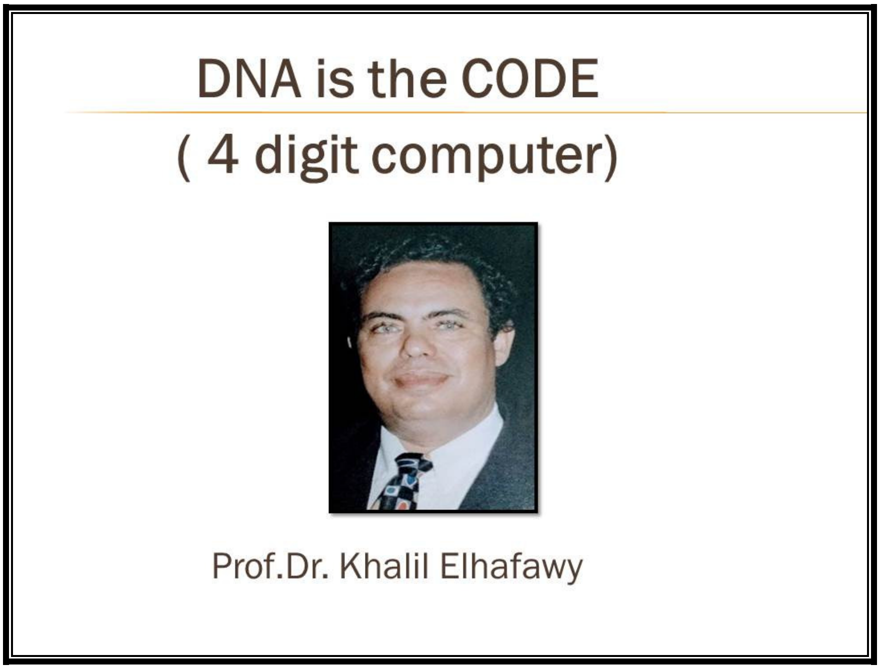
DNA IS THE CODE
(4 DIGIT COMPUTER)

Prof. Dr. Khalil Elkhalafawy*



تم تقديم هذه الدراسة فى صيغة ملف PowerPoint

* أستاذ الهندسة الجزيئية ونائب رئيس جامعة المنوفية السابق.

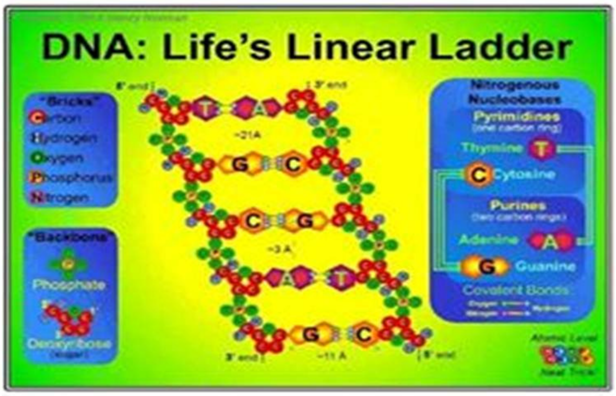
- Binary numeral system Used internally by nearly all computers, is base 2. The two digits are "0" and "1", expressed from switches displaying OFF and ON respectively. Used in most electric counters. Polynomials appear in many areas of mathematics and science. For example, they are used to form polynomial equations, which encode a wide range of problems, from elementary word problems to complicated scientific problems; they are used to define polynomial functions, which appear in settings ranging from basic chemistry and physics to economics and social science; they are used in calculus and numerical analysis to approximate other functions. In advanced mathematics, polynomials are used to construct polynomial rings and algebraic varieties, central concepts in algebra and algebraic geometry. Position Independent Code Dynamically linked libraries (.so under Unix, .dll on Microsoft) code cannot use static addresses internally because the code may appear in different places in memory in different situations. DNA has this too, where it is called 'transposing code': Nearly half of the human genome is composed of transposable elements or jumping DNA. First recognized in the 1940s by Dr. Barbara McClintock in studies of peculiar inheritance patterns found in the colors of Indian corn, jumping DNA refers to the idea that some stretches of DNA are unstable and "transposable," ie., they can move around – on and between chromos

Quaternary is the base-4 numeral system. It uses the digits 0, 1, 2 and 3 to represent any real number.

Four is the largest number within the subitizing range and one of two numbers that is both a square and a highly composite number (the other being 36), making quaternary a convenient choice for a base at this scale. Despite being twice as large, its radix economy is equal to that of binary. However, it fares no better in the localization of prime numbers (the smallest better base being the primorial base six, senary).

DNA is not "coded," DNA **is** the "code" — think of a DNA molecule as a digital memory device: just like a USB drive (for example), DNA stores a sequence of binary digits (**bits**, zeros and ones), but instead of a pure binary code (**base 2**), DNA uses a ***quaternary code*** (**base 4**).

The bases — T, C, A, and G — represent 0, 1, 2, and 3, respectively, which in binary code is 00, 01, 10, and 11. It "only so happened" that evolution opted for devices other than transistors to do the storing: the ***nucleobases.***



Below are the 64 possible DNA "triplets" (or ***"codons"),*** from 000 (TTT) to 333_4 (GGG), Each triplet is a **bit string** — TTT = 000000_2 to GGG = 111111_2 — so we could also say that Life is based *(no pun intended)* upon a ***binary system.***

DNA **Nucleobase** Triplets Encoded in **Decimal** and **Quaternal** (In **RNA**, substitute **U** for **T**)

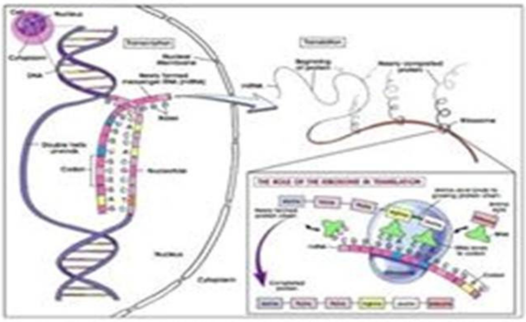
First Triplet Symbol (Base) Position

Second Position		0 Thymine					1 Cytosine					2 Adenine					3 Guanine					Third Position	
0	T	0	000	TTT	Phe	F	16	100	CTT	Leu	L	32	200	ATT	Ile	I	48	300	GTT	Val	V	T	0
		1	001	TTC			17	101	CTC			33	201	ATC			49	301	GTC			C	1
		2	002	TTA	Leu	L	18	102	CTA			34	202	ATA			50	302	GTA			A	2
		3	003	TTG			19	103	CTG			35	203	ATG	Met[2]	M[1]	51	303	GTG			G	3
1	C	4	010	TCT	Ser	S	20	110	CCT	Pro	P	36	210	ACT	Thr	T	52	310	GCT	Ala	A	T	0
		5	011	TCC			21	111	CCC			37	211	ACC			53	311	GCC			C	1
		6	012	TCA			22	112	CCA			38	212	ACA			54	312	GCA			A	2
		7	013	TCG			23	113	CCG			39	213	ACG			55	313	GCG			G	3
2	A	8	020	TAT	Tyr	Y	24	120	CAT	His	H	40	220	AAT	Asn	N	56	320	GAT	Asp	D	T	0
		9	021	TAC			25	121	CAC			41	221	AAC			57	321	GAC			C	1
		10	022	TAA	Stop[1]		26	122	CAA	Gln	Q	42	222	AAA	Lys	K	58	322	GAA	Glu	E	A	2
		11	023	TAG			27	123	CAG			43	223	AAG			59	323	GAG			G	3
3	G	12	030	TGT	Cys	C	28	130	CGT	Arg	R	44	230	AGT	Ser	S	60	330	GGT	Gly	G	T	0
		13	031	TGC			29	131	CGC			45	231	AGC			61	331	GGC			C	1
		14	032	TGA	Stop[1]		30	132	CGA			46	232	AGA	Arg	R	62	332	GGA			A	2
		15	033	TGG	Trp[2]	W	31	133	CGG			47	233	AGG			63	333	GGG			G	3

Computers work with (uses) the code stored in their electronic memory devices.

RNA structures work with (uses) the code stored in DNA memory devices. So, if anything should be called a "computer," it is the many RNA structures, working together, that performs the "computing" (but only in a loosely analoguous way).

DNA is (most of the time) "read-only." The image below shows some of the magic of RNA **working with** DNA to extract **copies** of genes stored in DNA, and using these, the RNA proceeds to synthesize proteins (or other RNA structures), as dictated by the **binary code** stored in the (pre-processed, "edited" by yet other RNA structures) gene copies.



***Gene Transcription, Translation, and Protein Synthesis** infograph lifted from* ***www.biologicscorp.com** page **Protein Synthesis vs Protein Production.** (Image copyright © 2001 Terese Winslow)*

الشفرة الخفية،

While there are 64 possible ways to combine four bases into groups of three, called codons, the translation process uses only 20 amino acids. To account for the difference, multiple codons translate to the same amino acid. Leucine, for example, can be encoded in six ways.‹‹

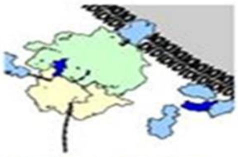
HEALTH & MEDICINE

A hidden genetic code

Researchers identify key differences in seemingly synonymous parts of the structure

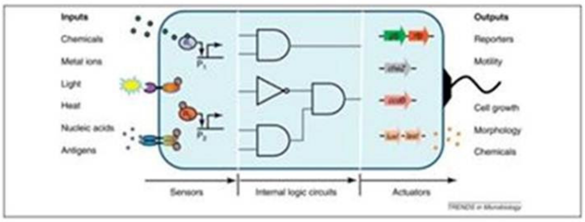
Synthetic biological circuits are an application of synthetic biology where biological parts inside a cell are designed to perform logical functions mimicking those observed in electronic circuits. The applications range from simply inducing production to adding a measurable element, like GFP, to an existing natural biological circuit, to implementing completely new systems of many parts.[1]

The goal of synthetic biology is to generate an array of tunable and characterized parts, or modules, with which any desirable synthetic biological circuit can be easily designed and implemented.[2] These circuits can serve as a method to modify cellular functions, create cellular responses to environmental conditions, or influence cellular development. By implementing rational, controllable logic elements in cellular systems, researchers can use living systems as engineered "biological machines" to perform a vast range of useful functions.[1]

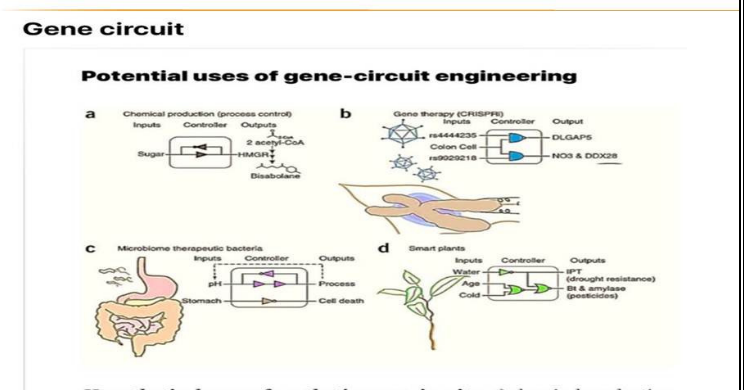


A ribosome is a biological machine.

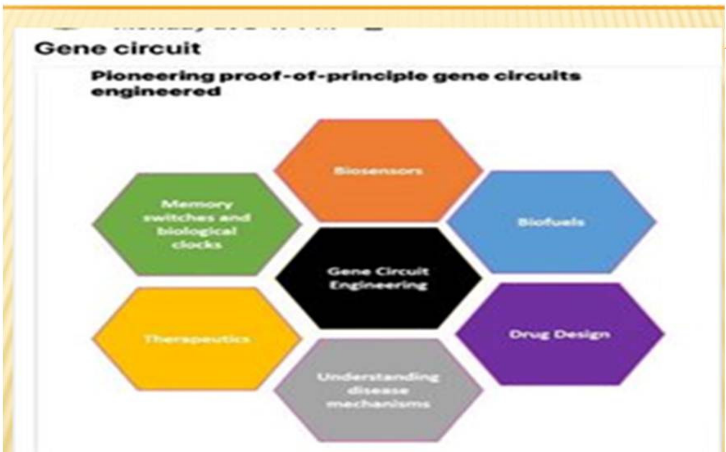
Basic modular design for gene-circuit engineering



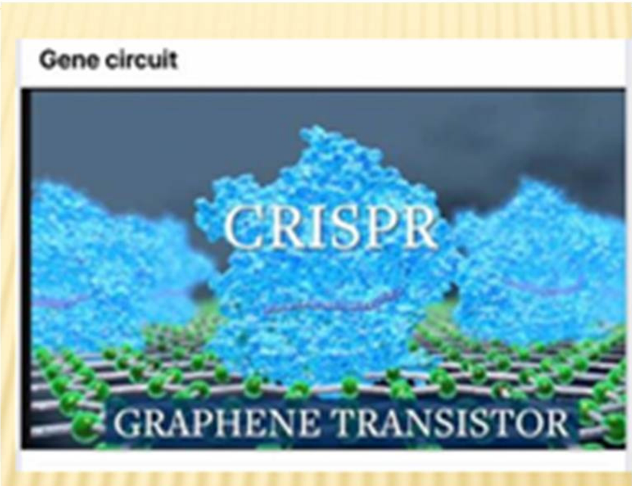
Cells designed for programmed functions: genetically engineered cell circuits custom designed via methods in synthetic biology, in comparison to electronic circuits (via Trends in Microbiology 2012).

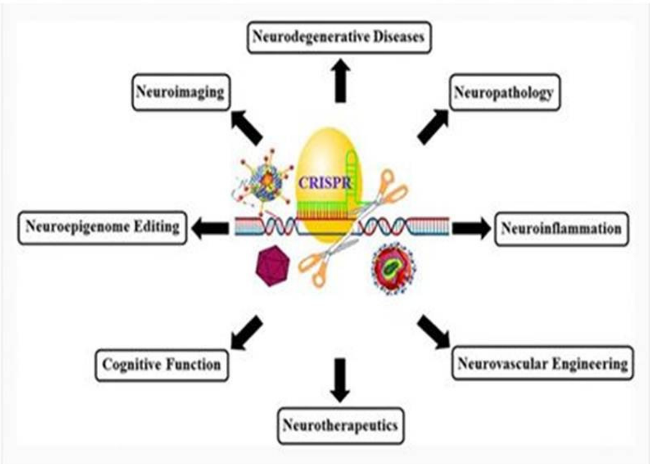


Hypothetical uses of synthetic gene circuits: a) chemical production (a non-toxic alternative to diesel) b) gene therapy (early detection to edit genetic anomalies in disease) c) engineering therapeutic gut bacteria c) smart plants that sense environmental cues and implement responses (*via* Nature Methods 2014).



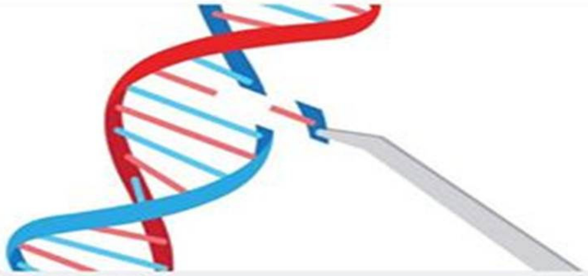
Applications of gene-circuit engineering: pioneering proof-of-principle applications with synthetic gene circuits achieved so far.


Gene circuit
CRISPR
GRAPHENE TRANSISTOR


Neurodegenerative Diseases
Neuroimaging
Neuropathology
CRISPR
Neuroepigenome Editing
Neuroinflammation
Cognitive Function
Neurovascular Engineering
Neurotherapeutics

Bacteria use adaptive immune systems encoded by CRISPR and Cas genes to maintain genomic integrity when challenged by pathogens and mobile genetic elements[1,2,3]. Type I CRISPR–Cas systems typically target foreign DNA for degradation via joint action of the ribonucleoprotein complex Cascade and the helicase–nuclease Cas3[4,5], but nuclease-deficient type I systems lacking Cas3 have been repurposed for RNA-guided transposition by bacterial Tn*7*-like transposons[6,7]. How CRISPR- and transposon-

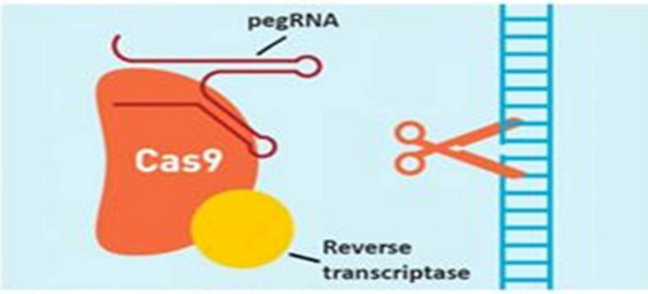
Free four article collection: Human genome editing is here. How should it be governed? included: "Using the 4-S Framework to Guide Conversations With Patients About CRISPR."



AMA-ASSN.ORG
Human genome editing is here. How should it be governed?

Gene-Editing Advance Puts More Gene-Based Cures Within Reach

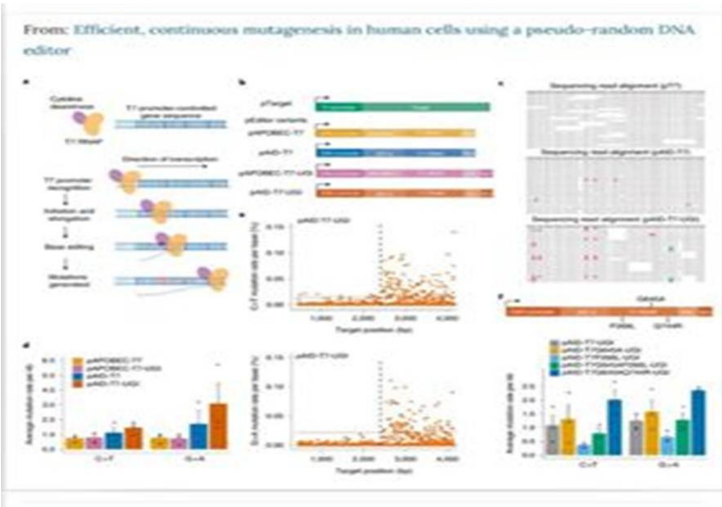
Posted on November 5th, 2019 by Dr. Francis Collins



Caption: The prime editing system (left) contains three parts: two enzymes, Cas9 and reverse transcriptase, and an engineered guide RNA, pegRNA. Unlike regular CRISPR gene editing, prime editing nicks just one strand of the DNA molecule (right) and then uses RNA and reverse transcriptase to direct highly targeted changes to a cell's DNA. Credit: Broad Institute of MIT and Harvard, Cambridge, MA

Beam Therapeutics is developing gene editing tools based on a new technique called base editing. The enzymatic approach doesn't make double-stranded breaks in DNA. Instead, it induces chemical reactions to change the sequence of the genetic alphabet -- A (adenine), T (thymine), C (cytosine), and G (guanine) -- one letter at a time. Base editing can make A-to-G edits, C-to-T edits, G-to-A edits, and T-to-C edits.

Efficient, continuous mutagenesis in human cells using a pseudo-random DNA editor



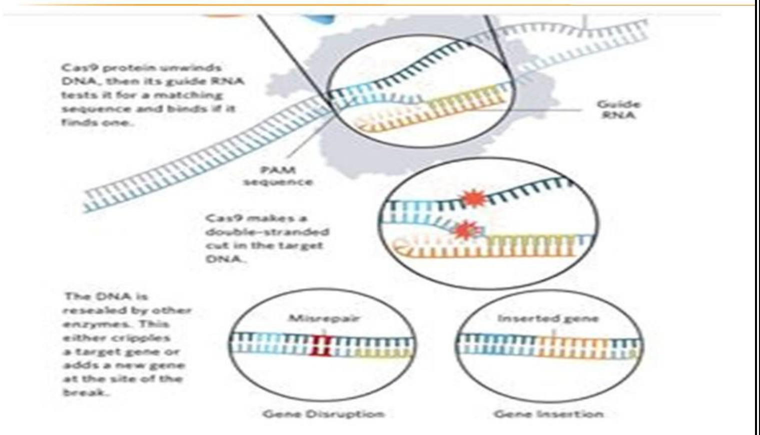
Induced pluripotent stem cells (iPS cells or iPSCs) are a type of pluripotent stem cell that can be generated from adult somatic cells such as skin fibrobalsts or peripheral blood mononuclear cells (PBMCs) by genetic reprograming or the 'forced' introduction of reprogramming genes (Oct4, Sox2, Klf4 and c-Myc).

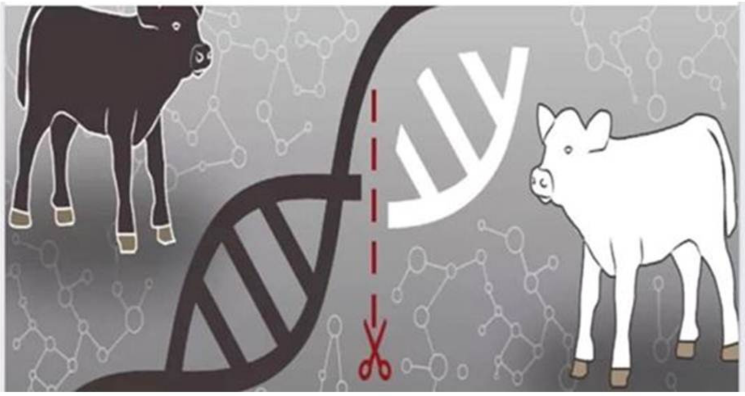
An IPS, or intrusion prevention system is used in computer security. It provides policies and rules for network traffic along with an intrusion detection system for alerting system or network administrators to suspicious traffic, but allows the administrator to provide the action upon being alerted.

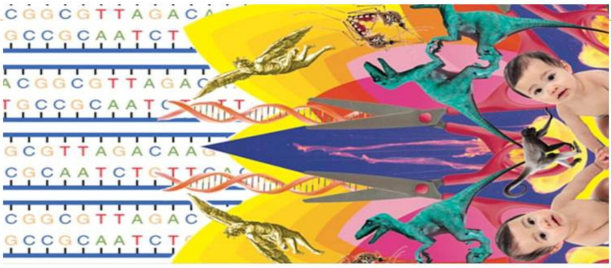
CAR T Therapy: Treating Cancer with Engineered Cells (with Podcast)

How CAR T Technology Works

Chimeric Antigen Receptor (CAR) T cell therapy involves using patient's own cells as the source of treatment. Cells are harvested from the cancer patient, engineered and turned into CAR T cells, and then transplanted back in the patient, killing their cancerous cells.


Cas9 protein unwinds DNA, then its guide RNA tests it for a matching sequence and binds if it finds one.
Guide RNA
PAM sequence
Cas9 makes a double-stranded cut in the target DNA.
The DNA is resealed by other enzymes. This either cripples a target gene or adds a new gene at the site of the break.
Misrepair
Inserted gene
Gene Disruption
Gene Insertion





HOME / CALIFORNIA MAGAZINE / WINTER 2019

Meet CRISPR: Humanity's Shiny New Tool

A technology we took from bacteria is poised to transform our world.

Human Genome Editing: Road to creation of Metahumans

Human Genome Editing: Road to creation of Metahumans

The term metahumans/super humans is probably more of a mythical term but has now become a regular part of our everyday life and is usually called to describe humans or people with exceptional physical strength and mental capabilities. Scientific world backed by various governments and private organizations have been working for creations of such human beings mainly for military purposes but good results were rarely observed. It seemed to be an impossible thing "The creation of super humans" until now. The recent arrival of CRISPR/CAS9 and its use in various living being with high success rates has revived the hope of creating such super humans—humans which will be immune to multiple genetic disorders, will have exceptional physical strength, high endurance and extremely high IQ level. Experiments have been conducted by various research groups from across the globe with Chinese scientists leading the race. A claim was made by Chinese researchers in 2015 that they have genetically edited human embryo genome to make it resistant to certain genetic disorders but the embryos were not good enough to survive. Until now there has been many ups and downs in use of CRISPR for human gene editing but a recent announcement by a Chinese scientist named "He Jiankui" has completely changed everything.