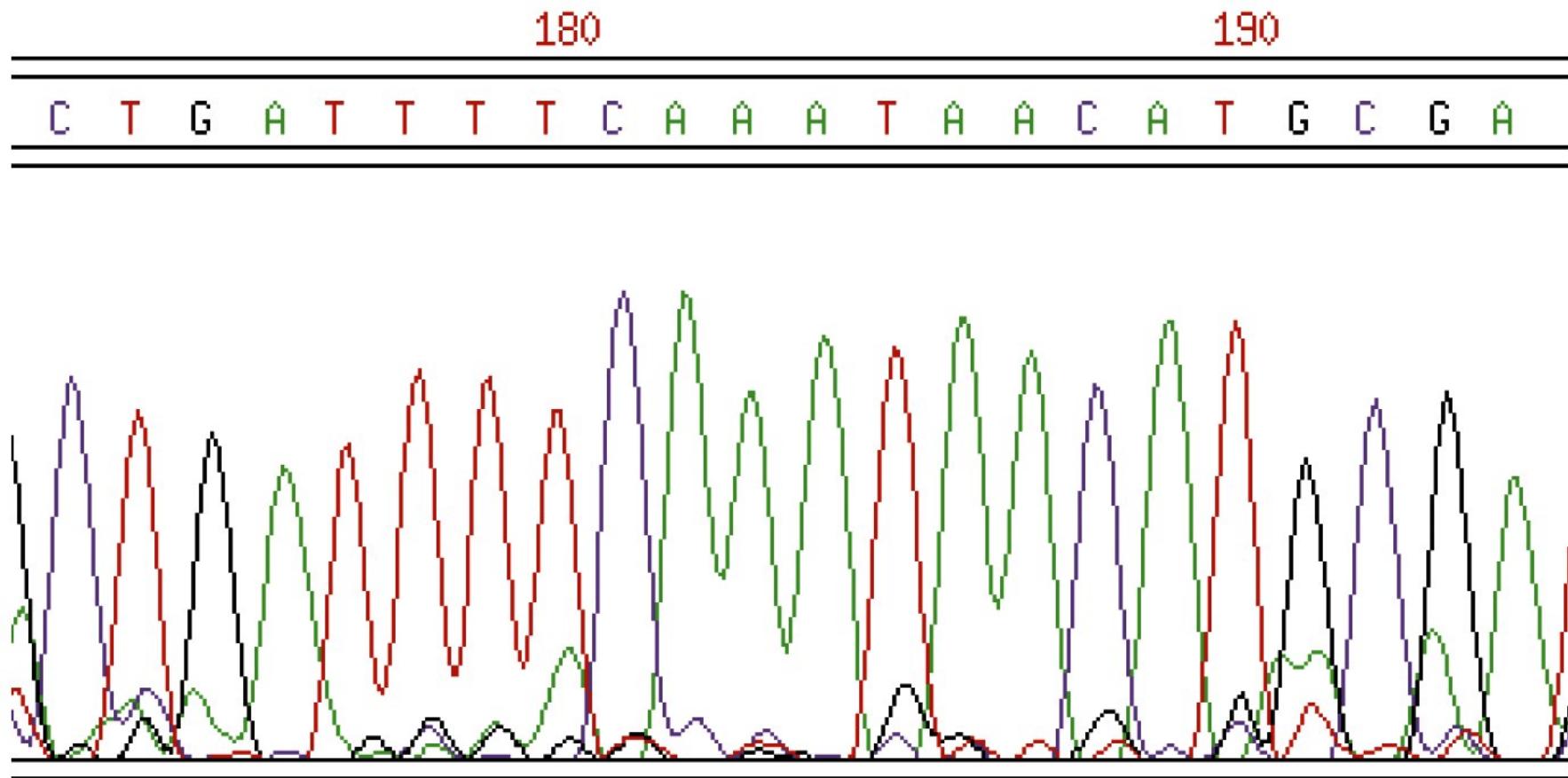


Figure 8-51 Molecular Biology of the Cell 5/e (© Garland Science 2008)

CELL 550

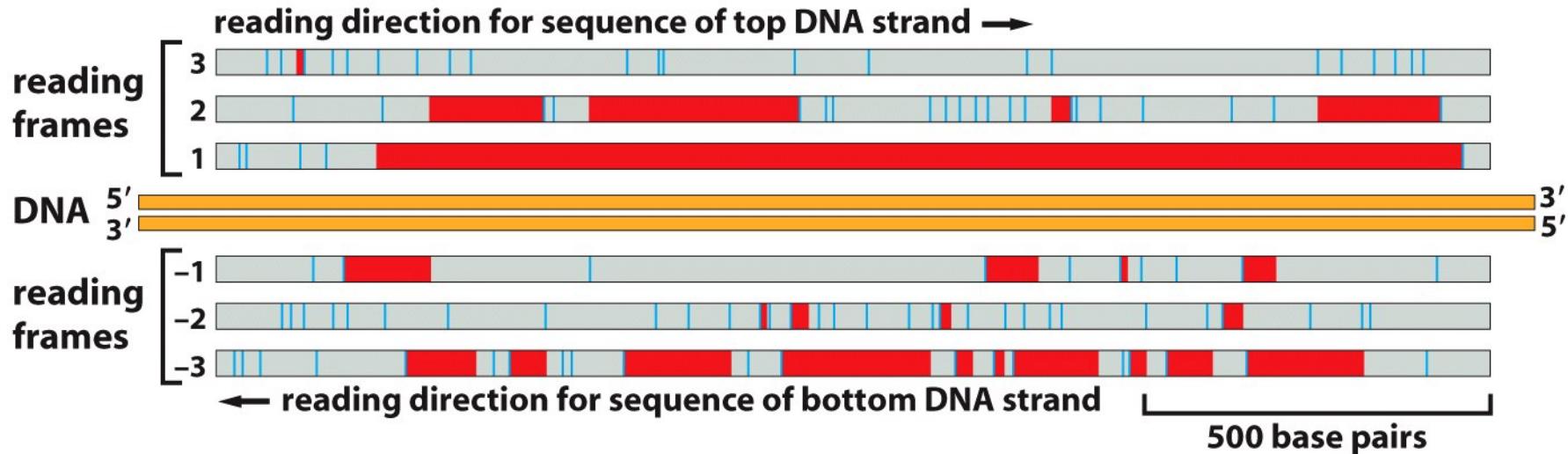


Figure 8-52b Molecular Biology of the Cell 5/e (© Garland Science 2008)

Tässä esimerkissä on tarkasteltu 1700 nukleotidia. STOP on merkitty vihreällä viivalla, ja mahdolliset START-STOP -välit on väritetty punaisella.

Ainoastaan FRAME 1 näyttää sisältävän pitkän jakson, joka *voi* olla polypeptidiketjun rakennusohjetta.

Tätä sanotaan **ORF**: iksi (open reading frame) ja se on geenin ennustamisen ensimmäinen askel.

ORF:in ennustaminen jos matskua on vähän enemmän

Gyrodactylus arcuatusen mtDNA (CO1)



DNA Sequences | Translated Protein Sequences

三

12

with w/o Gap

Ensimmäinen TÄYSI kodoni ATT



DNA Sequences Translated Protein Sequences

Site # with w/o Gaps Edit disabled for translated protein data



DNA Sequences | Translated Protein Sequences

三

4

9

• with

© w/o Gap

Ensimmäinen luettu TAT, mites se toimisi?



DNA Sequences Translated Protein Sequences

| | |
|----------------------------------|---|
| 1LV16 BtA1 (L-Varjakka) DQ078701 | -YLMERFD*VVVQDEHFIHHYDGLHITAEQV*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| V2 BtA2 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAEQV*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 1OLV1 BtA2 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAEQV*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 18LV11 BtA2 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAEQV*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 1LV18 BtA2 (L-Varjakka) DQ078702 | -YLMERFD*VVVQDEHFIHHYDGLHITAEQV*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 2LV23 BtA2 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAEQV*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 3LV24 BtA2 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAEQV*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 3LV25b BtA2 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAEQV*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 4LV30 BtA2 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAEQV*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 6LV41 BtA2 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAEQV*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 24LV65 BtA2 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAEQV*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 41LV101 BtA2 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAEQV*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 41LV102 BtA2 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAEQV*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 42LV108 BtA2 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAEQV*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 42LV110 BtA2 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAEQV*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| V6 BtA4 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 12LV2 BtA4 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 12LV3 BtA4 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 20LV13 BtA4 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 2LV21 BtA4 (L-Varjakka) DQ078704 | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 4LV29 BtA7 (L-Varjakka) DQ078707 | -YLMERFD*VVVQDEHSIIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYALYLVLLEVYLLMLVIEP*MYRHIYLH |
| 4LV31 BtA8 (L-Varjakka) DQ078708 | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 3LV25a BtA9 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 3LV27 BtA9 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 4LV32 BtA9 (L-Varjakka) DQ078709 | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 5LV34 BtA9 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 5LV35 BtA9 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 5LV37 BtA9 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 7LV46 BtA9 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 40LV100 BtA9 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 42LV103 BtA9 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 42LV106 BtA9 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 42LV109 BtA9 (L-Varjakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |
| 42LV112 BtA9 (L-Variakka) | -YLMERFD*VVVQDEHFIHHYDGLHITAE*V*T CYCSLYIYQFLRLVLYTLYVLYLVLLEVYLLMLVIEP*MYRHIYLH |

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Data Edit Search Alignment Web Sequencer Display Help

DNA Sequences Translated Protein Sequences

| | | | | | | | | | | | | | | | | | | | | | | |
|--------------------------|--|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bu7 BtA27 (Bolshaya Uya) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 1C2 BtA28 (Wilkojadka) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 1C1 BtA29 (Wilkojadka) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| C3 BtA29 (Wilkojadka) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| C21 BtA29 (Krzna) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 1Bb2 BtA26 (Biebrza) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 3Bb1 BtA26 (Biebrza) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 4Bb1 BtA26 (Biebrza) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 4Bb2 BtA26 (Biebrza) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 6Bb2 BtA26 (Biebrza) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 7Bb2 BtA26 (Biebrza) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 8Bb1 BtA26 (Biebrza) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 8Bb2 BtA26 (Biebrza) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 5Bb2 BtA29 (Biebrza) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 7Bb1 BtA29 (Biebrza) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 2Bb1 BtA44 (Biebrza) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 2Bb2 BtA44 (Biebrza) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 5Bb1 BtA44 (Biebrza) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 6Bb1 BtA44 (Biebrza) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 1Est1 BtA2 (Muhu) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 4Est2 BtA5 (Muhu) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 2Est1 BtA10 (Muhu) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 2Est2 BtA16 (Muhu) | -TATTATGAGAATTCTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 5Est2 BtA18 (Muhu) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 3Est2 BtA27 (Muhu) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 4Est1 BtA27 (Muhu) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 3Est1 BtA44 (Muhu) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 5Est1 BtB2 (Muhu) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 1Est2 BtD1 (Muhu) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 4Epl BtA3 (Purtse) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 4Epl2 BtA3 (Purtse) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 5Epl BtA16 (Purtse) | -TATTATGAGAATTCTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 5Epl2 BtA16 (Purtse) | -TATTATGAGAATTCTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |
| 7Epl BtA19 (Purtse) | -TATTATGAGAATTGATTAGCTAGTGGTACAGGATGAA | C | T | T | T | A | T | C | C | A | C | T | A | G | G | T | T | A | C | A | C | A |

Site # 778 with w/o Gaps

Ensimmäinen kokonainen TTT?



DNA Sequences Translated Protein Sequences

| | |
|----------------------------------|---|
| 1LV16 BtA1 (L-Varjakka) DQ078701 | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| V2 BtA2 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 1OLV1 BtA2 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 18LV11 BtA2 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 1LV18 BtA2 (L-Varjakka) DQ078702 | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 2LV23 BtA2 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 3LV24 BtA2 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 3LV25b BtA2 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 4LV30 BtA2 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 6LV41 BtA2 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 24LV65 BtA2 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 41LV101 BtA2 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 41LV102 BtA2 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 42LV108 BtA2 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 42LV110 BtA2 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| V6 BtA4 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 12LV2 BtA4 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 12LV3 BtA4 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 20LV13 BtA4 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 2LV21 BtA4 (L-Varjakka) DQ078704 | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 4LV29 BtA7 (L-Varjakka) DQ078707 | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 4LV31 BtA8 (L-Varjakka) DQ078708 | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 3LV25a BtA9 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 3LV27 BtA9 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 4LV32 BtA9 (L-Varjakka) DQ078709 | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 5LV34 BtA9 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 5LV35 BtA9 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 5LV37 BtA9 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 7LV46 BtA9 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 40LV100 BtA9 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 42LV103 BtA9 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 42LV106 BtA9 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 42LV109 BtA9 (L-Varjakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |
| 42LV112 BtA9 (L-Variakka) | ? FMSIINLGCGTGNTFYPPLESVITYNSSTGVDLLMFSLHLSCGIISSIFSSLNFICTIIISAGVSVNVSDTPIIVVAYLFITS |

< >

27

with

w/o Gaps

Edit disabled for translated protein data.

Fenylalaniinilla alkaa, stoppeja ei ole, variaatiota vähän. Tämä kehys OK.

tagctatgactaccaccctaattacccacattattaaccccctcgcatatatcgccccg ttcttttagcagtcgccttcctca
ccttac tcgaacgaaa agtccttgg a tatatgcaacttcggaaaggccaaacatcgctggccatacggattgcttca
acctatcgccggacggcctaaaactattcattaaagaaccagttcgaccgtccacccctccctccctatttcgctaca
cccatacttgcccttacgcttgcactaaccctgtgagccccatgccatccctacccattacagacctaaatctcgaaa
gtactatttgtcctcgacttccagcctagccgtgtattctattttaggctcagggtgagctcaaattctaaatatgccctaaat
tggagctctacgagcagtggcacaaaccatttcctacgaagttagcctggactaatcttactcagcgttaattatcttacgg
ggggatttacactacaaacccatcaatgttagccaaagaaagcatctgactactcgtaaccgcctgacccttgcgcctat
ggta tatctctact ctagctgaaa

4441 caaacccgtgc accctttgac cttacagaag gagaatcaga attagtcctcc ggatttaatg
4501 tagaatacgc cgaggggccc ttcgcctct tctttcttagc cgaatacgct aatatccttc
4561 taatgaacac actctcggcc attctatTTT taggcgcata ccacatcccc gccttccccg
4621 aattaacagc cgtaaaccta ataacaaagg ccgccttcct ctccgttgta ttttatgag
4681 tacgagcctc ctacccacga ttgcgtacg accaactcat acatTTAGTT tgaaaaagct
4741 tcttacctt gacactagcc cttgtcctat gacacccatcg acttccaacc gcaatggcag
4801 gcctccctcc ccaactttaa gccccaaagga attgtgcctg aatgtttaag gaccacccctg

[NCBI homepage](#)

Jonkun otuksen jonkun geenin aminohapposekvenssiä??

MTTTLITHIINPLAYIVPVLLAVAFLTLERKVLGYMQLRKGP
PNIVGPYGLLQPIADGLKLFIKEPVRPSTSSPFLFLATPMLALT
LALTLWAPMPIPYPITDLNLGVLFVLALSSLAVYSILGSGWAS
NSKYALIGALRAVAQTISYEVSLGLILLSVIIFTGGFTLQTFN
VAQESIWLLVPAWPLAAMWYISTLAETNRAPFDLTEGESEL
VSGFNVEYAGGPFALFFLAEYANILLMNTLSAILFLGASHI
PAFPELTAVNLMTKAALLSVVFLWVRASYPRFRYDQLMHLV
WKSFLPLTLALVLWHLALPTAMAGLPPQL

?????????????????

[NCBI homepage](#)

Geneettinen koodi on “universaali”

Oleellisesti samaa koodia, *pienin* muutoksin, käyttävät arkit, bakteerit, eukaryootit ja vielä mitokondriot ja kloroplastitkin

Eukaryootin tuman geenit ja mitokondriion geenit luetaan eri koodilla, siksi mitokondriossa on oma rRNA (2) ja 22 tRNA:ta
(TRANSLAATIOKONEISTO)

Esim. UGA on universaalisti STOP, mutta mitokondriossa se on tryptofaanin koodi, ja AGA ja AGG taas ovat yleensä arginiinin koodina, mutta nisäkäsmitokondriossa ne luetaan STOP.

The Genetic Code

| 1st position (5' end) | 2nd Position | | | | 3rd Position (3' end) |
|--------------------------|--------------|-----|-------------|-------------|--------------------------|
| U | U | C | A | G | |
| | Phe | Ser | Tyr | Cys | U |
| | Phe | Ser | Tyr | Cys | C |
| | Leu | Ser | STOP | STOP | A |
| | Leu | Ser | STOP | Trp | G |
| C | Leu | Pro | His | Arg | U |
| | Leu | Pro | His | Arg | C |
| | Leu | Pro | Gln | Arg | A |
| | Leu | Pro | Gln | Arg | G |
| A | Ile | Thr | Asn | Ser | U |
| | Ile | Thr | Asn | Ser | C |
| | Ile | Thr | Lys | Arg | A |
| | Met | Thr | Lys | Arg | G |
| G | Val | Ala | Asp | Gly | U |
| | Val | Ala | Asp | Gly | C |
| | Val | Ala | Glu | Gly | A |
| | Val | Ala | Glu | Gly | G |

| | | | | | | | |
|-----|---|-----|---|-----|---|-----|---|
| Phe | [171 UUU] AAA 0 203 UUC — GAA 14 | Ser | [147 UCU] AGA 10 172 UCC — GGA 0 118 UCA — UGA 5 45 UCG — CGA 4 | Tyr | [124 UAU] AUA 1 158 UAC — GUA 11 stop — 0 UAA — UUA 0 stop — 0 UAG — CUA 0 | Cys | [99 UGU] ACA 0 119 UGC — GCA 30 stop — 0 UGA — UCA 0 Trp — 122 UGG — CCA 7 |
| Leu | [73 UUA — UAA 8 125 UUG — CAA 6 | | | | | | |
| Leu | [127 CUU] AAG 13 187 CUC — GAG 0 69 CUA — UAG 2 392 CUG — CAG 6 | Pro | [175 CCU] AGG 11 197 CCC — GGG 0 170 CCA — UGG 10 69 CCG — CGG 4 | His | [104 CAU] AUG 0 147 CAC — GUG 12 | Arg | [47 CGU] ACG 9 107 CGC — GCG 0 63 CGA — UCG 7 115 CGG — CCG 5 |
| Ile | [165 AUU] AAU 13 218 AUC — GAU 1 71 AUA — UAU 5 Met — 221 AUG — CAU 17 | Thr | [131 ACU] AGU 8 192 ACC — GGU 0 150 ACA — UGU 10 63 ACG — CGU 7 | Asn | [174 AAU] AUU 1 199 AAC — GUU 33 | Ser | [121 AGU] ACU 0 191 AGC — GCU 7 |
| Val | [111 GUU] AAC 20 146 GUC — GAC 0 72 GUA — UAC 5 288 GUG — CAC 19 | Ala | [185 GCU] AGC 25 282 GCC — GGC 0 160 GCA — UGC 10 74 GCG — CGC 5 | Lys | [248 AAA] UUU 16 331 AAG — CUU 22 | Arg | [113 AGA] UCU 5 110 AGG — CCU 4 |
| | | | | Asp | [230 GAU] AUC 0 262 GAC — GUC 10 | Gly | [112 GGU] ACC 0 230 GGC — GCC 11 168 GGA — UCC 5 160 GGG — CCC 8 |
| | | | | Glu | [301 GAA] UUC 14 404 GAG — CUC 8 | | |

Figure 34 The human genetic code and associated tRNA genes. For each of the 64 codons, we show: the corresponding amino acid; the observed frequency of the codon per 10,000 codons; the codon; predicted wobble pairing to a tRNA anticodon (black lines); an unmodified tRNA anticodon sequence; and the number of tRNA genes found with this anticodon. For example, phenylalanine is encoded by UUU or UUC; UUC is seen more frequently, 203 to 171 occurrences per 10,000 total codons; both codons are expected to be decoded by a single tRNA anticodon type, GAA, using a G/U wobble; and there are 14

tRNA genes found with this anticodon. The modified anticodon sequence in the mature tRNA is not shown, even where post-transcriptional modifications can be confidently predicted (for example, when an A is used to decode a U/C third position, the A is almost certainly an inosine in the mature tRNA). The Figure also does not show the number of distinct tRNA species (such as distinct sequence families) for each anticodon; often there is more than one species for each anticodon.

Kaikki kodonit eivät ole yhtä suosittuja