Plant Molecular Biology

Chapter 1: Basic Genetics

Gene & Allele Phenotype & Genotype Ploidy & Allelism

Molecular Biology (Molecular Genetics) is simple?



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대장균에 적용되는 것은 코끼리에도 적용된다.

모노(Jacques Monod)

What does determine the similarity and difference?





- The birth of modern genetics was due to the discoveries of Gregor Mendel
- Each of the characteristics examined by Mendel is determined by a <u>single</u> <u>gene</u> (gene = a unit of genetic information)
- Each gene may exist in alternative forms, called <u>alleles</u> (allele = one particular version of a gene)

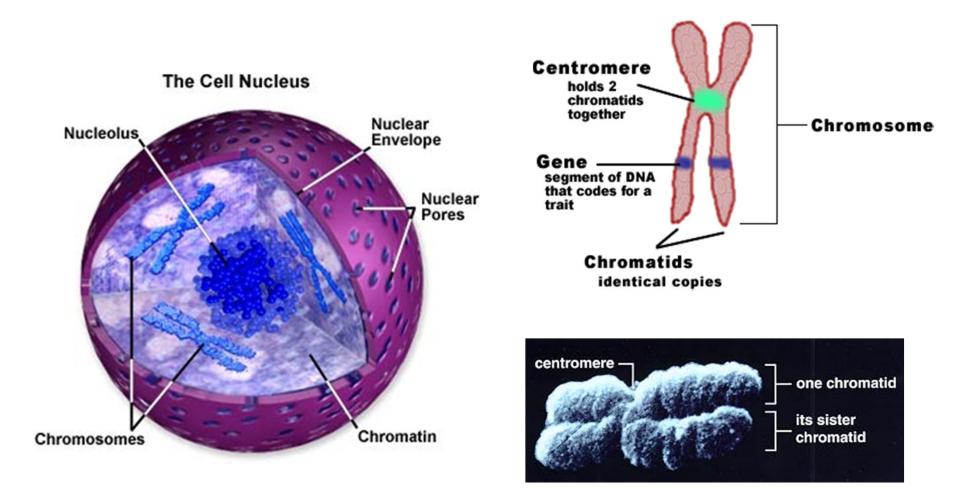
Gene & Allele

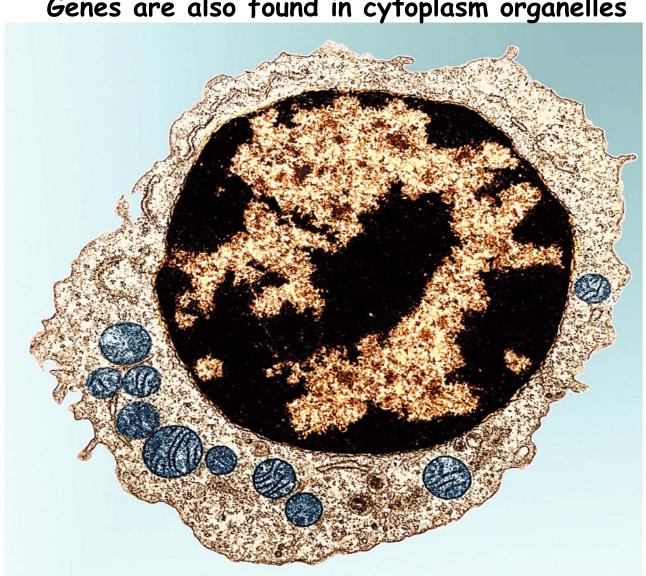
Questions!

- How did Mendel describe the genes and their alleles?
- How many alleles for a gene exist in our classroom?
- How many different alleles for a gene exist in our classroom?

A, a, A1, A2, A3.....

Chromosomal basis of genetic inheritance





Genes are also found in cytoplasm organelles

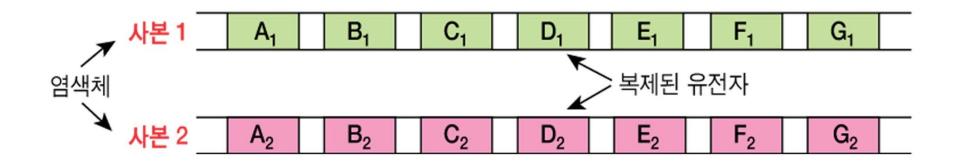
Figure 2-1b Principles of Genetics, 4/e

eukaryotic cells typically contain one or more mitochondria Light colored material: chromosomes

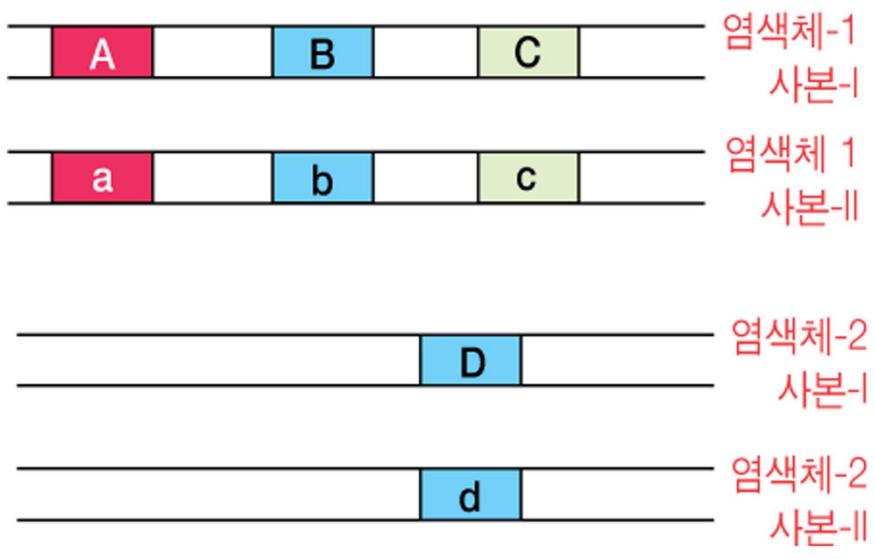
Genes in a chromosome



Genes(alleles) in homologous chromosomes of diploid



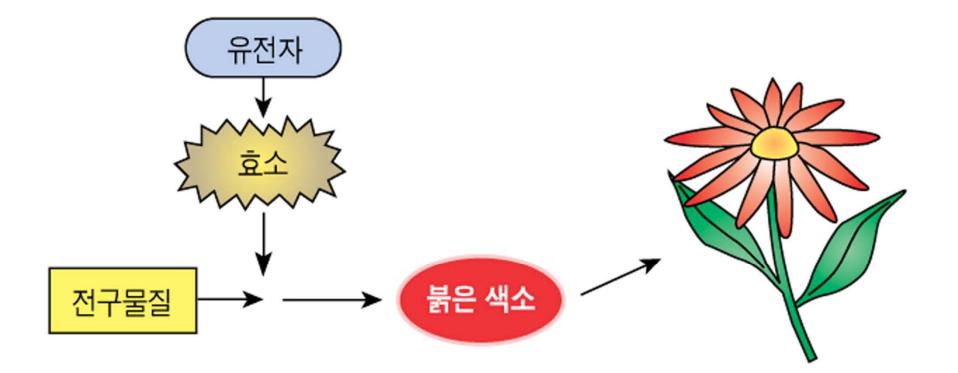
Genes(alleles) in homologous chromosomes of diploid



What is the function of genes?

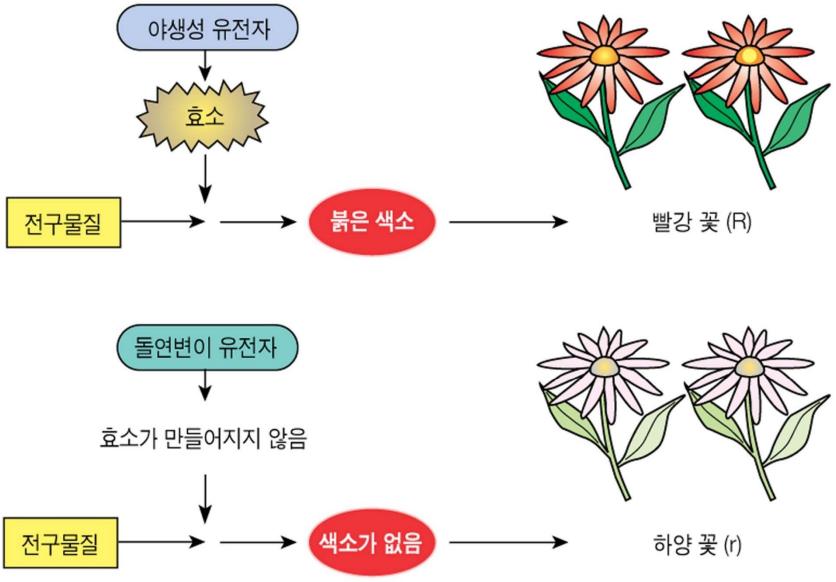
- Each step of a biosynthetic pathway is controlled by a single gene
- Each biosynthetic reaction is carried out by a special protein known as <u>enzyme</u>, produced by a single gene (<u>one gene - one enzyme</u> model)
- The properly functioning gene is referred to as the <u>wild-type allele</u>, and defective gene as the <u>mutant allele (genetic alteration)</u>
- A mutant allele that results in the complete absence of an enzyme is known as a <u>null allele</u>

A genes encodes an enzyme playing a role in a biochemical pathway

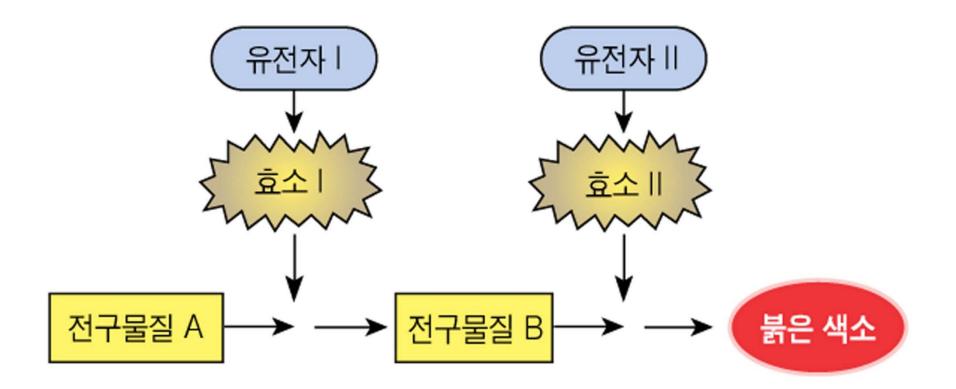


Example of a pathway for red pigment synthesis

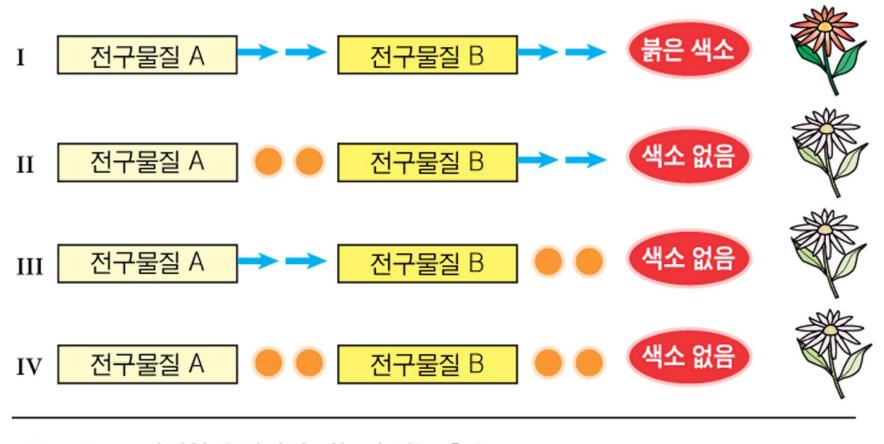
Wild-type allele & mutant allele



One gene - One enzyme model



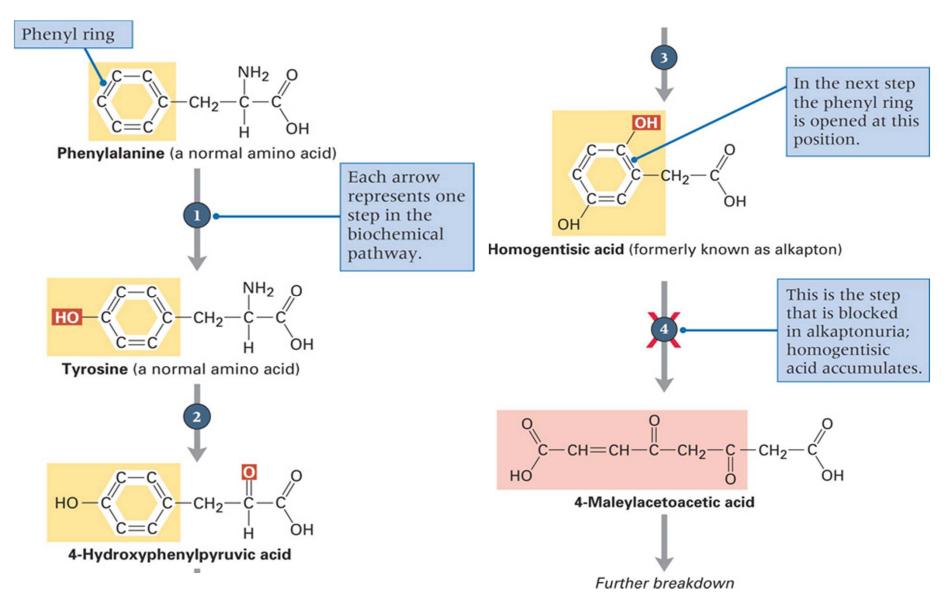
Each step of a metabolic pathway requires an enzyme encoded by a gene



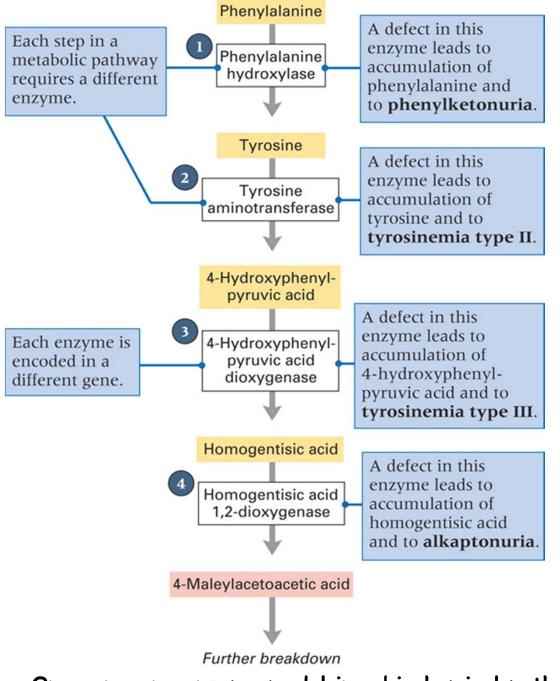
A classical example of one gene-one enzyme in human disease



Inborn errors of metabolism: Alkaptonuria (A black urine disease)

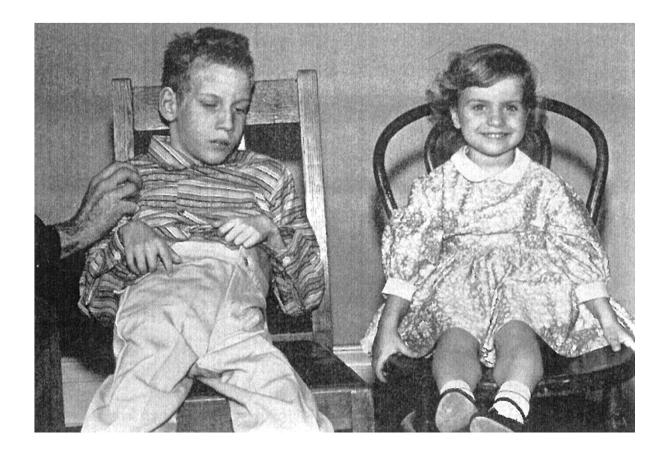


Metabolic pathway for the breakdown of phenylalanine and tyrosine



One gene-one enzyme model in a biochemical pathway

Phenylketonuria (PKU)

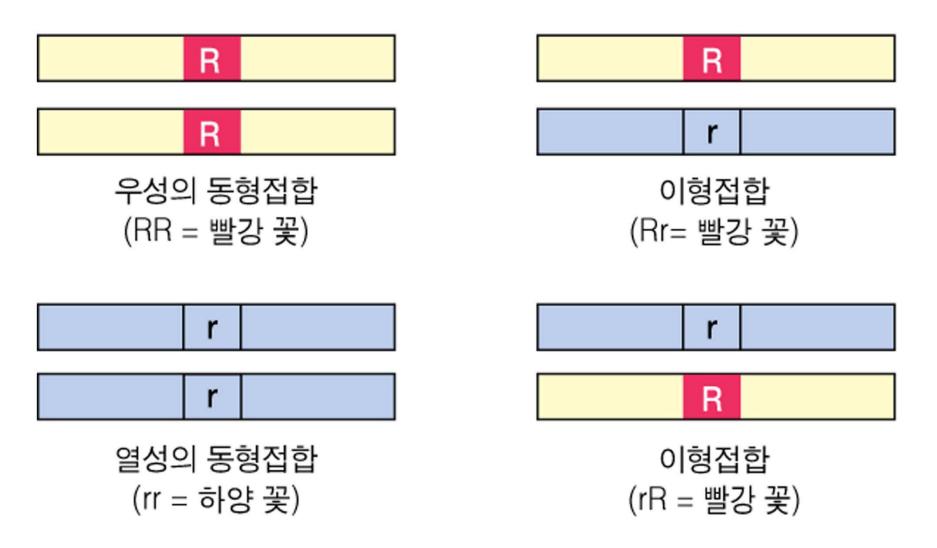


- Most biochemical pathways have several steps, not just one.
- The outward characteristics at the final step of the a biochemical pathway is referred to as the <u>phenotype</u>.
- The genetic make-up of the phenotype is referred to as the <u>genotype</u>, and the phenotype is a visible effect of the genotype.
- A defective gene (mutant allele) near the beginning of a pathway will make later reaction irrelevant by making the effect of alterations in another gene (<u>epistasis</u>)

- Genes consist of DNA and the genes belonging to each cell are arranged on chromosomes, a giant molecules of DNA
- Genes are <u>a portion</u> of a chromosome
- Lower organisms have only a single copy (one allele) of each gene (<u>haploid</u>), but higher organisms have duplicate copies (two alleles) of each gene (<u>diploid</u>)

- The allele whose properties are expressed as the phenotype is called <u>dominant allele</u>, and the allele masked its expression by dominant allele is called <u>recessive allele</u>
- If you have two identical alleles of the same gene, you are <u>homozygous</u> for that gene, if you have to different alleles, you are <u>heterozygous</u> for that gene

Allelism and dominance effect on the flower color phenotype



Homologous chromosomes in human: each chromosome contains an allele for a gene(locus)



Figure 6-4c Principles of Genetics, 4/e

TABLE 3.3

Inherited Conditions in Human Beings

Dominant Traits

Achondroplasia (dwarfism) Brachydactyly (short fingers) Congenital night blindness Ehler-Danlos syndrome (a connective tissue disorder) Huntington's disease (a neurological disorder) Marfan syndrome (tall, gangly stature) Neurofibromatosis (tumorlike growths on the body) Phenylthiocarbamide (PTC) tasting Widow's peak Woolly hair

Recessive Traits

Albinism (lack of pigment) Alkaptonuria (a disorder of amino acid metabolism) Ataxia telangiectasia (a neurological disorder) Cystic fibrosis (a respiratory disorder) Duchenne muscular dystrophy Galactosemia (a disorder of carbohydrate metabolism) Glycogen storage disease Phenylketonuria (a disorder of amino acid metabolism) Sickle-cell anemia (a hemoglobin disorder) Tay-Sachs disease (a lipid storage disorder)

Phenotypes controlled by single gene in human

Achondroplasia (dwarfism)



Dominant allele

Albinism (lack of pigment)



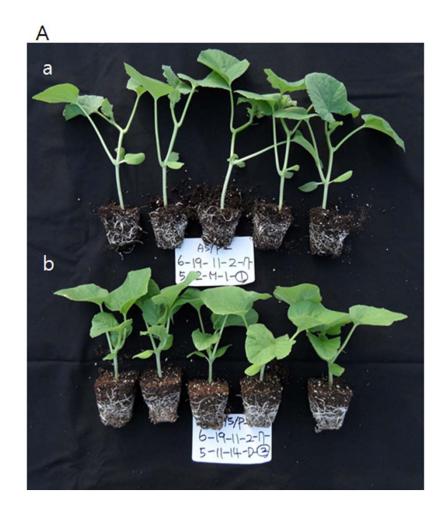
Recessive allele

Many important crops are polyploidy

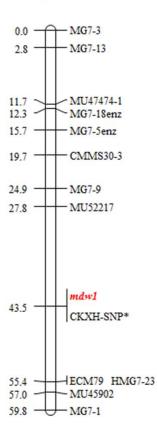


Figure 6-6 Principles of Genetics, 4/e

CKX(cytokine oxidase) gene could controls dwarfism in melon



В



CKX(cytokinin oxidase) gene could controls dwarfism in melon

	1	10	20	30	40	50	60	70	80	90	100	110	120	130
H D Consensus	ATGAT	GATTGCTT	ACCTCGAACCO	ITTTCTGCAAG	ACACCGATT	CCCGCCGGCCF	ICACGACGG	CTCCGCCCTAT CTCCGCCCTAT CTCCGCCCTAT	GCGAAGCTCTF	CAGCTTCAAT	TACAAGGTG	GCGTCAGTAC	CGACTCGCG	GGACACAG
	131	140	150	160	170	180	190	200	210	220	230	240	250	260
H D Consensus	GTTTA	GCCGGGAA	GGATTTCGGGG	GGCTACATTC	CTTAACTCC	GTTGGCTTTGG	TAACTCCA	GCTGGTGCCGA GCTGGTGCCGA GCTGGTGCCGA	TGACGTGGCGF	AGGTAGTGAA	ATCAGCTGT	ACAATCGTCTA	AATCTAACG	GTAGCAGC
	261	270	280	290	300	310	320	330	340	350	360	370	380	390 I
H D Consensus	GAGAG	GTAACGGC	CACTCAATCAA	ICGGCCAAGCG	ATGACGGAT	GGAGGTTTGGT	TTTGGACA	TGCGTGCCATG TGCGTGCCATG TGCGTGCCATG	GAGGATAATTI	CCGTGTCGT	ACAATTAAT	GGATTTTC <mark>C</mark> TA	ATGCCGACG	TGTCGGGA
	391	400	410	420	430	440	450	460	470	480	490	500	510	520
H D Consensus	GGGGCI	ATTATGGG	AAGACGTCTTC	AAACGCTGCG	TTTCAAGTT	ACGGATTAGCT	CCTAGGTC	ATGGACGGATT Atggacggatt Atggacggatt	ACCTTAGCTTF	ACCGTCGGC	GTACACTGT	CTAACGCCGGG	CGTTAGTGG	CCAGGCTT
	521	530	540	550	560	570	580	590	600	610	620	630	640	650
H D Consensus	TCCGG TCCGG	racggacc	ACAAATTTCCF	ACGTGGCTGA	ATTGGAAGT	CGTCACTGGAF	IAAGGCGATI	ACTTTAATTTG Actttaatttg Actttaatttg	TTCGGAAAATO	GAAAATTCTGA	ATTGTTTTT	TAGCGTTCTT	GGTGGTTTA	GGTCAGTT
	651	660	670	680	690	700	710	720	730	740	750	760	770	780
H D Consensus	TGGAA TGGAA	TATCACA	AGAGCTCGTGT	TTTGCTTCAG	CCAGCTCCG	GA <mark>R</mark> ATGGTGAG GATATGGTGAG	ATGGATTA ATGGATTA	GATTGGTTTAT GATTGGTTTAT GATTGGTTTAT	GATGAATTTGA TATGAATTTGA	AAGGTTTGC1	ICACGATGCCI ICACGATGCCI	GAATCC <mark>C</mark> TAA1	FACGGCGGC	CGGAAGGT
	781	790	800	810	820	830	840	850	860	870	880	890	900	910
H D Consensus	GACTC	GTTTGATT	ACGTGGAAGGO	TTTGTTTTT	CGAACAACG	ATGACCCATTA	ACCGGAAG	ACCGACAGTGC ACCGACAGTGC ACCGACAGTGC	CGTTAGACTCO	AATACTGTA	ITTGACTCGT	CTTATTTACCO	GGAAACCGC	CGGTTCGG
	911	920	930	940	950	960	970	980	990	1000	1010	1020	1030	1040
H D Consensus	TTCTC	FATTGCCT	CGAAGTCGCCC	ITTCACTACCG	igaacaacga	CCAAGTCTCAF	ICCGTCGACI	ACGGATGTTGA ACGGATGTTGA ACGGATGTTGA	GAGATTGCTGF GAGATTGCTGF	GTGGGCTTG	GTATGTAAA	GGGGCTGAGAT	ITTGAGGTG	GACCTAAG
	1041	1050	1060	1070	1080	1090	1100	1110	1120	1130	1140	1150	1160	1170
H D Consensus	TTACA	FACAATTT	TTGTCACGTG	GAAGCGTGCG	igaagaggaa	GCAGTTGCCAF	CGGTGTAT	GGGATGCGCCT GGGATGCGCCT GGGATGCGCCT	CATCCTTGGC1	TAATCTCTT	GTGTCCAAA	TCTGATATCG	CTGATTTTG	ATCGTGTG
	1171	1180	1190	1200	1210	1220	1230	1240	1250	1260	1270	1280	1290	1300
H D Consensus	GTCTT	CAAGACTC	TCCTTAAAAA	GGGGTCGGTG	GGCCTATGC	TCGTCTACCCI	CTTCTGCG	AAGCAAGTGGG AAGCAAGTGGG AAGCAAGTGGG	ATTCACGGACF	TCGGTGGTG	TACCGGAAG	GGGAAGTGTT(GTACTTAGT	GGCGTTGT
	1301	1310	1320	1330	1340	1350	1360	1370	1380	1390	1400	1410	1420	1430
H D Consensus	TACGA	TTCACTCC	TCCGAACCCTA	AACCAGCATT	GGTTAATAA	ATTAGTGGAAC	AAAATCGT	GAAATAATCAA Gaaataatcaa Gaaataatcaa	TATATGCAATO	GGAATTGCAT	TGACTTCAA	ACTCTACTTG	CCACATTAC	CATTCAGA
	1431	1440	1450	1460	1470	1480	1490	1500	1510	1520	1530	1540	1550	1557
H D Consensus	AAAGGI	AGTGGAAG	CTTCATTTTG	GAATCAGTGG	AGTAGATTT	GTGGAGAGAAA	AGCTTGGT	TTGATCCAATG TTGATCCAATG TTGATCCAATG	GCTGTTCTTGC	TCCAGGTCA	AAGATCTTC	ACTAGAATTT	Cacgcaaac	ATTGA