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Genetics Neural Codes

Number of Neurons brain 10^{10} $\sim 5 \times 10^{9}$ DNM

" " synapses/cell 10^{3} ~RM

" " synapses/brain 10^{13} ~RM

~RM

Kinds of Neurons ~200

" " ~~Stim~~ transmitters 5 } 6 - 6 kinds of cells

" " Inhib " 1 }

Kind of Chem | * Transmitter/cell 0-1 — A, B, C, D E F

" " " Receptors/cell 0-1 a b c d e f

Kinds of synapses/cell + < 1 bA + 25 mills

− 1 cA +

Kinds of synapses of + < 30 dA + = 10 ++

− 6 eA + 7 −+

fA − 4 +−

1 −−

25

$5^5 =$

$5 \times 5 \times 5 \times 5 \times 5$

5 25 125 625 $\boxed{3125}$ kinds of words

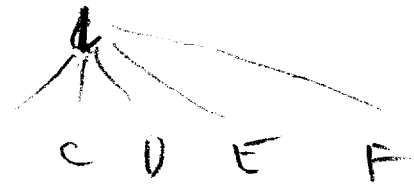
5

3125

assume anchor dens. 1. assume
magnitude Need 150 kinds of receptors

$6^1 = 6$
$6^2 = 36$
$6^3 = 216$

cell — cell code. ~ 6 kinds of letters ABCDEF
1 triplet/cell
216 kinds of cells.



If 10 kinds

	B	C	D	E	F
not A	−	−	+	+	+
			−	+	+
				−	+

3 symbols

5		10
4	1	5
2	2	32
1	3	24 1

assume 9 kinds of letters Max
9 − 1 = 8 choices/cell
3 choices needed to distinguish
= triplet
8 × 8 = 64
× 8
512 kinds of triplets

12
6
3
2

ABCD
4
2 2
1 1

2 kinds of codes necessary

Embodied 1) cell-cell contact type from circuits etc

Predict Max of 10 letters. Triplet

Neural 2) Use circuits

~~[illegible]~~

Predict 1) of 1000 words

1) Logical Code for assembling cells.

2) Prob. < 12 letter alphabet for

2) three organisms

3) $12 \times 12 = 144$

$$\begin{array}{r} 144 \\ 12 \\ \hline \boxed{1448} \end{array}$$

Question

1) How many kinds of codes?

a) Minimum of 3 kinds of neural codes. Prob more.

1) Genetic Order Base sequence & AA sequence

Neural Code 2) Order cell - cell sequence.

3) Code to use neurons.

b) Not neurons system

2) ~~Code for~~ cell assembly ~~Logical~~ Rules

1) Logical

~~2) Alogical~~ 2) alogical

3) No rules.

1) Nonrandom

2) Random

Problem Order

1) ~~Ex~~ 10^{13} cells - cell - contacts (synapses)

or 10^{10} cells

1) ~~Separate~~

Each cell has a diff instruction

10^{8} kinds of cells

10^{8} instructions

~10^{2} cells/human

2) Not DNA in Diffeo's nucleus =

6 ~ 1×10^{9} = 10^{9} AA maximum

= ~ 3×10^{6} kinds of Proteins

Not not enough genetic info for any cell to have a diff prot

~~Doubt~~ Enough for diff set of proteins / cell

This predicts pairing mech. receptor 1) Mucopolysacc
Lipopolysacc
Proteins
oligonucleotide
oligosaccharide
Proteins

Rich ~~Max~~ <1000 kinds of cells / organism
Man ~ 10^{12} cells
Neurons system — 200 kinds cells. Position of All cells fixed

Rule 1. Logical code for ordering cells.

Predict ~10 " 2. Rich ~~Max~~ 15 kinds of letters in alphabet.
Predict few letters

1000 3) 3 letters / word = 2225 words Max.
~~for~~ 3–5 letters / word

? 4) Combine words? # of kinds of words / cell.
1 — 4 kinds of words / cell
1 word / cell = 1000
2 " / " = 10^6
3 " / " = 10^9
4 " " = 10^{12}

If 4 words / cell,
1 cell recognizes 1–4 words.
kinds of cells contacting 1 cell – 1

cells		
1	1	Frequent
2	1	"
3	1	
4	1	
5	1	
6	1	Rare

schizo
axon
Dendrite

Quest. How many cells does 1 cell contacts?

1 kind of cell	(N cells of 1 kind)	Frequently
2 " "	(2)	"
3		occasionally
4		rare
5		very rare or never

Predict, 1 cell contacts < 5 kinds of cells

Quest

How many kinds of cells does 1 cell receive?

1) Neurons 4 kinds dendrides on Mauthner's cell

Rare

1	Frequent
2	"
3	Occasionally
4	Rare
5	~~[illegible]~~

Predict 2) Supporting cells 2

1 cell receives < 6 cell contacts

1 neuron receives < 5 kinds of neurons

contacts < 5 " " " (not same as receives)

Hence either ~~[illegible]~~ 5 kinds of cells can have same kind receptor or 1 cell can have 5 kinds of receptors

? [Predict Neurons probably do not have self-self axon dendrides!! Amergerine cells ??]

often but not always true. Other cells often have self self.

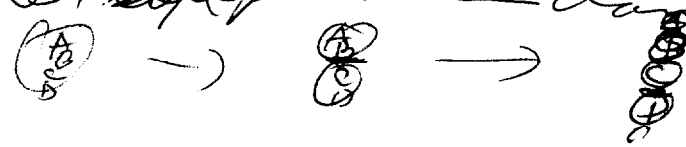
Predict synapse is neuronal cell-cell contact recognition for contact Inhibition

Predict (or always) axon-dendrite recognition

dendrite-axon

Incomplete dendrite fixed via cell division

daughter cells



Predict

1 axon recognizes 1 bind by word (1000)

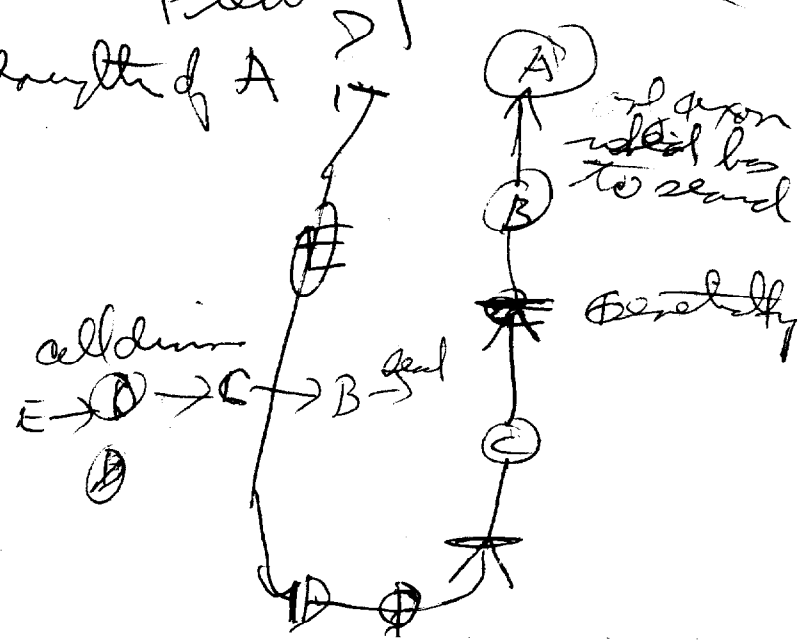
than 2 "

This is Mech Preuring

Read

Sensory cells

no dendrite may be daughter of A



cell division

E → D → C → B → seal

all axon ~~[illegible]~~ has to seal

Genetically

Logic of Design

1) Template

1) Fan Units - Diff Seq - Linear

2) Logic - all nodes equal length.

3) [illegible] Degenerate Logic

2 Parallel vs Serial Operation

1) Define

1) Prot Sym is statistical process

2) .1 - 2000 copies/cell

3) L

3) Coding based on letter groups & Error limited. Group Corrections

4

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Principles 2

1) # of units
2) # of units combinated

	Alue Ac		Pr[illegible]
1	Units 1,2,3,4		20 ~32
2)	Cols 111	64	1 ~32
3)			
3)			Pr[illegible]

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Generalization Neural vs Genetic Code

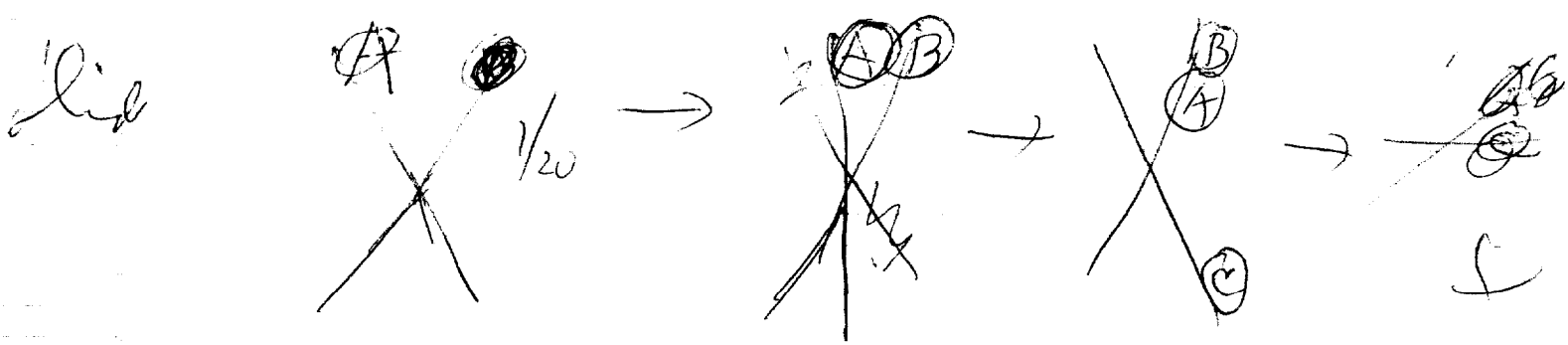
1) Loquil
2) Redundant (loquil)
Combine characteristics to achieve complexity
3) Few letters 4

~~3 Bit letters / 4 letters~~

complex
3 characters/sequence = 1 ~~character~~ 64
(54)

N characters/protein infinite

4 Increase discrimination doing 10 operations via 2 sequential steps
~~Reduce~~
4) 1 ~~Error correction~~
1) step 1 X step 2
20 X 20 = 400 discrimination
2) Error correction



Ile

ABC
+
A

AA 1 operation 3 step AATM

DMT 3 steps 1 operation RM 1 operation

Increase accuracy greatly (2 or 3 cells) by 2 serial step operations

Serial operations

AA, TM, ATP 1/20 1/4

~1/6000

1, A + B → AB

1

2 AB + C → AC + B

1/50

serial 3 → 2 serial

3 (2,25) serial choices max / AA

2 " (increase accuracy)

Codon Rec 6 choices sym. use logical Redundancy

DNA
↓
1 A
↓
2 AB
↓
.25 ABC
R AATM
1 ATRM
2 AA ~ AMT
3 AA

DM
3 .25
1 ABC
2 ABC
AD

10	AA	1 TM	1/50	1/32
5		2	1/25	1/32
5		3	1/17	1/16
3		~4		1/11

in RM sym

1 1 3/4

1 → 2 → 3

1/4 → 1/4 → 1/2

2,25

Sensitive / cardio 3 4 characters in 1st + 2nd position
4 characters in 3rd position

G A U U
G C C
G A A
A U C

U	U	U = C = A	5
C	C	U = C	5 5
A	A	A = G	5
G	G	G	5

Specify Template

1) Matter, template, read ~~Object Molecule~~ Matter quantum of Matter
2) Time for matter, template, reader
3) Space for Matter, template
4) Space for reader
5) Time for reader

Position (space)

Universality

1) Code
2) Mech. codon recog. & Prot Sys.
3) few basic units combined
4)

Template only present reader

Memory

1) Direct address, specific Molecule for each instruction
2) Finite amt info.
3) Constant change (random)
4) Encoded Memory = 1-3 units

1) Matter (Template)
2) Space of 1 unit relative to another
3) Time

Quantum

1) Matter matter
2) Time of Direction of time
3) Space of matter of Direction of Space
4) Beginning & end of Reader
5) Space-Time-Matter linked

2) If templates when read corresponds to
1) Matter - Template
2) Matter - antitemplate & Reader
3) Space Path Position & Direction
4) Time Biological Clock

antitemplate & Template

~~* Time = Matter = Space of Matter~~

~~Matter = Time + Space of Matter + Matter~~

~~3 parameters are quantized (Space) or of matter and of both~~

Quantum of AA / cell

Quantum / generation

AA ~ 3.2×10^8 / genome / 25 min

AA ~ 5.0×10^8 / 1.4 Genome / Generation 25 min

~~$\sim 10^9$ bases (RNA~~

$= \sim 1.3 \times 10^7$ AA / min / cell (25 min generation)

$= 2.2 \times 10^5$ AA / sec / cell (25 min generation)

220,000 quant AA / sec / cell

1 AA quant / cell = Time Position

$= \sim 1.4$ ~~$\times 10^3$~~ AA / Rib / sec

$= \sim 0.07$ sec = 1 AA quant ave.

$= \sim 3 \times 5 \times 2 = \sim 30 A^3 = 1$ space quant / AA

$= 0.07$ sec = 1 AA / Rib

(Time quant / Rib

) cell / sec.

~~sec~~ = $\sim 5 \times 10^{-6}$ quant of time

2.2×10^5 quantum AA = ___ pg Mass / sec / cell AA

1 quant mass / sec = ___ pg Mass / sec / cell

1 " energy = ___ / sec / cell

1 quant space = ___ A^3 / ~~sec~~ / cell

1 quant time = ___ sec / cell

Matter

↓

Quanta Matter
Quanta Time
Quanta Space

↓

Matter + Matter — Quanta Matter subsumes

quanta = order = { — Quanta Time
— Quanta Space }

Matter = quanta energy + quanta order
= [Space + Time + Energy]

Matter = { 1) quanta energy
2) " ~~space + time~~
3) " ~~time~~

000

End of Mass + Beginning of Mass + Mass = Energy + space + time direction

~~Matter = 1) Energy — Mass~~
~~2) Energy~~

~~Intend~~ Beginning — end = Time

↓ ↓

Time is ~~function of space~~ velocity × ~~rate~~ of travel

1 quanta time (not uniform) (uniform)
= 1 quanta space
= 103 " matter of mass

Space = Start ⟷ Intend Stop
Time = " ⟷ Intend " × Velocity.

1 quant Time = 1 quantum Matter (+ start + stop) × 1 quantum space × 1 quantum velocity.

M × S × V

Mass = energy + start + stop (or internal between start + stop)

2 commands

internal = 2 commands

if has a fixed exceptional effect

Template determining

1) kind of reaction
2) Position of Reactants
3) Time of reactions
4) Position of Product
5) Time of Product

Order of Matter = Relative space + Time of ed. subsequently.

$M_1 + S_1 + t_{S_1} = M_2$

(= energy)

Template for Mass
Order of Mass.
Time
Space
Direction of Time + space + order + Mass.
Start Stop, Direct
Start Stop
Interval

Space = interval

Time = interval + ~~Direction~~

Order = Direction of start - stop

Mass = Energy + Space + Time + Order

Order start = order stop

" sym = " breakdown

1 quantum Space = 1 quantum time = 2 quantum order
= 1 quantum start + 1 quantum

1 quantum order = 2 of Space
= 2 of Time

1 quantum [space + time] = 1 quantum order

Space = 0.5 order (stability)

Time = " ( )

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+ = fire
— = dont fire

Basic Neural Signals

Neurons

[+ −] 1) + [Fire + Dont Fire] = [+ −] not equal

— 2) + Dont fire

— + 3) + Dont fire + [Fire − Dont fire] = Dont fire

+ — — 4) + [Fire − Dont Fire] + Dont Fire = [Fire − Dont fire] ?

[+ −] + [−] = + — —

4 kinds neurons

2 + + −
+ — —

2 — — −
— +