Modeling of charge oscillations in DNA. A search for resonance structures in the genome.

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Morphogenetic field
Morphogenetic field

- Gradients of morphogenic proteins and other signaling molecules
- Neuronal signaling
- Mechanoception
- Electrostatic fields
- [Electromagnetic, acoustic and other fields are rejected]
Morphogenetic field

- Gradients of morphogenic proteins and other signaling molecules
- Neuronal signaling
- Mechanoception
- Electrostatic fields
- [Electromagnetic, acoustic and other fields are rejected]
1774 Animal magnetism
Franz Mesmer
vitalism: life is driven by a vital force.

the presence of a soul makes each organism an indivisible whole and
light and sound waves show that living organisms possess a life-energy unexplainable by physical laws.

Based on experiments with fertilized sea urchin eggs proposed biofield

Experimental biologist and metaphysicist Hans Driesch.
Alexander Gurwitsch, Hans Spemann, and Paul Weiss independently proposed **morphogenetic fields** early 1920s.
1953

Double helix

Crick, Watson, Franklin, Wilkins
Per-Olov Löwdin

- Quantum genetics
- proton tunneling in DNA
- delocalized pi electrons in DNA

(didn't expand to biofield, only discussed nano-scale quantum events).


Biological Quantum Mechanics and DNA hologram - an electrical engineering view.
Dr. Richard Alan Miller, the coauthor, proposed that DNA creates biofield in 1972.

1976
Terence and Dennis McKenna

DNA

hologram

body

consciousness

Experimental evidence is scarce
Objective: To verify the existence of the biofield
biological object

device

biological object
biological object

device

biological object

biological object
Gurwitsch, A. G., Über den Begriff des embryonalen Feldes. 1922
"Die Mitogenetische Srtahlung", Berlin, 1932
Non-chemical signaling

fish embryos

older

repression

younger

Burlakov 2013
bit.ly/burlakov
Germanium mirror

fish embryos

acceleration of growth

retroreflector

repression, abnormalities

Burlakov 2013
bit.ly/burlakov
What needs to be proven or verified:

- The existence of biofield
- Its morphogenic function
- That DNA produces the biofield
- That DNA produces the biofield in a sequence-specific manner.
Гипотеза морфогенного поля: поле влияет на форму организма

Гурвич, 1920е годы

Гурвич 1923 г. Частичное эксп. подтверждение: митогенетическое излучение в УФ спектре влияет на скорость роста

Бурлаков 1990е, эксп. нарушение поля влияет на форму организма

Механизм?

Миллер 1973 г. Гипотеза о механизме: ДНК создает морфогенное поле посылает и принимает сигналы. до сих пор нет подтверждения

Наши исследования
1. Гипотеза о молекулярном механизме
2. Косвенное подтверждение участия ДНК в резонансной передаче сигнала.
chromatin structures may transmit and receive electric signals
Electron wire patterns in the genome
3.7Å cutoff for h-bonds

- electron wires
- proton wires
Natural oscillation criteria

1. Not damped by viscosity
2. DNA sequence dependent

Electron clouds in purine stretches meet the requirements
Molecular modeling - merged electron clouds of purines as oscillators

red - purines (A,G)
green- pyrimidines (C,T)

merged electron clouds

Purine
Pyrimidine

Rempel 2017 PMID: 29294317
• Similar patterns resonate
• Our genome is 3 Gbps
• 50% of the genome is repetitive
• Alu repeat - 11% of our genome
• Line repeat - 6% of our genome.
• 50% of the genome is made of unique sequences
• Similar patterns resonate
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• 50% of the genome is made of unique sequences
Purine HIDERs

seq1
GTGACTTTCTTTTGCACTG
seq2
ATAAGTTTTTTAATATTGTTA
seq3
CGGAATTTCCTAGCAGTGCCCA
seq4
GTGGTTTCTTTCCGCGACTAA
seq5
GTAGAFTTTTTTGGCACA

A
Colored by nucleotide

seq1
GTGACTTTCTTTTGCACTG
seq2
ATAAGTTTTTTAATATTGTTA
seq3
CGGAATTTCCTAGCAGTGCCCA
seq4
GTGGTTTCTTTCCGCGACTAA
seq5
GTAGAFTTTTTTGGCACA

B
Colored by purine code

Human

Dolphin

Mouse

Drosophila

Arabidopsis

Purine HIDER count

Orig, Rand

Human

Dolphin

Mouse

Drosophila

Arabidopsis

***

**

n.s.

**
Proton wires
Longitudinal hydrogen bonds
Dinucleotides have different longitudinal hydrogen bonds.
Fig. 3. Recoding scheme. (A) Definitions of longitudinal H-bond bond types. (B) Conversion table of dinucleotides to longitudinal H-bond types. (C) Algorithm of recoding a nucleotide sequence into protocode.
Мы предположили, что даже различающиеся последовательности могут резонировать, если в них похожие структуры водородных связей.

Хайдеры = фрагменты ДНК, имеющие различные первичные последовательности, но совпадающие по структуре продольных водородных связей

Хайдеры
Fig. 5. HIDEK density is enriched in the original over the randomized sequence.

Fig. 4. Example of protocode HIDER sequences.

Colored by base:

seq1: CTCACCTCTCCCAAAT
seq2: CTCACCCAGAGAAAT
seq3: GGAAGCTGTGGGAAT
seq4: GGAAGTGTGGTGAAT
seq5: AGAAGGCTCCTTTGAT

seq1: CTCACCTCTCCCAAAT
seq2: CTCACCCAGAGAAAT
seq3: GGAAGCTGTGGGAAT
seq4: GGAAGTGTGGTGAAT
seq5: AGAAGGCTCCTTTGAT

The same sequences colored by protocode:

Fig. 7. The density of Tandum HIDERs is enriched in the original over the randomized sequence.

Colored by base:

seq6: AGACAGATGGAGTGGAGAGAGACAG
seq7: GAAATGGTGGATGAGATGAATGG
seq8: AATGGAGTTGTTGATGAGATGAATGG
seq9: GAAATGGTGGTTGATGAGATGAATGG
seq10: GAAATGGTGGTTGATGAGATGAATGG

The same sequences colored by protocode:
• Морфогенное поле должно создаваться ДНК (Гурвич - Миллер)

• Для добротности колебаний, ДНКовые резонаторы должны быть высококопийными повторами.

• Внутри резонатора должно быть изолированное облако делокализованных электронов или протонов, так чтобы форма облака зависела от последовательности.

• Облако делокализованных протонов (протонный провод) получается из продольных водородных связей

• Должны существовать Хайдеры. Повторы и хайдеры должны участвовать в передаче сигнала и регуляции генома.

• Хайдеры должны быть обогащены в процессе эволюции

• Проверили - обнаружено сильное и статистически значимое обогащение. Это косвенно подтверждает всю логическую цепочку.
Хайдеры обогащены в консервативных участках генома
Хайдеры обогащены в консервативных участках генома
Fig. 8. Conservation of HIDERs compared to background (Bg).
Repetitive patterns of proton wires are enriched by evolution in all tested species

Rempel 2020 PMID: 32712047
Repetitive patterns of proton wires are enriched by evolution in all tested species

Repetitive patterns of proton wires are enriched in conserved regions

Rempel 2020 PMID: 32712047
Repetitive patterns of proton wires (HIDERs) colocalize with gene transcription starts.
Does the nucleosome read DNA as a VCR head?
A Dotplot map of proton and electron wires.

How the future analysis may look like

Genome browser annotations.
Quantum chemical modeling of proton wires
Comparison of different methods of prediction

stereometric
by distance
quantum
chemical
flexible model

How flexible is B-form?

complete agreement
partial agreement
Quantum chemical modeling methods

Designed B-DNA using Winmopac 7.21

MOPAC – molecular orbital modeling program

• Method UHF PM6-DH2X
  • is widely used for modeling macromolecules
  • good agreement with spectrometry and crystallography
  • does half-empirical computation = Ab initio + empirical
  • does Schrödinger equation computation
• we computed transition energies for tautomeric transitions

Komarov, Samchenko. "Bi-Stability... Genomic DNA." Russian Physics Journal 63.8 (2020)
Closed-loop proton jumps obey neutrality requirement.
Closed-loop proton jumps obey neutrality requirement

Tautomer transition energy

AG dinucleotide
Closed-loop proton jumps obey neutrality requirement.

Tautomer transition energy

AG dinucleotide
Closed-loop proton jumps obey neutrality requirement

Tautomer transition energy

AG dinucleotide
Dinucleotides have different longitudinal hydrogen bonds
Nonrandomness of mutations
Evolution favors longer purine chains

GWAS genome-wide SNP data. GWAS – genome wide association studies
SNP – single nucleotide polymorphism

1000 volunteers
11M SNPs – Allele frequencies

SNP1
CGGAGGAGGAA AAGGAGT - 83%

SNP2
CAGGTT - 28%

CAGTTG - 72%

SNP1
CGGAGGAGGAA AAGGAGT - 17%

Longer purine stretches evolve longer and shorter stretches evolve shorter
Suggesting biological function of longer stretches – oscillators

P<0.0001
Evolution favors longer purine chains

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SnP1

C           G           G           G           G           A           G           G           G           G           G           A           G           G           G           G           T
83%

C           G           G           G           G           T
17%

SnP2

A           G           G           G           G           T
28%

C           A           G           T
72%

Longer purine stretches evolve longer and shorter stretches evolve shorter
Suggesting biological function of longer stretches – oscillators
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GWAS genome-wide SNP data.
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1000 volunteers
11M SNPs – Allele frequencies

C
GGGAGGAGGAG
A
AAGGAG
T
83%  
C
GGGAGGAGGAG
C
AAGGAG
T
17%  
C
AG
A
GG
T
28%  
C
AG
T
GG
T
72%  
P<0.0001

Longer purine stretches evolve longer and shorter stretches evolve shorter
Suggesting biological function of longer stretches – oscillators
Purine stretches in other biological species plus proton chains

Human

Bird

Fish

Plant

Rempel 2020 PMID: 32712047
Evolutionary pressure to elongate purine chains

Human

Fish (salmon)

Bird (Great Tit)

Plant (cocoa)
Evolution favors longer purine chains

GWAS genome-wide SNP data.
GWAS – genome wide association studies
SNP – single nucleotide polymorphism

1000 volunteers
11M SNPs – Allele frequencies

CGGGAGGAGGAAAGGAGGT - 83%
CGGGAGGAGGAAACAGGAGGT - 17%
CAGGTT - 72%

Less frequent alleles have shorter purine stretches
P<0.0001

Longer purine stretches evolve longer and shorter stretches evolve shorter
Suggesting biological function of longer stretches – oscillators
Water structures in DNA groves
Does water mediate longitudinal proton jumping in DNA?
Does water mediate longitudinal proton jumping in DNA?
3.7Å cutoff for h-bonds

electron wires

proton wires
3.7 Å cutoff for H-bonds

electron wires

proton wires
3.7 Å cutoff for h-bonds
7.5 Å cutoff for h-bonds
10Å cutoff for H-bonds
3.7 Å cutoff for h-bonds

electron wires

proton wires
What is the physical nature of DNA resonance?
Closed-loop proton jumps obey neutrality requirement

Tautomer transition energy

AG dinucleotide
Oscillations of protons in tautomers and the requirement of neutrality
The dinucleosome as an LC circuit

Traditional electronic oscillator

Induction coil  Capacitor

alternating charges
The dinucleosome as an LC circuit

Traditional electronic oscillator

- Induction coil
- Capacitor

alternating charges
A model of charge oscillations in tetranucleosomes

Rempel 2017
PMID: 29294317
A model of charge oscillations in tetranucleosomes

Rempel 2017
PMID: 29294317
Electroacoustic conversion of wavelengths. Currently, the shortest described wavelength for ultrasound is 250 nm, so the shorter wavelengths are shown in grey as tentative.

<table>
<thead>
<tr>
<th>light wavelength</th>
<th>sound wavelength</th>
<th>nucleosome as a speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 mm</td>
<td>10 nm</td>
<td>nucleosome diameter</td>
</tr>
<tr>
<td>3.6 mm</td>
<td>24 nm</td>
<td>tetranucleosome width</td>
</tr>
<tr>
<td>3.7 mm</td>
<td>25 nm</td>
<td>millimeer wave therapy frequency</td>
</tr>
<tr>
<td>4.2 mm</td>
<td>28 nm</td>
<td>mm wave therapy, chromatin fiber diam.</td>
</tr>
<tr>
<td>5.3 mm</td>
<td>36 nm</td>
<td>millimeer wave therapy frequency</td>
</tr>
<tr>
<td>7.5 mm</td>
<td>50 nm</td>
<td>millimeer wave therapy frequency</td>
</tr>
<tr>
<td>1.5 cm</td>
<td>100 nm</td>
<td>Alu repetitive element, 300 bp</td>
</tr>
<tr>
<td>3.74 cm</td>
<td>250 nm</td>
<td>millimeer wave therapy frequency</td>
</tr>
<tr>
<td>15 cm</td>
<td>1.0 um</td>
<td>mitochondrion length</td>
</tr>
<tr>
<td>30 cm</td>
<td>2.0 um</td>
<td>Line repetitive element, 6 kbp</td>
</tr>
<tr>
<td>1.0 m</td>
<td>7 um</td>
<td>mammalian nucleus</td>
</tr>
<tr>
<td>3.0 m</td>
<td>20 um</td>
<td>mammalian cell</td>
</tr>
<tr>
<td>75 m</td>
<td>500 um</td>
<td>ultrasound imaging frequency</td>
</tr>
<tr>
<td>224 m</td>
<td>1.5 mm</td>
<td>ultrasound imaging frequency</td>
</tr>
<tr>
<td>2.2 km</td>
<td>1.5 cm</td>
<td>many biological objects</td>
</tr>
<tr>
<td>22 km</td>
<td>15 cm</td>
<td>chromosome length</td>
</tr>
<tr>
<td>224 km</td>
<td>1.5 m</td>
<td>human height</td>
</tr>
<tr>
<td>299 km</td>
<td>2 m</td>
<td>human height and genome length</td>
</tr>
<tr>
<td>12742 km</td>
<td>85 m</td>
<td>Earth diameter</td>
</tr>
<tr>
<td>28637 km</td>
<td>192 m</td>
<td>Schumann resonance frequency</td>
</tr>
</tbody>
</table>
Electroacoustic conversion of wavelengths. Currently, the shortest described wavelength for ultrasound is 250 nm, so the shorter wavelengths are shown in grey as tentative.

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Frequency (MHz)</th>
<th>Relevant Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>150</td>
<td>Nucleosome diameter</td>
</tr>
<tr>
<td>24</td>
<td>63</td>
<td>Tetranucleosome width</td>
</tr>
<tr>
<td>25</td>
<td>60</td>
<td>Millimeter wave therapy frequency</td>
</tr>
<tr>
<td>28</td>
<td>53</td>
<td>Millimeter wave therapy frequency</td>
</tr>
<tr>
<td>36</td>
<td>42</td>
<td>Millimeter wave therapy frequency</td>
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<tr>
<td>50</td>
<td>30</td>
<td>Millimeter wave therapy frequency</td>
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<tr>
<td>100</td>
<td>15</td>
<td>Alu repetitive element, 300 bp</td>
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<tr>
<td>250</td>
<td>6</td>
<td>Millimeter wave therapy frequency</td>
</tr>
<tr>
<td>1.0</td>
<td>214</td>
<td>Mammalian nucleus</td>
</tr>
<tr>
<td>2.0</td>
<td>753</td>
<td>Line repetitive element, 6 kbp</td>
</tr>
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<td>Chromosome length</td>
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<tr>
<td>1.5</td>
<td>224</td>
<td>Human height</td>
</tr>
<tr>
<td>2.0</td>
<td>299</td>
<td>Human height and genome length</td>
</tr>
<tr>
<td>85</td>
<td>12742</td>
<td>Earth diameter</td>
</tr>
<tr>
<td>192</td>
<td>28637</td>
<td>Schumann resonance frequency</td>
</tr>
</tbody>
</table>
Nucleosome as a speaker
**Table [Wavelengths]**: A very approximate prediction of resonance wavelengths of genomic repeats

<table>
<thead>
<tr>
<th>Repeat unit length</th>
<th>Periodic</th>
<th>Type</th>
<th>wavelength</th>
<th>PEMF</th>
<th>UHF</th>
<th>MWT</th>
<th>LLLT</th>
<th>UVB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 bp</td>
<td>y</td>
<td>simple</td>
<td>light</td>
<td>37km</td>
<td>0.3m</td>
<td>7mm</td>
<td>800nm</td>
<td>300nm</td>
</tr>
<tr>
<td>2 bp</td>
<td>y</td>
<td>simple</td>
<td>light</td>
<td>186m</td>
<td>1.5um</td>
<td>30nm</td>
<td>4nm</td>
<td>1.5nm</td>
</tr>
<tr>
<td>3 bp</td>
<td>y</td>
<td>simple</td>
<td>light</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 bp</td>
<td>y</td>
<td>simple</td>
<td>light</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 bp</td>
<td>y</td>
<td>telomeric</td>
<td>light</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>171 bp</td>
<td>y</td>
<td>centromeric</td>
<td>light</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>260 bp</td>
<td>n</td>
<td>MIR</td>
<td>sound</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 bp</td>
<td>n</td>
<td>Alu</td>
<td>sound</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000 bp</td>
<td>n</td>
<td>Mariner</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6000 bp</td>
<td>n</td>
<td>LINE1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(UHF - ultra high frequency, MWT - millimeter wave therapy)
Snowflake type of signaling (crystal pattern propagation)

Microtubules

GTP-tubulin dimer  GDP-tubulin dimer
Snowflake type of signaling (crystal pattern propagation)

Microtubules

Snowflake signaling
Snowflake type of signaling (crystal pattern propagation)
Heat signaling - Hypothetical resonance signaling via radiant and conductive heat

Coherence transfer - quantum entanglement - spintronics

Sauna
Moxibustion
Acupuncture with moxibustion
Tanning with sunscreen

Ball, Philip. *Beyond weird*. 2020
What is the nature of DNA resonance signaling?

physical in the traditional sense

nonphysical in the traditional sense
physical in the traditional sense

1. electromagnetic signaling
2. electroacoustic signaling
3. snowflake (crystal pattern propagation) signaling
4. Brownian and radiant heat - quantum entanglement - mediated signaling
5. Subtle signaling (local, sequence-specific based on resonance, agnostic to the nature of the carrier wave)

nonphysical in the traditional sense

local signaling
detected by living things but not devices

nonlocal signaling

the experimental study is challenging
can be studied experimentally with traditional devices
can be studied with live sensor models
We are heading towards spectroscopic experiments

We synthesized a series of DNA samples with varied predicted proton chains.

Same composition – varied chain lengths.

Spectroscopic measurements

Will the spectrum changes reflect predicted proton chain lengths?

Looking for collaborators
Aim 1
- fish embryos
- morphogenic field
- fish cell culture
- genomic analysis

Aim 2
- synthetic DNA solution
- morphogenic field
- fish embryos
- microscopic analysis
- electric pulsing
Future directions
What can serve as a breakthrough point?

- A model that explains much of the existing genomics data, or
- Independently reproduced evidence of sequence-specific DNA resonance signaling
- A practically useful method
Challenges and future directions of DNA resonance research (wave genetics)

**Theory**
- To find order in the genome
- To discover agreement between DNA resonance models and genomic data
- Incorporate water into models
- Integrate positive and negative charge oscillations
- Integrate chaos theory
- Integrate quantum entanglement

**Experiments**
- Demonstrate DNA resonance
- Develop easy to reproduce assays
- Have it independently reproduced
- Demonstrate the role of DNA resonance in morphogenesis
- Demonstrate the role of DNA resonance in the work of mind

**Applications**
- Therapeutic
- Diagnostic
- Brain-computer interface
- Mood, entertainment, meditation
- Drug abuse monitoring
- Biotechnological
- Animals, plants, food.
Acknowledgements

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Ivan Savelev
Elena Naumova
Anton Klimov
Alex Samchenko
Alex Voronka
Elena Erdyneyeva

Past:
Nellie Zyryanova
Nikolai Kondratyev
Eugenia Kananykhina
[Vadim Guschin]
Konstantin Kupriyanov
Irina Garanina
Ancha Baranova
Evgenia Kananykhina
Alexei Tovmash
Lev Shishkin
Liliya Yulmetova

Collaborators:
Richard Alan Miller
Glen Rein
Anna Byalik
Alexandre Vetcher
[Irina Konstantinova]

Collaborations invited:
1. Spectroscopy
2. Electrodynamic modeling of oscillations
3. Quantum chemical modeling of oscillations

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i1. Hypothesis: morphogenic field (Gurwitch 1921)

i2. Hypothesis: Morphogenic field is generated by DNA (Mueller 1973)

i4. Hypothesis: DNA resonators are high copy repeats

i5. Hypothesis: Alu transposons are key resonators

i6. Hypothesis: structure of electron and proton clouds defines resonances in DNA

i7. Hypothesis: nonidentical sequences exist which resonate due to structure similarities (HIDERs)

i8. Hypothesis: repeats and HIDERs serve a positive function

i9. Repeats and HIDERs serve as resonators for genomic signaling

i10. Hypothesis: HIDERs should be enriched by evolution

i11. This study confirmed that HIDERs are enriched in studied genomes

Overall logic

i3. Experiments: Manipulation of the field leads to developmental abnormalities (Burlakov 90s)
<table>
<thead>
<tr>
<th>Allele</th>
<th>Allele</th>
<th>Affinity</th>
<th>tangent</th>
<th>Shout with</th>
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<tr>
<td>AA</td>
<td>AA</td>
<td>-12%</td>
<td>-0.30%</td>
<td>39.7%</td>
</tr>
<tr>
<td>AA</td>
<td>AC</td>
<td>-9%</td>
<td>-0.24%</td>
<td>38.81%</td>
</tr>
<tr>
<td>AA</td>
<td>T</td>
<td>-6%</td>
<td>-0.18%</td>
<td>40.91%</td>
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<tr>
<td>AA</td>
<td>TA</td>
<td>-4%</td>
<td>-0.16%</td>
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<tr>
<td>AA</td>
<td>AT</td>
<td>-8%</td>
<td>-0.12%</td>
<td>37.01%</td>
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</tbody>
</table>

How come good single RR to good single RR gives a 12% fall? Just because of A to G? maybe a result of Polyadenilase? Maybe not.

-12% fall
GA likely a stop

RR
F - Maybe not a good single O0 3.1A maj weak WNOO W maj
NN 3.7A min
OO 3.9A min

-6% fall
CA good Single

-4% fall
TA medium diamond

AA Good single

RR
K good single
NN – maj
NO 3.0A – maj
Nothing in min