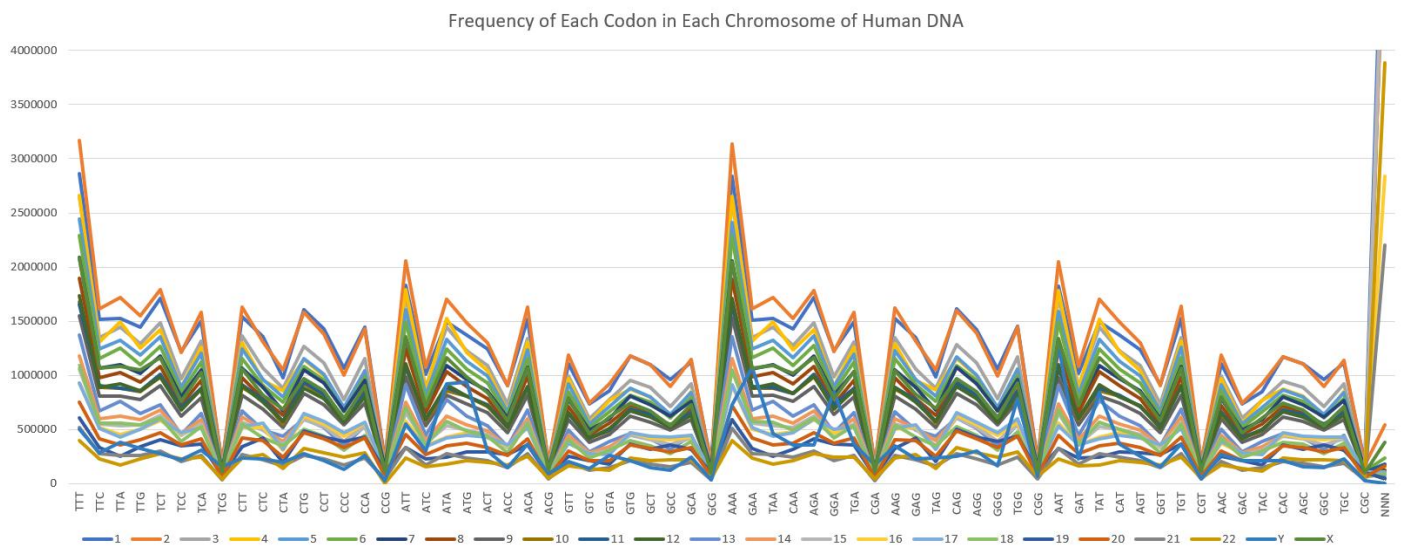


Comparing Chimp and Human DNA

By Craig Paardekoooper

I used a computer to count the frequency of occurrence of each of the 64 codons within each of the 22 chromosomes and in the Y and X chromosomes. The results can be found in an excel spread sheet here – <https://howbad.info/human-all-codon-freq.xlsx>. In the spreadsheet, the 64 different codons are in the far left column, and each column is for a different human chromosome.

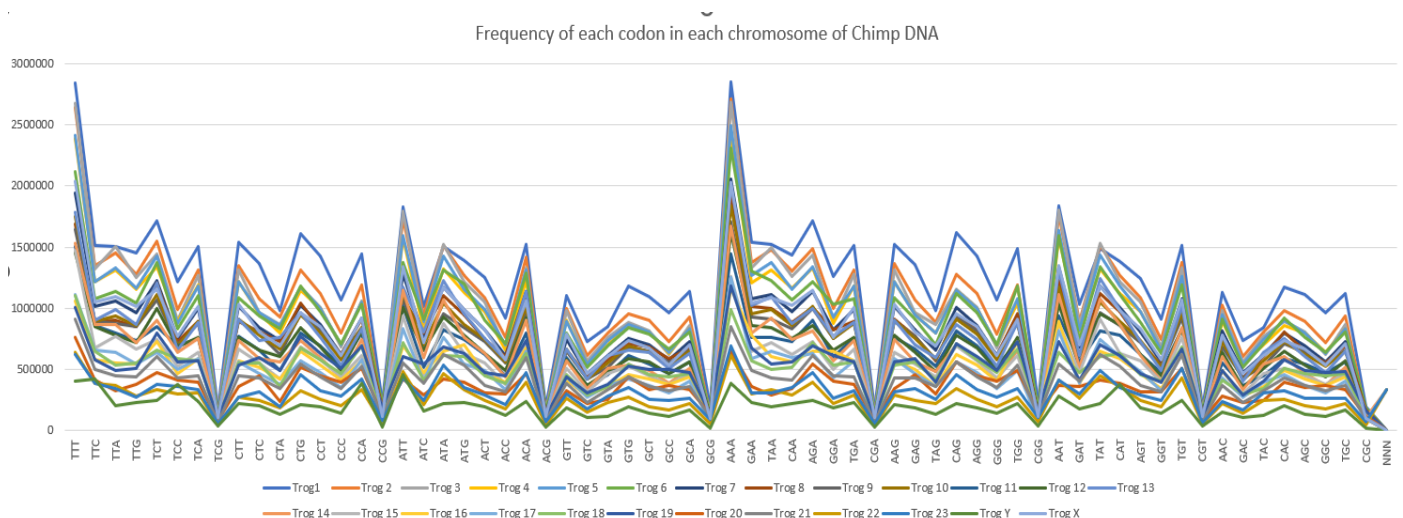
When the frequency of each codon is plotted on a graph, we get the chart shown below –



Observations.

1. The first 32 codons have frequencies that mirror the last 32 codons.
2. The frequencies repeat in octaves.
3. Within each octave, the first and seventh always form peaks.
4. There is a middle peak in each octave which occurs in positions 3, 4, or 5.
5. Codons ending in CG or beginning with CG have the lowest frequencies.

I repeated this with Pan Troglodytes (Chimpanzee). I counted the frequency of each codon in each chromosome. Here is the excel file for chimp data – <https://howbad.info/trog-all-codon-freq.xlsx> . Here are the results –



Observations

1. The same octave pattern is observed.
2. The frequencies of the first 32 codons mirror those of the last 32
3. The reflection between chromosomes is less perfect in chimps compared to humans. Observe how the chart for humans looks so orderly – with frequencies for different chromosomes rising and falling together. Such a synchrony is less with chimps, as can be seen in their chart.

Update

After writing this article, I came across a complete version of the human genome, with no un-sequenced areas. This version was only published in April 2022, so only a few years ago. So, I have repeated all of the calculations using this data instead of the previous version of the human genome. With the complete human genome, I should get more accurate results.

The data source for human chromosomes on NCBI is here - [Homo sapiens genome assembly T2T-CHM13v2.0 - NCBI - NLM](#)

I downloaded all of the chromosomes and used my software to count the frequency of each codon. I created a new spreadsheet that you can download here – <https://howbad.info/human-all-codon-freq-complete.xlsx>

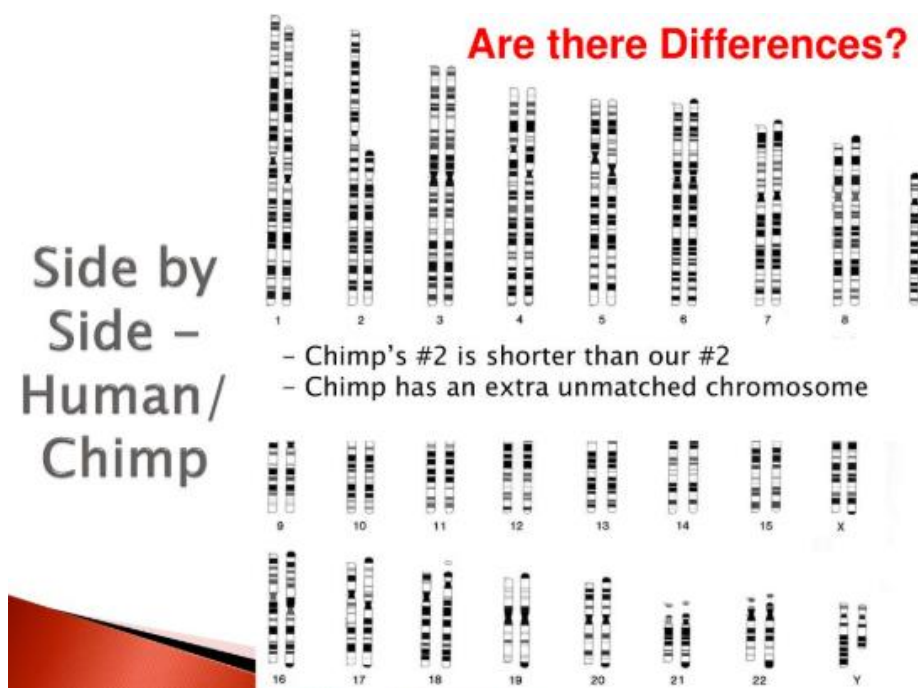
The Big Question – Are There Differences?

On this website - [Which Ape is Closest to Humans?](#) – it is claimed that our nearest relative is the Chimpanzee, and it is claimed that we are 98-99% identical in DNA. However, this calculation was based on false premises because –

1. It only compared protein coding regions, and ignored everything else. (It is estimated that 99% of DNA is non-coding - [Non-coding DNA - Wikipedia](#))
2. These conclusions were reached BEFORE the complete genomes of chimpanzees and humans became available in 2005

Since the complete genomes became available in 2005, the estimate of similarity has been lowered substantially.

[Differences between human and chimpanzee genomes and their implications in gene expression, protein functions and biochemical properties of the two species | BMC Genomics | Full Text](#)



You will be surprised at the answer to this question. It lies hidden in the non-coding regions.

Though the black bands are suggestive, and very useful for matching the chromosomes between man and chimp, the black bands are only the genes, that account for a mere 2% of the entire chromosome. In the pages that follow, I will be analyzing ALL of the non-coding regions covering the remaining 98% of each chromosome, to see how much DNA we really share with our chimp neighbors.

Comparing Absolute Frequencies of Each Codon between Monkey and Man

Before embarking upon this journey, I must specify which human chromosomes match each chimp chromosome. Initially I considered several possible approaches to doing this –

1. Examining the shapes of the chromosomes using graphical system (see [monkey-man.pdf](#))
2. Identify matching chromosomes by their banded patterns
3. Identify matching chromosomes by the genes they contain
4. Identifying matching chromosomes by looking at non-coding DNA sequences using BLASTn
5. Identify matching chromosomes by their size (see [man-beast.pdf](#))

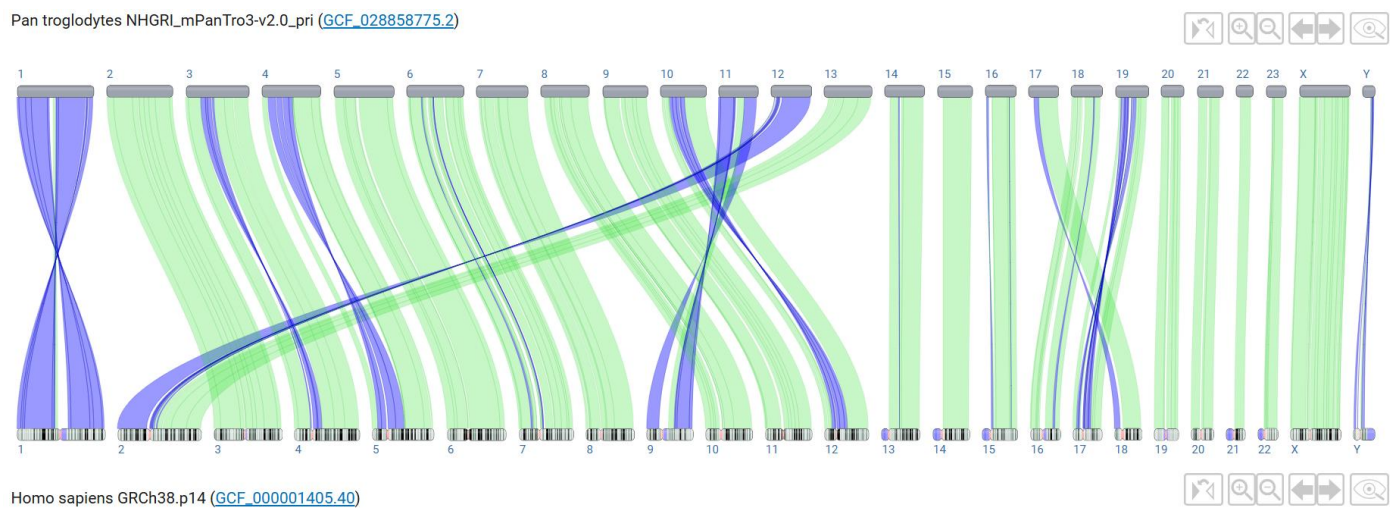
However, the matching has been done for us. Here is a useful table for matching human and chimp chromosomes –

Reference: [Pan troglodytes chromosome name table](#)

Human Chromosome Designations	NEW Chimpanzee Chromosome Designations	Original Chimpanzee Chromosome Designations
1	1	1
2p-q13	2A	12
2q14-qter	2B	13
3	3	2
4	4	3
5	5	4
6	6	5
7	7	6
8	8	7
9	9	11
10	10	8
11	11	9
12	12	10
13	13	14
14	14	15
15	15	16
16	16	18
17	17	19
18	18	17
19	19	20
20	20	21
21	21	22

22	22	23
X	X	X
Y	Y	Y

And here is the output from the Comparative Genome Viewer, showing the mapping between human and chimp chromosomes. Great!



Comparative Genome Viewer - NHGRI_mPanTro3-v2.0_pri vs GRCh38.p14

All of this mapping is one-to-one, with the exception of chromosome 2, which maps onto 2 chimp chromosomes. So, now we are ready to go. Having determined which human chromosomes map to which chimp chromosomes, we can now proceed to compare the codon counts between matching chromosomes.

At this point I should apologize for my mistake in my first analysis of these chromosomes, where I mistakenly assumed that matching chromosomes were simply identified by their number. As you can see in the diagram above, this is not the case.

Comparing whole Genomes

Initially, I summed the frequency of each of the 64 codons for the entire genome or both chimp and human – and I compared these.

I found that all the differences summed to 33,658,984 codon changes – equivalent to about 3.24% of the entire human genome.

As you will see later, the differences for individual chromosomes are much bigger because when we combine all chromosomes, we end up cancelling lower counts in one chromosome with higher counts in another. Still, it is useful to see an overview.

Codon	Human	Chimp	Diff	Abs	Percent
TCG	2957238.00	2422128.00	535110.00	535110.00	18.09
CGA	2932297.00	2426634.00	505663.00	505663.00	17.24
GAA	22451798.00	21478474.00	973324.00	973324.00	4.34
GGA	17492540.00	16787382.00	705158.00	705158.00	4.03
TTC	21924111.00	21162015.00	762096.00	762096.00	3.48
ATT	27086646.00	26281895.00	804751.00	804751.00	2.97
AAT	27494873.00	26776597.00	718276.00	718276.00	2.61
TGA	20355922.00	19943030.00	412892.00	412892.00	2.03
TCC	16904605.00	16581139.00	323466.00	323466.00	1.91
TTG	19694921.00	19337145.00	357776.00	357776.00	1.82
TGG	20087939.00	19761948.00	325991.00	325991.00	1.62
TCA	20386919.00	20072538.00	314381.00	314381.00	1.54
GAC	9609627.00	9515089.00	94538.00	94538.00	0.98
CTT	20325696.00	20130627.00	195069.00	195069.00	0.96
CGT	2788959.00	2762784.00	26175.00	26175.00	0.94
GAG	17133394.00	17015290.00	118104.00	118104.00	0.69
ATG	20341522.00	20202430.00	139092.00	139092.00	0.68
ACG	2797133.00	2784005.00	13128.00	13128.00	0.47
AGG	17850335.00	17777614.00	72721.00	72721.00	0.41
AAG	20244452.00	20165139.00	79313.00	79313.00	0.39
CTC	17281707.00	17250621.00	31086.00	31086.00	0.18
AGT	16507212.00	16482068.00	25144.00	25144.00	0.15
GGG	13191929.00	13172059.00	19870.00	19870.00	0.15
GCA	14696580.00	14678662.00	17918.00	17918.00	0.12
GTC	9611218.00	9611310.00	-92.00	92.00	0.00
CAA	19535010.00	19565464.00	-30454.00	30454.00	-0.16
ACT	16577802.00	16621007.00	-43205.00	43205.00	-0.26
CCC	13193429.00	13235714.00	-42285.00	42285.00	-0.32
TGC	14691885.00	14755535.00	-63650.00	63650.00	-0.43
CCT	17806709.00	17900855.00	-94146.00	94146.00	-0.53
GAT	14157054.00	14260524.00	-103470.00	103470.00	-0.73
GGC	11827722.00	11921726.00	-94004.00	94004.00	-0.79
CCA	19561797.00	19784840.00	-223043.00	223043.00	-1.14
AGC	13926143.00	14110283.00	-184140.00	184140.00	-1.32
TTT	38974459.00	39518845.00	-544386.00	544386.00	-1.40
CGG	3064071.00	3113227.00	-49156.00	49156.00	-1.60
GGT	11667593.00	11914906.00	-247313.00	247313.00	-2.12

GTT	14999288.00	15320004.00	-320716.00	320716.00	-2.14
TTA	20787915.00	21233431.00	-445516.00	445516.00	-2.14
GTG	15405093.00	15738863.00	-333770.00	333770.00	-2.17
CAG	20383007.00	20837035.00	-454028.00	454028.00	-2.23
AGA	22563834.00	23102472.00	-538638.00	538638.00	-2.39
GCC	11814893.00	12111959.00	-297066.00	297066.00	-2.51
TAG	13092546.00	13434993.00	-342447.00	342447.00	-2.62
CAT	20065144.00	20595189.00	-530045.00	530045.00	-2.64
GCT	13905798.00	14285899.00	-380101.00	380101.00	-2.73
TAA	20844418.00	21721373.00	-876955.00	876955.00	-4.21
AAA	39049989.00	40795968.00	-1745979.00	1745979.00	-4.47
CTG	20397132.00	21313712.00	-916580.00	916580.00	-4.49
AAC	15095111.00	15819736.00	-724625.00	724625.00	-4.80
GCG	2532734.00	2655259.00	-122525.00	122525.00	-4.84
ACC	11662040.00	12384461.00	-722421.00	722421.00	-6.19
CAC	15301810.00	16285801.00	-983991.00	983991.00	-6.43
TCT	22726401.00	24195644.00	-1469243.00	1469243.00	-6.46
TGT	20720653.00	22132799.00	-1412146.00	1412146.00	-6.82
ATC	14182474.00	15248792.00	-1066318.00	1066318.00	-7.52
GTA	11695469.00	12638938.00	-943469.00	943469.00	-8.07
ATA	21872332.00	23937974.00	-2065642.00	2065642.00	-9.44
CTA	13039756.00	14301957.00	-1262201.00	1262201.00	-9.68
ACA	20641555.00	22738737.00	-2097182.00	2097182.00	-10.16
TAT	21787661.00	24035805.00	-2248144.00	2248144.00	-10.32
TAC	11658061.00	12907844.00	-1249783.00	1249783.00	-10.72
CCG	3013606.00	3387636.00	-374030.00	374030.00	-12.41
CGC	2505488	2950525.00	-445037.00	445037.00	-17.76

Total Codons 1038877455.00

Total Differences 33658984.00

Percentage Difference 3.239937862

In the pages that follow, I analyse each chromosome. Here is a preview summary of the differences between each human chromosome and each chimp chromosome. In most cases the maximum % of codons changed is the same as the minimum, except in those few instances where the chimpanzee chromosome contains small un-sequenced regions – these are highlighted in green.

Chimp Chromosome	Human Chromosome	Minimum % of codons changed	Maximum % of codons changed
1	1 complete	6.87	6.87
2	3 complete	1.23	1.23
3	4 complete	1.40	1.40
4	5 complete	1.69	1.69
5	6 complete	6.49	6.49
6	7 complete	8.83	8.83
7	8 complete	6.44	6.44
8	10 complete	8.63	8.63
9	11 complete	2.26	2.26
10	12 complete	5.18	5.18
11	9 complete	21.08	21.08
12 / 13	2 complete	10.13	10.13
14	13 complete	4.62	6.30
15	14 complete	4.82	6.80
16	15 complete	12.65	12.65
17	18 complete	10.24	12.72
18	16 complete	11.99	11.99
19	17 complete	18.23	18.23
20	19 complete	10.79	10.79
21	20 complete	17.97	17.97
22	21 complete	12.07	16.15
23	22 complete	15.64	19.54
Y	Y complete	45.86	45.86
X	X complete	0.56	0.56

High scores are highlighted.

Chimp chromosomes with small un-sequenced regions. Only these chimp chromosomes have un-sequenced areas – totalling 333301 codons.

Human chromosomes are fully sequenced.

The % is the percent of all codons within the human chromosome that are changed when we go from chimpanzee to human.

As you can see –

- the percentage exceeds 10% for 11 human chromosomes!
- The percentage exceeds 6% for 16 human chromosomes.

This represents a substantial change in codon usage, that is concentrated in the non-coding areas of DNA

This is what we might expect if two species used common building blocks (the proteins coded by the coding regions) but organized these blocks in different ways (the regulatory sequences in the non-coding regions).

Chimp Chromosome 1

Chimp chromosome 1 is matched with human chromosome 1 - (complete human genome 2022)

Absolute Differences require **5,688,072** codon changes.

Codon	Human 1	Chimp 1	Number of Differences	Absolute Differences	% Difference
TTT	2892809	2846390	46419	46419	1.60463411
TTC	1590591	1517001	73590	73590	4.62658219
TTA	1571356	1509074	62282	62282	3.96358305
TTG	1532659	1452227	80432	80432	5.24787314
TCT	1779316	1717697	61619	61619	3.46307233
TCC	1277837	1215206	62631	62631	4.90132936
TCA	1776360	1504231	272129	272129	15.3194735
TCG	364316	181178	183138	183138	50.2689972
CTT	1575616	1539579	36037	36037	2.28716895
CTC	1416665	1361821	54844	54844	3.87134573
CTA	1014924	980480	34444	34444	3.39375165
CTG	1641845	1610930	30915	30915	1.88294267
CCT	1452177	1425956	26221	26221	1.80563389
CCC	1090141	1067691	22450	22450	2.05936663
CCA	1504587	1443449	61138	61138	4.06344067
CCG	245443	227800	17643	17643	7.188227
ATT	1980217	1832979	147238	147238	7.43544773
ATC	1421605	1013198	408407	408407	28.7285849
ATA	1549602	1502806	46796	46796	3.0198722
ATG	1714419	1391956	322463	322463	18.8088793
ACT	1293918	1253760	40158	40158	3.10359698
ACC	941127	917734	23393	23393	2.4856369
ACA	1571768	1524711	47057	47057	2.99388968
ACG	233373	195982	37391	37391	16.0219905
GTT	1136940	1105351	31589	31589	2.77842278
GTC	776756	729550	47206	47206	6.07732673
GTA	876158	849952	26206	26206	2.99101304
GTG	1211750	1179439	32311	32311	2.66647411
GCT	1121130	1098709	22421	22421	1.99985729
GCC	979740	963563	16177	16177	1.65115235
GCA	1166206	1135931	30275	30275	2.59602506
GCG	203647	191489	12158	12158	5.9701346
AAA	2993810	2849292	144518	144518	4.82722684
GAA	2062492	1543756	518736	518736	25.1509339
TAA	1578973	1522646	56327	56327	3.56731876
CAA	1542665	1432747	109918	109918	7.12520217
AGA	1784742	1711468	73274	73274	4.10557941
GGA	1552792	1264775	288017	288017	18.548331
TGA	1622685	1513598	109087	109087	6.72262331
CGA	361728	175781	185947	185947	51.4051995
AAG	1581265	1527184	54081	54081	3.42010985
GAG	1393016	1355542	37474	37474	2.69013421
TAG	1016471	985493	30978	30978	3.04760293
CAG	1651263	1619112	32151	32151	1.94705507
AGG	1457355	1426569	30786	30786	2.11245716

GGG	1087392	1071661	15731	15731	1.44667241
TGG	1755228	1488146	267082	267082	15.2163708
CGG	261432	227779	33653	33653	12.8725634
AAT	2418384	1838754	579630	579630	23.9676577
GAT	1080139	1031434	48705	48705	4.50914188
TAT	1550532	1488272	62260	62260	4.01539601
CAT	1612385	1380126	232259	232259	14.4046862
AGT	1281289	1242461	38828	38828	3.03038581
GGT	938513	913194	25319	25319	2.69777829
TGT	1566181	1515104	51077	51077	3.26124503
CGT	214203	196720	17483	17483	8.16188382
AAC	1187626	1134115	53511	53511	4.50571139
GAC	783742	734814	48928	48928	6.24287074
TAC	861744	844234	17510	17510	2.03192595
CAC	1208484	1177400	31084	31084	2.57214825
AGC	1123235	1109030	14205	14205	1.26465076
GGC	980028	964391	15637	15637	1.59556666
TGC	1156205	1122069	34136	34136	2.95241761
CGC	208828	196266	12562	12562	6.01547685
	82779825			5688072	

The codon changes between chimp and human amount to -

6.87% of Human Chromosome 1

Chimp Chromosome 2

Chimp chromosome 2 is matched with human chromosome 3 – (complete human genome 2022)

Absolute Differences require **825,614** mutations.

Codon	Human 3	Chimp 2	Number of Differences	Absolute Differences	% Difference
TTT	2648810	2641889	6921	6921	0.26128714
TTC	1355814	1345230	10584	10584	0.78063805
TTA	1471643	1454843	16800	16800	1.14158121
TTG	1278006	1276114	1892	1892	0.14804312
TCT	1493878	1546951	-53073	53073	-3.55269975
TCC	988787	992190	-3403	3403	-0.34415906
TCA	1331612	1312702	18910	18910	1.42008333
TCG	128979	131414	-2435	2435	-1.88790423
CTT	1347117	1348744	-1627	1627	-0.12077644
CTC	1065346	1076697	-11351	11351	-1.06547544
CTA	896486	931780	-35294	35294	-3.93692707
CTG	1300690	1315960	-15270	15270	-1.17399227
CCT	1120573	1125125	-4552	4552	-0.40622075
CCC	796904	793734	3170	3170	0.39778945
CCA	1184284	1189494	-5210	5210	-0.43992826
CCG	149948	166636	-16688	16688	-11.1291915
ATT	1755616	1733867	21749	21749	1.23882444
ATC	913321	948251	-34930	34930	-3.8245042
ATA	1560618	1510232	50386	50386	3.22859278
ATG	1250155	1265951	-15796	15796	-1.26352332
ACT	1104588	1090511	14077	14077	1.27441182
ACC	752655	763946	-11291	11291	-1.50015611
ACA	1383869	1414466	-30597	30597	-2.21097517
ACG	153510	154383	-873	873	-0.56869259
GTT	1000732	997499	3233	3233	0.32306352
GTC	609319	614716	-5397	5397	-0.88574294
GTA	816056	797177	18879	18879	2.31344418
GTG	954219	954297	-78	78	-0.00817422
GCT	890078	905072	-14994	14994	-1.68457146
GCC	713155	727322	-14167	14167	-1.98652467
GCA	922597	927877	-5280	5280	-0.57229755
GCG	128537	130182	-1645	1645	-1.27978714
AAA	2731484	2710529	20955	20955	0.76716539
GAA	1360467	1375330	-14863	14863	-1.0924925
TAA	1464131	1479494	-15363	15363	-1.04929135
CAA	1323755	1301432	22323	22323	1.68633924
AGA	1492461	1490092	2369	2369	0.15873112
GGA	982533	1002417	-19884	19884	-2.02374882
TGA	1322170	1316538	5632	5632	0.4259664
CGA	132057	133778	-1721	1721	-1.30322512
AAG	1386746	1363086	23660	23660	1.70615239
GAG	1066363	1065740	623	623	0.05842288
TAG	890161	884908	5253	5253	0.59011797
CAG	1276175	1282917	-6742	6742	-0.52829745
AGG	1127880	1124945	2935	2935	0.26022272

GGG	785369	792950	-7581	7581	-0.96527874
TGG	1168170	1194124	-25954	25954	-2.22176567
CGG	147204	150508	-3304	3304	-2.24450423
AAT	1770778	1767494	3284	3284	0.18545521
GAT	894972	895146	-174	174	-0.01944195
TAT	1552539	1518753	33786	33786	2.17617722
CAT	1258220	1273908	-15688	15688	-1.24684078
AGT	1111064	1090060	21004	21004	1.89044015
GGT	746152	743465	2687	2687	0.36011429
TGT	1366630	1373953	-7323	7323	-0.53584364
CGT	150958	151545	-587	587	-0.38884988
AAC	994355	1023926	-29571	29571	-2.9738876
GAC	603518	605535	-2017	2017	-0.3342071
TAC	833005	809790	23215	23215	2.78689804
CAC	962931	984957	-22026	22026	-2.28739131
AGC	890887	893563	-2676	2676	-0.3003748
GGC	713507	718879	-5372	5372	-0.75290081
TGC	925174	934114	-8940	8940	-0.96630472
CGC	129155	146705	-17550	17550	-13.5883241
67028873		825614			
0.012317289					

The codon changes between chimp and human amount to -

1.23 %

Chimp Chromosome 3

Chimp chromosome 3 maps on to human chromosome 4 – (complete human genome 2022)

Absolute Differences require 901,188.

Codon	Human 4	Chimp 3	Number of Differences	Absolute Differences	% Difference
TTT	2746874	2674890	71984	71984	2.62057888
TTC	1334125	1324183	9942	9942	0.74520753
TTA	1515157	1508172	6985	6985	0.46100833
TTG	1300758	1253973	46785	46785	3.59674897
TCT	1437329	1445430	-8101	8101	-0.56361487
TCC	900940	907035	-6095	6095	-0.67651564
TCA	1276105	1268983	7122	7122	0.55810454
TCG	123765	121619	2146	2146	1.73393124
CTT	1343041	1309432	33609	33609	2.50245525
CTC	971894	968238	3656	3656	0.37617271
CTA	869191	871020	-1829	1829	-0.21042556
CTG	1153878	1169884	-16006	16006	-1.38714838
CCT	1005663	1004167	1496	1496	0.14875759
CCC	674417	680164	-5747	5747	-0.85214341
CCA	1054416	1063286	-8870	8870	-0.84122396
CCG	132787	133931	-1144	1144	-0.86153012
ATT	1824809	1793073	31736	31736	1.73914092
ATC	876385	880243	-3858	3858	-0.44021748
ATA	1605634	1525509	80125	80125	4.99024062
ATG	1229772	1218802	10970	10970	0.89203527
ACT	1077242	1050125	27117	27117	2.51726167
ACC	676944	675129	1815	1815	0.26811671
ACA	1351875	1332292	19583	19583	1.44858067
ACG	142720	144718	-1998	1998	-1.39994395
GTT	985935	982835	3100	3100	0.31442235
GTC	562092	569697	-7605	7605	-1.35298136
GTA	810012	766507	43505	43505	5.37090809
GTG	890607	886781	3826	3826	0.42959465
GCT	809535	814378	-4843	4843	-0.59824467
GCC	615020	619628	-4608	4608	-0.74924393
GCA	865367	861756	3611	3611	0.41727961
GCG	116042	113649	2393	2393	2.06218438
AAA	2680412	2689253	-8841	8841	-0.32983735
GAA	1337513	1334944	2569	2569	0.1920729
TAA	1515943	1500368	15575	15575	1.0274133
CAA	1239527	1258290	-18763	18763	-1.51372257
AGA	1440342	1437086	3256	3256	0.22605742
GGA	917787	893041	24746	24746	2.69626831
TGA	1289923	1280211	9712	9712	0.75291316
CGA	118903	121860	-2957	2957	-2.48690109
AAG	1307145	1317031	-9886	9886	-0.75630477
GAG	967934	966044	1890	1890	0.19526125
TAG	880737	864842	15895	15895	1.80473853
CAG	1179924	1156328	23596	23596	1.99978982
AGG	1005832	1006253	-421	421	-0.0418559

GGG	686421	678191	8230	8230	1.19897264
TGG	1080577	1056888	23689	23689	2.19225469
CGG	136498	132340	4158	4158	3.04619848
AAT	1804990	1800337	4653	4653	0.25778536
GAT	895591	871655	23936	23936	2.67264856
TAT	1593896	1531548	62348	62348	3.91167303
CAT	1248284	1219071	29213	29213	2.3402527
AGT	1067789	1053531	14258	14258	1.33528253
GGT	687797	680150	7647	7647	1.11181061
TGT	1349882	1331191	18691	18691	1.38463955
CGT	143931	141989	1942	1942	1.34925763
AAC	987098	978316	8782	8782	0.88967863
GAC	564443	561262	3181	3181	0.56356443
TAC	810733	772643	38090	38090	4.69821754
CAC	883310	893005	-9695	9695	-1.09757616
AGC	819291	809268	10023	10023	1.22337484
GGC	615859	619285	-3426	3426	-0.55629617
TGC	858916	864767	-5851	5851	-0.68120748
CGC	115634	118692	-3058	3058	-2.64455091
64513193			901188		
0.01396905					

The codon changes between chimp and human amount to -

1.40%

Chimp Chromosome 4

Chimp chromosome 4 maps on to human chromosome 5 – (complete human genome 2022)

Absolute Differences require **1,025,016** codon changes.

Codon	Human 5	Chimp 4	Number of Differences	Absolute Differences	% Difference
TTT	2456349	2388659	67690	67690	2.7557159
TTC	1269493	1220773	48720	48720	3.83775255
TTA	1328816	1316596	12220	12220	0.91961566
TTG	1190367	1152940	37427	37427	3.14415638
TCT	1361137	1341459	19678	19678	1.44570311
TCC	909419	892114	17305	17305	1.90286326
TCA	1210103	1187028	23075	23075	1.90686247
TCG	124460	117444	7016	7016	5.6371525
CTT	1249929	1213086	36843	36843	2.94760742
CTC	971819	953959	17860	17860	1.83779078
CTA	802226	800592	1634	1634	0.20368325
CTG	1155713	1151205	4508	4508	0.39006224
CCT	1013484	996263	17221	17221	1.69918815
CCC	706283	702288	3995	3995	0.56563729
CCA	1062120	1049948	12172	12172	1.14600987
CCG	138251	136994	1257	1257	0.90921585
ATT	1618330	1577291	41039	41039	2.53588576
ATC	817043	812478	4565	4565	0.55872212
ATA	1337509	1318539	18970	18970	1.41830821
ATG	1131940	1127652	4288	4288	0.37881867
ACT	996428	973246	23182	23182	2.32651029
ACC	663848	661208	2640	2640	0.3976814
ACA	1241003	1224426	16577	16577	1.33577437
ACG	142014	138756	3258	3258	2.29414001
GTT	925132	900285	24847	24847	2.68577889
GTC	549743	547193	2550	2550	0.46385311
GTA	711184	698260	12924	12924	1.81725123
GTG	886859	859040	27819	27819	3.13680078
GCT	805072	804883	189	189	0.02347616
GCC	641708	633720	7988	7988	1.24480293
GCA	843522	834232	9290	9290	1.10133464
GCG	122840	119746	3094	3094	2.51872354
AAA	2420104	2387740	32364	32364	1.3372979
GAA	1242569	1211864	30705	30705	2.47109014
TAA	1329724	1309650	20074	20074	1.50963659
CAA	1170618	1164808	5810	5810	0.49631904
AGA	1374501	1334695	39806	39806	2.89603281
GGA	895862	877273	18589	18589	2.07498476
TGA	1198484	1181710	16774	16774	1.3996015
CGA	120794	118560	2234	2234	1.84942961
AAG	1231277	1220199	11078	11078	0.89971631
GAG	964967	948031	16936	16936	1.75508593
TAG	807284	794522	12762	12762	1.5808563
CAG	1172833	1143573	29260	29260	2.49481384
AGG	1009351	997502	11849	11849	1.17392265

GGG	707467	703018	4449	4449	0.62886325
TGG	1060200	1040407	19793	19793	1.8669119
CGG	139959	137139	2820	2820	2.01487579
AAT	1592704	1575122	17582	17582	1.10390882
GAT	826102	812449	13653	13653	1.65270148
TAT	1337293	1324023	13270	13270	0.99230311
CAT	1148850	1121253	27597	27597	2.40214127
AGT	993543	975753	17790	17790	1.79056166
GGT	670180	659292	10888	10888	1.62463816
TGT	1262872	1229960	32912	32912	2.60612319
CGT	145920	139246	6674	6674	4.57373904
AAC	917178	892735	24443	24443	2.66502249
GAC	553654	543416	10238	10238	1.84916934
TAC	702131	699070	3061	3061	0.43595853
CAC	872961	860778	12183	12183	1.39559499
AGC	805993	796926	9067	9067	1.12494774
GGC	642683	636646	6037	6037	0.93934335
TGC	846680	835569	11111	11111	1.31230217
CGC	120911	119545	1366	1366	1.1297566
60669793			1025016		
0.016894997					

The codon changes between chimp and human amount to -

1.69%

Chimp Chromosome 5

Chimp chromosome 5 maps on to human chromosome 6 – (complete human genome 2022)

Absolute Differences require **3,724,328** codon changes.

Codon	Human 6	Chimp 5	Number of Differences	Absolute Differences	% Difference
TTT	2320185	2413059	-92874	92874	-4.00287046
TTC	1175788	1213603	-37815	37815	-3.21614101
TTA	1256434	1327182	-70748	70748	-5.63085685
TTG	1122561	1161839	-39278	39278	-3.49896353
TCT	1289415	1423470	-134055	134055	-10.3965752
TCC	846694	880204	-33510	33510	-3.95774625
TCA	1133322	1184870	-51548	51548	-4.54839843
TCG	119019	124971	-5952	5952	-5.00088221
CTT	1182982	1215614	-32632	32632	-2.75845279
CTC	923644	960711	-37067	37067	-4.01312627
CTA	760030	861627	-101597	101597	-13.3674987
CTG	1091574	1175361	-83787	83787	-7.6757966
CCT	969611	1002059	-32448	32448	-3.34649669
CCC	673425	699803	-26378	26378	-3.9169915
CCA	995718	1051471	-55753	55753	-5.5992761
CCG	136205	168534	-32329	32329	-23.7355457
ATT	1511874	1589636	-77762	77762	-5.14341804
ATC	770202	890346	-120144	120144	-15.5990247
ATA	1263357	1426744	-163387	163387	-12.9327656
ATG	1064151	1159017	-94866	94866	-8.91471229
ACT	938657	987530	-48873	48873	-5.20669425
ACC	642427	699809	-57382	57382	-8.93206543
ACA	1171031	1313667	-142636	142636	-12.1803778
ACG	138184	145999	-7815	7815	-5.65550281
GTT	860187	897585	-37398	37398	-4.34765929
GTC	520279	545649	-25370	25370	-4.87622987
GTA	675067	738740	-63673	63673	-9.43210081
GTG	836104	864188	-28084	28084	-3.35891229
GCT	757623	806762	-49139	49139	-6.48594354
GCC	610155	640710	-30555	30555	-5.00774393
GCA	802323	835020	-32697	32697	-4.07529137
GCG	123519	126272	-2753	2753	-2.2288069
AAA	2301984	2497360	-195376	195376	-8.48728749
GAA	1182174	1268674	-86500	86500	-7.31702778
TAA	1259505	1374846	-115341	115341	-9.15764527
CAA	1098745	1159558	-60813	60813	-5.53476921
AGA	1297650	1336324	-38674	38674	-2.98031056
GGA	862003	931062	-69059	69059	-8.01145704
TGA	1136030	1182958	-46928	46928	-4.13087683
CGA	117925	126914	-8989	8989	-7.62264151
AAG	1168467	1214408	-45941	45941	-3.93173277
GAG	924629	945817	-21188	21188	-2.29151368
TAG	772470	797802	-25332	25332	-3.27935065

CAG	1103126	1144480	-41354	41354	-3.74880113
AGG	959022	997737	-38715	38715	-4.03692512
GGG	675657	699990	-24333	24333	-3.60138354
TGG	1007160	1081589	-74429	74429	-7.38998769
CGG	139703	141856	-2153	2153	-1.54112653
AAT	1500639	1632891	-132252	132252	-8.81304564
GAT	783670	820067	-36397	36397	-4.64442942
TAT	1259614	1431694	-172080	172080	-13.661328
CAT	1066859	1181179	-114320	114320	-10.7155678
AGT	938512	976049	-37537	37537	-3.9996292
GGT	635201	660114	-24913	24913	-3.92206561
TGT	1181013	1257387	-76374	76374	-6.46682128
CGT	139045	146236	-7191	7191	-5.171707
AAC	871791	950763	-78972	78972	-9.05859317
GAC	526248	542698	-16450	16450	-3.12590262
TAC	665347	749529	-84182	84182	-12.6523453
CAC	825030	902733	-77703	77703	-9.41820297
AGC	767985	796773	-28788	28788	-3.74851071
GGC	608889	629559	-20670	20670	-3.39470741
TGC	794167	834736	-40569	40569	-5.10837141
CGC	119450	149950	-30500	30500	-25.5336961
	57371457			3724328	
				0.064916044	

The codon changes between chimp and human amount to -

6.49%

Chimp Chromosome 6

Chimp chromosome 6 maps on to human chromosome 7 – (complete human genome 2022)

Absolute Differences require 4,724,126 codon changes.

Codon	Human 7	Chimp 6	Number of Differences	Absolute Differences	% Difference
TTT	2107075	2118836	-11761	11761	-0.55816713
TTC	1089759	1074516	15243	15243	1.39874963
TTA	1104296	1137124	-32828	32828	-2.97275368
TTG	1029250	1041890	-12640	12640	-1.2280787
TCT	1184315	1376134	-191819	191819	-16.19662
TCC	819137	834409	-15272	15272	-1.86440119
TCA	1065782	1100527	-34745	34745	-3.26004755
TCG	126245	130616	-4371	4371	-3.46231534
CTT	1076403	1087188	-10785	10785	-1.00194816
CTC	898715	936879	-38164	38164	-4.24650751
CTA	678784	831705	-152921	152921	-22.5286689
CTG	1060848	1178808	-117960	117960	-11.1194064
CCT	934451	969902	-35451	35451	-3.79377838
CCC	677000	713372	-36372	36372	-5.37252585
CCA	979939	1034531	-54592	54592	-5.57095901
CCG	150130	211455	-61325	61325	-40.8479318
ATT	1365180	1373855	-8675	8675	-0.63544734
ATC	709588	910555	-200967	200967	-28.3216458
ATA	1098039	1315506	-217467	217467	-19.8050342
ATG	973785	1196756	-222971	222971	-22.8973541
ACT	860025	899183	-39158	39158	-4.55312346
ACC	613750	713983	-100233	100233	-16.3312424
ACA	1078258	1284819	-206561	206561	-19.1569179
ACG	142223	155709	-13486	13486	-9.48229189
GTT	788266	794281	-6015	6015	-0.76306729
GTC	495724	520659	-24935	24935	-5.0300167
GTA	603668	694814	-91146	91146	-15.0986966
GTG	816495	844209	-27714	27714	-3.39426451
GCT	734430	788215	-53785	53785	-7.32336642
GCC	626477	667053	-40576	40576	-6.4768539
GCA	767182	804681	-37499	37499	-4.8878884
GCG	133162	141064	-7902	7902	-5.93412535
AAA	2068544	2307049	-238505	238505	-11.5300907
GAA	1068678	1302123	-233445	233445	-21.8442786
TAA	1109400	1224864	-115464	115464	-10.407788
CAA	1011929	1069781	-57852	57852	-5.71700188
AGA	1196084	1221440	-25356	25356	-2.119918
GGA	833885	1035171	-201286	201286	-24.1383404
TGA	1042507	1076214	-33707	33707	-3.23326366
CGA	124261	140179	-15918	15918	-12.8101335
AAG	1053909	1088562	-34653	34653	-3.28804479
GAG	899930	911959	-12029	12029	-1.33665952
TAG	686141	705860	-19719	19719	-2.8738991
CAG	1082252	1123015	-40763	40763	-3.76649801
AGG	927066	960665	-33599	33599	-3.62422956

GGG	679150	703978	-24828	24828	-3.65574615
TGG	979247	1183489	-204242	204242	-20.8570463
CGG	153519	164954	-11435	11435	-7.44858943
AAT	1339596	1594502	-254906	254906	-19.0285728
GAT	722764	745020	-22256	22256	-3.07929006
TAT	1097079	1337721	-240642	240642	-21.9347923
CAT	989006	1113085	-124079	124079	-12.5458288
AGT	865927	882385	-16458	16458	-1.90062211
GGT	604863	629974	-25111	25111	-4.15151861
TGT	1089072	1193830	-104758	104758	-9.61901509
CGT	143983	149173	-5190	5190	-3.60459221
AAC	793409	913680	-120271	120271	-15.1587643
GAC	500990	516450	-15460	15460	-3.08588994
TAC	593964	708741	-114777	114777	-19.3238984
CAC	807992	918939	-110947	110947	-13.7312003
AGC	732715	764217	-31502	31502	-4.29935241
GGC	621964	643052	-21088	21088	-3.39054994
TGC	776203	810874	-34671	34671	-4.46674388
CGC	129671	183541	-53870	53870	-41.5435988
53514081		4724126			
0.088278186					

The codon changes between chimp and human amount to -

8.83%

Chimp Chromosome 7

Chimp chromosome 7 maps on to human chromosome 8 – (complete human genome 2022)

Absolute Differences require 3,139,200 codon changes.

Codon	Human 8	Chimp 7	Number of Differences	Absolute Differences	% Difference
TTT	1907550	1946463	-38913	38913	-2.03994653
TTC	985558	1017737	-32179	32179	-3.26505391
TTA	1032824	1058691	-25867	25867	-2.50449254
TTG	944096	964912	-20816	20816	-2.20486052
TCT	1091551	1224777	-133226	133226	-12.2052016
TCC	735437	757723	-22286	22286	-3.03030715
TCA	963648	1002061	-38413	38413	-3.98620658
TCG	105701	114798	-9097	9097	-8.60635188
CTT	989708	1019048	-29340	29340	-2.96451074
CTC	795036	838174	-43138	43138	-5.42591782
CTA	636021	733245	-97224	97224	-15.2862877
CTG	956679	1028882	-72203	72203	-7.54725462
CCT	835435	867790	-32355	32355	-3.87283272
CCC	598765	624856	-26091	26091	-4.35746912
CCA	865862	921317	-55455	55455	-6.40460027
CCG	122366	161076	-38710	38710	-31.6346044
ATT	1251286	1278170	-26884	26884	-2.14850961
ATC	660201	775775	-115574	115574	-17.5058808
ATA	1036922	1174927	-138005	138005	-13.3091014
ATG	908843	986535	-77692	77692	-8.54845116
ACT	789594	826084	-36490	36490	-4.62136237
ACC	549734	613617	-63883	63883	-11.6207111
ACA	1001863	1138053	-136190	136190	-13.593675
ACG	124008	134277	-10269	10269	-8.28091736
GTT	720743	741340	-20597	20597	-2.85774541
GTC	453715	469826	-16111	16111	-3.55090751
GTA	559552	615281	-55729	55729	-9.9595748
GTG	724028	756369	-32341	32341	-4.4668162
GCT	663270	703184	-39914	39914	-6.01776049
GCC	538244	576415	-38171	38171	-7.09176507
GCA	699845	723690	-23845	23845	-3.40718302
GCG	106671	116278	-9607	9607	-9.00619662
AAA	1900110	2060320	-160210	160210	-8.43161712
GAA	996419	1077778	-81359	81359	-8.16513936
TAA	1033951	1115160	-81209	81209	-7.85424067
CAA	928336	972987	-44651	44651	-4.8097887
AGA	1092302	1135919	-43617	43617	-3.99312644
GGA	749512	821458	-71946	71946	-9.59904578
TGA	964964	987065	-22101	22101	-2.29034451
CGA	102329	115653	-13324	13324	-13.0207468
AAG	986668	1014551	-27883	27883	-2.82597591
GAG	796747	821557	-24810	24810	-3.11391194
TAG	638445	656707	-18262	18262	-2.86038735
CAG	968333	1005571	-37238	37238	-3.84557792
AGG	837382	859926	-22544	22544	-2.69220021

GGG	601499	615929	-14430	14430	-2.39900648
TGG	877459	945228	-67769	67769	-7.72332382
CGG	124694	136917	-12223	12223	-9.80239627
AAT	1244220	1337992	-93772	93772	-7.53660928
GAT	660925	685883	-24958	24958	-3.77622272
TAT	1038897	1185954	-147057	147057	-14.1551087
CAT	914868	1007303	-92435	92435	-10.1036434
AGT	787375	810567	-23192	23192	-2.94548341
GGT	549215	560605	-11390	11390	-2.07386907
TGT	996709	1079264	-82555	82555	-8.28275856
CGT	123979	133944	-9965	9965	-8.03765154
AAC	730382	813399	-83017	83017	-11.366244
GAC	456921	473007	-16086	16086	-3.52052105
TAC	556129	626313	-70184	70184	-12.6200935
CAC	722754	799458	-76704	76704	-10.6127396
AGC	671800	692800	-21000	21000	-3.12593034
GGC	540026	559740	-19714	19714	-3.65056497
TGC	694044	725351	-31307	31307	-4.51080911
CGC	106115	141788	-35673	35673	-33.617302
48748265		3139200			
0.064396138					

The codon changes between chimp and human amount to -

6.44%

Chimp Chromosome 8

Chimp chromosome 8 maps on to human chromosome 10 – (complete human genome 2022)

Absolute Differences require **3,877,003** codon changes.

Codon	Human 10	Chimp 8	Number of Differences	Absolute Differences	% Difference
TTT	1687533	1686667	866	866	0.05131751
TTC	898969	894162	4807	4807	0.53472367
TTA	885005	904526	-19521	19521	-2.20575025
TTG	854625	850118	4507	4507	0.5273658
TCT	993241	1210804	-217563	217563	-21.9043515
TCC	705532	730210	-24678	24678	-3.49778607
TCA	888948	897466	-8518	8518	-0.95821128
TCG	113501	112173	1328	1328	1.17003374
CTT	898767	896962	1805	1805	0.20083069
CTC	771204	809641	-38437	38437	-4.98402498
CTA	559197	724222	-165025	165025	-29.5110668
CTG	923329	1044508	-121179	121179	-13.124141
CCT	812685	831783	-19098	19098	-2.349988
CCC	604736	619182	-14446	14446	-2.38881099
CCA	836199	907846	-71647	71647	-8.56817576
CCG	128486	189583	-61097	61097	-47.5514842
ATT	1085262	1089701	-4439	4439	-0.40902565
ATC	601287	794651	-193364	193364	-32.1583537
ATA	867353	1100610	-233257	233257	-26.8929721
ATG	832073	945749	-113676	113676	-13.6617821
ACT	714954	749006	-34052	34052	-4.7628239
ACC	525770	609426	-83656	83656	-15.9111399
ACA	899903	1127709	-227806	227806	-25.3145061
ACG	121210	134070	-12860	12860	-10.6096857
GTT	650666	659679	-9013	9013	-1.38519609
GTC	427897	449037	-21140	21140	-4.94044127
GTA	494587	579162	-84575	84575	-17.100126
GTG	699143	712560	-13417	13417	-1.91906377
GCT	634192	685435	-51243	51243	-8.08004516
GCC	548813	590019	-41206	41206	-7.50820407
GCA	661010	679446	-18436	18436	-2.78906522
GCG	112135	117588	-5453	5453	-4.86288848
AAA	1667361	1922539	-255178	255178	-15.3043042
GAA	918090	1018103	-100013	100013	-10.8935943
TAA	886461	1001802	-115341	115341	-13.0114015
CAA	837757	881645	-43888	43888	-5.23875062
AGA	992166	1006398	-14232	14232	-1.43443738
GGA	737218	820617	-83399	83399	-11.3126646
TGA	872321	895666	-23345	23345	-2.67619374
CGA	110372	116621	-6249	6249	-5.66176204
AAG	884093	909806	-25713	25713	-2.90840443
GAG	772565	776062	-3497	3497	-0.452648
TAG	562922	570420	-7498	7498	-1.3319785
CAG	937110	950272	-13162	13162	-1.40453095

AGG	806680	821449	-14769	14769	-1.83083751
GGG	603797	614984	-11187	11187	-1.85277502
TGG	869948	954782	-84834	84834	-9.75161734
CGG	131483	137594	-6111	6111	-4.64774914
AAT	1104605	1225003	-120398	120398	-10.8996429
GAT	593251	612862	-19611	19611	-3.30568343
TAT	868018	1122761	-254743	254743	-29.3476633
CAT	825129	974648	-149519	149519	-18.1206817
AGT	717686	727634	-9948	9948	-1.38612151
GGT	518936	534880	-15944	15944	-3.07244053
TGT	908527	1006350	-97823	97823	-10.7672089
CGT	121720	127878	-6158	6158	-5.05915215
AAC	653271	766755	-113484	113484	-17.3716574
GAC	431231	434175	-2944	2944	-0.68269674
TAC	486138	609919	-123781	123781	-25.4621116
CAC	690784	808642	-117858	117858	-17.0614838
AGC	637223	649872	-12649	12649	-1.98501937
GGC	547299	557247	-9948	9948	-1.8176536
TGC	660543	693319	-32776	32776	-4.96197825
CGC	111947	170835	-58888	58888	-52.6034641
	44904864			3877003	
				0.086338153	

The codon changes between chimp and human amount to -

8.63%

Chimp Chromosome 9

Chimp chromosome 9 maps on top human chromosome 11 – (complete human genome)

Absolute Differences require **1,019,527** codon changes.

Codon	Human 11	Chimp 9	Number of Differences	Absolute Differences	% Difference
TTT	1660614	1645148	15466	15466	0.93134226
TTC	910054	890341	19713	19713	2.1661352
TTA	882072	879485	2587	2587	0.29328672
TTG	858068	848540	9528	9528	1.11040151
TCT	1016443	1070916	-54473	54473	-5.35917902
TCC	708875	703681	5194	5194	0.73271028
TCA	885032	877310	7722	7722	0.87251082
TCG	100654	100612	42	42	0.0417271
CTT	917017	901140	15877	15877	1.73137466
CTC	780138	785858	-5720	5720	-0.73320361
CTA	578344	621229	-42885	42885	-7.41513701
CTG	939603	954114	-14511	14511	-1.54437566
CCT	826144	822416	3728	3728	0.45125305
CCC	616480	614619	1861	1861	0.30187516
CCA	833276	843890	-10614	10614	-1.27376764
CCG	123205	142281	-19076	19076	-15.4831379
ATT	1086721	1073217	13504	13504	1.24263725
ATC	600886	654630	-53744	53744	-8.94412584
ATA	891458	956444	-64986	64986	-7.2898555
ATG	812043	843664	-31621	31621	-3.89400561
ACT	732919	724815	8104	8104	1.10571564
ACC	527986	551027	-23041	23041	-4.36394147
ACA	902734	954469	-51735	51735	-5.73092406
ACG	114820	114553	267	267	0.23253789
GTT	647945	645915	2030	2030	0.3132982
GTC	421762	424151	-2389	2389	-0.5664332
GTA	497976	518821	-20845	20845	-4.1859447
GTG	691035	683476	7559	7559	1.09386645
GCT	637802	645336	-7534	7534	-1.18124434
GCC	546688	551235	-4547	4547	-0.83173583
GCA	661772	658966	2806	2806	0.4240131
GCG	107837	108117	-280	280	-0.25965114
AAA	1656862	1709873	-53011	53011	-3.19948191
GAA	904821	927305	-22484	22484	-2.48491138
TAA	889018	915389	-26371	26371	-2.96630664
CAA	838135	836153	1982	1982	0.23647742
AGA	1012550	998799	13751	13751	1.35805639
GGA	731142	751073	-19931	19931	-2.72600945
TGA	885693	881351	4342	4342	0.49023759
CGA	99328	98141	1187	1187	1.19503061
AAG	894102	892344	1758	1758	0.19662186
GAG	779925	768391	11534	11534	1.47886015
TAG	581186	576498	4688	4688	0.80662645
CAG	938158	930302	7856	7856	0.8373856
AGG	819671	812952	6719	6719	0.81971913

GGG	622222	619335	2887	2887	0.46398231
TGG	855925	879161	-23236	23236	-2.71472384
CGG	130997	129318	1679	1679	1.28170874
AAT	1068106	1103238	-35132	35132	-3.28918665
GAT	611400	604469	6931	6931	1.13362774
TAT	885932	962457	-76525	76525	-8.63779613
CAT	822526	862320	-39794	39794	-4.83802336
AGT	716406	715365	1041	1041	0.14530867
GGT	526184	523352	2832	2832	0.53821477
TGT	903797	918963	-15166	15166	-1.67803168
CGT	111209	114734	-3525	3525	-3.16970749
AAC	665750	687796	-22046	22046	-3.31145325
GAC	433477	430210	3267	3267	0.75367321
TAC	493047	527836	-34789	34789	-7.05591962
CAC	680954	706320	-25366	25366	-3.72506807
AGC	641256	639532	1724	1724	0.26884739
GGC	549400	544545	4855	4855	0.8836913
TGC	656974	655856	1118	1118	0.17017416
CGC	106092	124103	-18011	18011	-16.9767749
45030648		1019527			

The codon changes between chimp and human amount to -

2.26% of human chromosome 11

Chimp Chromosome 10

Chimp chromosome 10 maps on to human chromosome 12 – (complete human genome 2022)

Absolute Differences require **2,303,493** codon changes.

Codon	Human 12	Chimp 10	Number of Differences	Absolute Differences	% Difference
TTT	1716819	1753968	-37149	37149	-2.1638274
TTC	886021	895662	-9641	9641	-1.08812319
TTA	921898	937321	-15423	15423	-1.67296165
TTG	840876	862276	-21400	21400	-2.54496501
TCT	1001466	1110594	-109128	109128	-10.8968253
TCC	693957	689737	4220	4220	0.60810684
TCA	867310	894091	-26781	26781	-3.08782327
TCG	96400	103886	-7486	7486	-7.76556017
CTT	889160	907252	-18092	18092	-2.03472941
CTC	758956	777491	-18535	18535	-2.44217056
CTA	578231	665976	-87745	87745	-15.1747312
CTG	898111	944784	-46673	46673	-5.19679639
CCT	786346	801856	-15510	15510	-1.97241418
CCC	569862	580145	-10283	10283	-1.80447196
CCA	817524	841673	-24149	24149	-2.9539194
CCG	121883	154174	-32291	32291	-26.4934404
ATT	1099451	1119772	-20321	20321	-1.8482861
ATC	601296	702209	-100913	100913	-16.782583
ATA	912047	1041365	-129318	129318	-14.1788746
ATG	802857	869242	-66385	66385	-8.26859578
ACT	721351	746916	-25565	25565	-3.54404444
ACC	511329	563450	-52121	52121	-10.1932415
ACA	902956	1007498	-104542	104542	-11.5777513
ACG	113900	119007	-5107	5107	-4.48375768
GTT	660540	668702	-8162	8162	-1.23565568
GTC	417139	421854	-4715	4715	-1.13031867
GTA	499328	551203	-51875	51875	-10.3889628
GTG	662474	689093	-26619	26619	-4.01811996
GCT	615049	639129	-24080	24080	-3.91513522
GCC	519252	540114	-20862	20862	-4.01770239
GCA	630620	647479	-16859	16859	-2.67340078
GCG	106264	109967	-3703	3703	-3.48471731
AAA	1728738	1836724	-107986	107986	-6.24652203
GAA	891200	953309	-62109	62109	-6.96914273
TAA	917446	987099	-69653	69653	-7.59205446
CAA	854935	860236	-5301	5301	-0.62004714
AGA	991269	1013532	-22263	22263	-2.24590903
GGA	677511	749884	-72373	72373	-10.6821882
TGA	877294	873853	3441	3441	0.39222883
CGA	102700	104536	-1836	1836	-1.78773126
AAG	904305	901016	3289	3289	0.36370472
GAG	752217	758122	-5905	5905	-0.78501284
TAG	573222	587347	-14125	14125	-2.46414129
CAG	885474	909808	-24334	24334	-2.74813264
AGG	787579	788294	-715	715	-0.09078454

GGG	569441	582334	-12893	12893	-2.26415028
TGG	803601	881377	-77776	77776	-9.67843494
CGG	119050	126889	-7839	7839	-6.58462831
AAT	1103952	1177901	-73949	73949	-6.69857023
GAT	592294	613103	-20809	20809	-3.51328901
TAT	912421	1052574	-140153	140153	-15.3605627
CAT	807744	891054	-83310	83310	-10.3139113
AGT	720783	733151	-12368	12368	-1.71591172
GGT	513221	517530	-4309	4309	-0.83959931
TGT	889049	960886	-71837	71837	-8.08020705
CGT	112196	119795	-7599	7599	-6.77296873
AAC	653862	723881	-70019	70019	-10.7085287
GAC	413274	416004	-2730	2730	-0.6605787
TAC	508366	570749	-62383	62383	-12.271277
CAC	674808	725080	-50272	50272	-7.44982276
AGC	615058	623414	-8356	8356	-1.35857106
GGC	517589	525455	-7866	7866	-1.51973863
TGC	632271	651519	-19248	19248	-3.04426425
CGC	106137	136931	-30794	30794	-29.0134449
44429680			2303493		
0.051845816					

The codon changes between chimp and human amount to -

5.18%

Chromosome 11

Chimp chromosome 11 maps on to human chromosome 9 – (complete human genome)

Absolute Differences require **10,585,088** codon changes.

Codon	Human 9	Chimp 11	Number of Differences	Absolute Differences	% Difference
TTT	1604110	1504775	99335	99335	6.19253044
TTC	1490826	856159	634667	634667	42.5715006
TTA	866211	795604	70607	70607	8.15124721
TTG	914688	735346	179342	179342	19.6069042
TCT	948335	853407	94928	94928	10.0099648
TCC	1263912	690028	573884	573884	45.4053763
TCA	883376	755792	127584	127584	14.4427741
TCG	181493	94323	87170	87170	48.0294006
CTT	865938	768799	97139	97139	11.2177777
CTC	759479	653785	105694	105694	13.9166455
CTA	550848	492127	58721	58721	10.6601095
CTG	858129	799274	58855	58855	6.85852593
CCT	781682	692422	89260	89260	11.4189658
CCC	616621	523048	93573	93573	15.1751238
CCA	1298426	797506	500920	500920	38.579018
CCG	204962	117501	87461	87461	42.6718123
ATT	1710073	1015297	694776	694776	40.628441
ATC	640268	517185	123083	123083	19.2236688
ATA	863386	822723	40663	40663	4.70971269
ATG	1331070	741581	589489	589489	44.2868519
ACT	726682	618959	107723	107723	14.8239533
ACC	519377	451493	67884	67884	13.0702746
ACA	868345	794911	73434	73434	8.45677697
ACG	158381	102899	55482	55482	35.0307171
GTT	695836	601264	94572	94572	13.5911335
GTC	391602	366800	24802	24802	6.33347123
GTA	507734	455406	52328	52328	10.3061839
GTG	674740	611466	63274	63274	9.37753801
GCT	575935	547239	28696	28696	4.98250671
GCC	503662	468689	34973	34973	6.94374402
GCA	706417	563427	142990	142990	20.2415854
GCG	112776	110578	2198	2198	1.94899624
AAA	1593999	1446741	147258	147258	9.2382743
GAA	1505806	759753	746053	746053	49.5450941
TAA	871185	766754	104431	104431	11.9872358
CAA	895731	728501	167230	167230	18.6696676
AGA	952229	901681	50548	50548	5.30838695
GGA	1289223	605493	683730	683730	53.0342695
TGA	885755	756931	128824	128824	14.5439766
CGA	179523	89737	89786	89786	50.0136473
AAG	856385	766912	89473	89473	10.4477542
GAG	765002	664332	100670	100670	13.1594427
TAG	554030	526852	27178	27178	4.90551053
CAG	867325	811846	55479	55479	6.39656415
AGG	781011	694980	86031	86031	11.0153378

GGG	614899	526440	88459	88459	14.3859398
TGG	1321126	731570	589556	589556	44.6252666
CGG	209273	130010	79263	79263	37.8754068
AAT	1709264	937057	772207	772207	45.177749
GAT	645717	563355	82362	82362	12.7551234
TAT	859173	818949	40224	40224	4.68171137
CAT	1331227	777617	553610	553610	41.5864462
AGT	724713	625090	99623	99623	13.7465452
GGT	518142	471623	46519	46519	8.97804077
TGT	869974	829404	40570	40570	4.66335776
CGT	154756	108297	46459	46459	30.0208069
AAC	705458	556030	149428	149428	21.1817004
GAC	395841	366329	29512	29512	7.45551876
TAC	505739	452245	53494	53494	10.5773927
CAC	665731	591588	74143	74143	11.1370809
AGC	583085	547882	35203	35203	6.03737019
GGC	502254	478341	23913	23913	4.7611368
TGC	700802	565787	135015	135015	19.2657841
CGC	112071	98741	13330	13330	11.8942456
50201769			10585088		
0.210850897					

The codon changes between chimp and human amount to -

21.08%

Chimp Chromosomes 12 & 13

Chimp chromosomes 12 and 13 map on to human chromosome 2 – (complete human genome 2022)

Absolute Differences require 8,197,385 codon changes.

Codon	Human 2	Chimp 13	Chimp 12	Number of Differences	Absolute Differences	% Difference
TTT	3192491	1782367	1449925	-39801	39801	44.17002272
TTC	1634461	899300	851280	-116119	116119	44.97880341
TTA	1722256	986587	776222	-40553	40553	42.71542674
TTG	1566616	864023	722320	-19727	19727	44.8478121
TCT	1802743	1212291	999934	-409482	409482	32.75297699
TCC	1221019	662196	681473	-122650	122650	45.76693729
TCA	1600622	889689	761124	-50191	50191	44.41604576
TCG	175959	95238	93160	-12439	12439	45.87489131
CTT	1642257	910128	762974	-30845	30845	44.58065942
CTC	1318157	734420	661013	-77276	77276	44.28433032
CTA	1057300	759829	605066	-307595	307595	28.13496642
CTG	1593390	960401	845378	-212389	212389	39.72593025
CCT	1393047	760700	680250	-47903	47903	45.39308437
CCC	1006335	531643	490917	-16225	16225	47.17037567
CCA	1450686	829802	811201	-190317	190317	42.79933769
CCG	199474	165436	146666	-112628	112628	17.063878
ATT	2083461	1178011	1006223	-100773	100773	43.45893684
ATC	1091224	806372	656653	-371801	371801	26.10389801
ATA	1720303	1223841	926121	-429659	429659	28.85898589
ATG	1509499	956629	783212	-230342	230342	36.62605937
ACT	1306013	752304	631389	-77680	77680	42.39689804
ACC	909358	582262	493878	-166782	166782	35.96999202
ACA	1642384	1139746	920354	-417716	417716	30.60417052
ACG	195166	116871	110098	-31803	31803	40.11713106
GTT	1196476	665505	581136	-50165	50165	44.37790645
GTC	753992	417774	367442	-31224	31224	44.59171981
GTA	928567	615249	480457	-167139	167139	33.74209939
GTG	1191609	658972	585590	-52953	52953	44.69897424
GCT	1108914	640837	559732	-91655	91655	42.21039684
GCC	911297	510170	463440	-62313	62313	44.01715357
GCA	1152647	635448	559493	-42294	42294	44.8705458
GCG	175977	96056	91203	-11282	11282	45.41559408
AAA	3157232	2014493	1617183	-474444	474444	36.19433098
GAA	1644301	1025186	859878	-240763	240763	37.65216952
TAA	1721785	1093131	841272	-212618	212618	36.5117596
CAA	1533854	880505	754449	-101100	101100	42.59525352
AGA	1795983	997738	859996	-61751	61751	44.4461334
GGA	1243200	772366	659649	-188815	188815	37.87274775
TGA	1602566	883568	761433	-42435	42435	44.86542208
CGA	173582	96164	94549	-17131	17131	44.60024657
AAG	1628894	906206	777709	-55021	55021	44.36679121
GAG	1323749	703160	643158	-22569	22569	46.88116856
TAG	1058983	599025	487127	-27169	27169	43.43393614
CAG	1608303	870445	776355	-38497	38497	45.87804661
AGG	1397431	745417	672215	-20201	20201	46.65804609

GGG	1003441	528278	491232	-16069	16069	47.3533571
TGG	1468931	886536	761672	-179277	179277	39.64753961
CGG	202846	112844	112306	-22304	22304	44.3696203
AAT	2076952	1305436	1035807	-264291	264291	37.14654937
GAT	1094810	615810	519654	-40654	40654	43.75188389
TAT	1718742	1247405	953058	-481721	481721	27.42337128
CAT	1515527	991708	868791	-344972	344972	34.56348848
AGT	1310947	729828	621316	-40197	40197	44.32818413
GGT	914993	495042	448607	-28656	28656	45.89663527
TGT	1651486	1018724	834824	-202062	202062	38.31470567
CGT	195576	111875	105622	-21921	21921	42.79717348
AAC	1194984	783161	639010	-227187	227187	34.46263716
GAC	752473	408084	353894	-9505	9505	45.76762223
TAC	920802	644257	513369	-236824	236824	30.03305814
CAC	1182700	756650	650336	-224286	224286	36.02350554
AGC	1118695	608717	531796	-21818	21818	45.58686684
GGC	907972	478237	437941	-8206	8206	47.32910266
TGC	1143899	645921	573080	-75102	75102	43.53338887
CGC	173726	152315	129509	-108098	108098	12.32458009
80893065				8197385		
				0.10133607		

The codon changes between chimp and human amount to -

10.13%

Chimp Chromosome 14

Chimp chromosome 14 maps on to human chromosome 13 – (complete human genome)

Absolute Differences require **2,084,467** codon changes.

Codon	Human 13	Chimp 14	Number of Differences	Absolute Differences	% Difference
TTT	1485560	1528532	-42972	42972	-2.89264654
TTC	785911	865072	-79161	79161	-10.0725146
TTA	852816	870857	-18041	18041	-2.11546219
TTG	682839	720735	-37896	37896	-5.54977088
TCT	870395	906775	-36380	36380	-4.17971151
TCC	556737	643808	-87071	87071	-15.639521
TCA	746140	754096	-7956	7956	-1.06628783
TCG	88164	92054	-3890	3890	-4.41223175
CTT	727725	736134	-8409	8409	-1.15551891
CTC	607009	590346	16663	16663	2.74509933
CTA	486303	561439	-75136	75136	-15.4504496
CTG	710841	738811	-27970	27970	-3.93477585
CCT	572993	600263	-27270	27270	-4.75922044
CCC	437269	429222	8047	8047	1.84028596
CCA	648418	748298	-99880	99880	-15.4036439
CCG	114325	124733	-10408	10408	-9.10387054
ATT	1045013	1148070	-103057	103057	-9.86179119
ATC	529992	598676	-68684	68684	-12.9594409
ATA	1082870	1069598	13272	13272	1.22563189
ATG	706182	760688	-54506	54506	-7.71840687
ACT	623070	633392	-10322	10322	-1.65663569
ACC	410212	443504	-33292	33292	-8.11580354
ACA	808059	905946	-97887	97887	-12.1138432
ACG	95592	105238	-9646	9646	-10.0908026
GTT	548483	572836	-24353	24353	-4.44006469
GTC	341820	344465	-2645	2645	-0.77379908
GTA	516676	511832	4844	4844	0.93753145
GTG	515893	538323	-22430	22430	-4.3478008
GCT	464994	489377	-24383	24383	-5.24372357
GCC	368475	383827	-15352	15352	-4.16636135
GCA	484222	509291	-25069	25069	-5.1771708
GCG	96122	81128	14994	14994	15.5989264
AAA	1630693	1676151	-45458	45458	-2.78764918
GAA	748754	801629	-52875	52875	-7.06173189
TAA	845800	915991	-70191	70191	-8.29877039
CAA	768804	748892	19912	19912	2.58999693
AGA	785144	812895	-27751	27751	-3.53451087
GGA	513845	573760	-59915	59915	-11.660131
TGA	714671	740197	-25526	25526	-3.57171342
CGA	86018	86827	-809	809	-0.94050083
AAG	758102	743146	14956	14956	1.9728216
GAG	547866	560701	-12835	12835	-2.34272614
TAG	477003	479608	-2605	2605	-0.54611816
CAG	643284	700144	-56860	56860	-8.83901978
AGG	566635	588792	-22157	22157	-3.91027734

GGG	406469	415624	-9155	9155	-2.25232429
TGG	596238	659236	-62998	62998	-10.565915
CGG	107185	104934	2251	2251	2.10010729
AAT	1059827	1116258	-56431	56431	-5.32454825
GAT	485100	515787	-30687	30687	-6.32591218
TAT	1067357	1074869	-7512	7512	-0.70379451
CAT	750293	867300	-117007	117007	-15.5948409
AGT	622241	614114	8127	8127	1.30608558
GGT	391308	405942	-14634	14634	-3.7397651
TGT	808045	843775	-35730	35730	-4.42178344
CGT	104204	102902	1302	1302	1.24947219
AAC	541144	604095	-62951	62951	-11.632948
GAC	319249	334713	-15464	15464	-4.84386795
TAC	549476	542576	6900	6900	1.25574183
CAC	527537	606351	-78814	78814	-14.9399947
AGC	453411	467783	-14372	14372	-3.16975106
GGC	368253	369918	-1665	1665	-0.45213481
TGC	495344	517694	-22350	22350	-4.51201589
CGC	96564	108945	-12381	12381	-12.8215484
37846984			2084467		
0.055076172					

The codon changes between chimp and human amount to -

5.51% of human chromosome 13

Unknown Codons:

A significant number of codons in chimp chromosome 15 are NNN, totalling 333301 codons. NNN means not sequenced (or hidden).

Since I don't know what codons these NNN represent, then the absolute number of codon changes will be a minimum of

$$2,084,467 - 333301 = 1,751,166$$

and a maximum of

$$2,084,467 + 333301 = 2,417,768$$

The codon changes between chimp and human amount to -

Minimum 4.62%

Maximum 6.3%

Chimp Chromosome 15

Chimp chromosome 15 maps on to human chromosome 14 – (complete human genome)

Absolute Differences require **1,958,859** codon changes.

Codon	Human 14	Chimp 15	Number of Differences	Absolute Differences	% Difference
TTT	1276014	1469659	-193645	193645	-15.1757739
TTC	708483	675816	32667	32667	4.61083752
TTA	673780	771835	-98055	98055	-14.5529698
TTG	628274	667385	-39111	39111	-6.22515017
TCT	762505	743436	19069	19069	2.50083606
TCC	553090	528381	24709	24709	4.46744653
TCA	658539	641542	16997	16997	2.58101646
TCG	81658	75037	6621	6621	8.1082074
CTT	666285	667766	-1481	1481	-0.22227725
CTC	572119	556812	15307	15307	2.67549234
CTA	430705	417851	12854	12854	2.98440928
CTG	686351	688500	-2149	2149	-0.3131051
CCT	582341	576357	5984	5984	1.02757663
CCC	436562	439757	-3195	3195	-0.73185481
CCA	635740	614516	21224	21224	3.3384717
CCG	102090	94600	7490	7490	7.33666373
ATT	846991	935944	-88953	88953	-10.5022367
ATC	450861	439018	11843	11843	2.62675193
ATA	683905	877244	-193339	193339	-28.269862
ATG	632441	634808	-2367	2367	-0.37426416
ACT	543553	557488	-13935	13935	-2.56368744
ACC	379074	379523	-449	449	-0.11844653
ACA	670217	731991	-61774	61774	-9.21701479
ACG	89986	90378	-392	392	-0.43562332
GTT	498448	511796	-13348	13348	-2.67791224
GTC	323360	321529	1831	1831	0.56624196
GTA	373709	467599	-93890	93890	-25.1238263
GTG	512144	527711	-15567	15567	-3.03957481
GCT	467804	449373	18431	18431	3.93989791
GCC	388904	382630	6274	6274	1.6132516
GCA	476512	462892	13620	13620	2.8582701
GCG	87763	79598	8165	8165	9.30346501
AAA	1266496	1257225	9271	9271	0.73201968
GAA	700727	652610	48117	48117	6.86672556
TAA	661632	722154	-60522	60522	-9.14738102
CAA	636807	620565	16242	16242	2.55053729
AGA	747954	727159	20795	20795	2.78025119
GGA	548260	498080	50180	50180	9.15259184
TGA	654862	668839	-13977	13977	-2.13434281
CGA	80578	74713	5865	5865	7.27866167
AAG	667493	641369	26124	26124	3.91374891
GAG	570575	542875	27700	27700	4.85475179
TAG	433664	435744	-2080	2080	-0.479634
CAG	666586	693678	-27092	27092	-4.06429178

AGG	593232	568699	24533	24533	4.13548157
GGG	442814	426715	16099	16099	3.63561224
TGG	632397	615772	16625	16625	2.6288866
CGG	101037	93925	7112	7112	7.03900551
AAT	846120	876466	-30346	30346	-3.58648891
GAT	452283	470745	-18462	18462	-4.08195754
TAT	691625	907923	-216298	216298	-31.273884
CAT	625499	628238	-2739	2739	-0.43789039
AGT	546461	570733	-24272	24272	-4.44167104
GGT	385050	400049	-14999	14999	-3.89533827
TGT	682951	766300	-83349	83349	-12.2042431
CGT	93721	88871	4850	4850	5.17493411
AAC	485337	479909	5428	5428	1.11839814
GAC	309752	304035	5717	5717	1.84567008
TAC	375630	464543	-88913	88913	-23.6703671
CAC	511353	510133	1220	1220	0.23858274
AGC	452566	445474	7092	7092	1.56706425
GGC	391193	379382	11811	11811	3.0192258
TGC	488890	466893	21997	21997	4.49937614
CGC	86335	82039	4296	4296	4.97596571
	33710088			1958859	
					0.058108985

Unknown Codons:

A significant number of codons in chimp chromosome 15 are NNN, totalling 333301 codons. NNN means not sequenced (or hidden).

Since I don't know what codons these NNN represent, then the absolute number of codon changes will be a minimum of

$$1,958,859 - 333301 = 1,625,558$$

and a maximum of

$$1,958,859 + 333301 = 2,292,160$$

The codon changes between chimp and human amount to -

Minimum 4.82%

Maximum 6.8%

Chimp Chromosome 16

Chimp chromosome 16 maps on to human chromosome 15 – (complete human genome 2022)

Absolute Differences require **4,207,803** codon changes.

Codon	Human 15	Chimp 16	Number of Differences	Absolute Differences	% Difference
TTT	1179007	1057592	121415	121415	10.2980729
TTC	951776	583581	368195	368195	38.6850477
TTA	594742	550972	43770	43770	7.3594937
TTG	603901	547693	56208	56208	9.30748583
TCT	749767	725439	24328	24328	3.24474137
TCC	796227	469373	326854	326854	41.0503537
TCA	630195	586816	43379	43379	6.88342497
TCG	140512	75188	65324	65324	46.4899795
CTT	632572	572065	60507	60507	9.56523526
CTC	599478	517951	81527	81527	13.599665
CTA	408905	422721	-13816	13816	-3.37877991
CTG	669110	648097	21013	21013	3.14044029
CCT	586824	539524	47300	47300	8.06033836
CCC	445597	410122	35475	35475	7.96122954
CCA	858368	574876	283492	283492	33.0268603
CCG	126107	124214	1893	1893	1.5011062
ATT	1047744	695090	352654	352654	33.6584127
ATC	425668	471767	-46099	46099	-10.8298016
ATA	609723	646967	-37244	37244	-6.10834756
ATG	553245	704664	-151419	151419	-27.3692487
ACT	524698	469031	55667	55667	10.609341
ACC	369823	392215	-22392	22392	-6.05478837
ACA	626976	672852	-45876	45876	-7.31702649
ACG	90443	93706	-3263	3263	-3.60779718
GTT	468506	415362	53144	53144	11.3432912
GTC	342533	282952	59581	59581	17.3942365
GTA	338118	361768	-23650	23650	-6.99459952
GTG	485948	455379	30569	30569	6.29059076
GCT	447118	425032	22086	22086	4.93963562
GCC	401123	376634	24489	24489	6.1051099
GCA	464944	437650	27294	27294	5.87038439
GCG	97932	80389	17543	17543	17.9134501
AAA	1115487	1162667	-47180	47180	-4.22954279
GAA	600865	784442	-183577	183577	-30.5521207
TAA	578615	604040	-25425	25425	-4.39411353
CAA	603655	565774	37881	37881	6.27527313
AGA	664805	647185	17620	17620	2.65040125
GGA	495798	653147	-157349	157349	-31.7365137
TGA	611502	567643	43859	43859	7.17233958
CGA	130770	90875	39895	39895	30.5077617
AAG	601370	571944	29426	29426	4.89316062
GAG	554208	503113	51095	51095	9.21946273
TAG	378819	363258	15561	15561	4.10776651

CAG	648320	627086	21234	21234	3.27523445
AGG	561456	532257	29199	29199	5.20058562
GGG	435690	402846	32844	32844	7.53838739
TGG	588534	728503	-139969	139969	-23.7826532
CGG	111371	98679	12692	12692	11.3961444
AAT	744533	894685	-150152	150152	-20.1672726
GAT	446851	389943	56908	56908	12.7353413
TAT	630217	650421	-20204	20204	-3.20587988
CAT	820389	587399	232990	232990	28.399942
AGT	520483	466695	53788	53788	10.3342472
GGT	371251	340260	30991	30991	8.34772162
TGT	630728	621695	9033	9033	1.43215459
CGT	114328	87610	26718	26718	23.3696032
AAC	440232	488771	-48539	48539	-11.0257773
GAC	296990	282852	14138	14138	4.76042964
TAC	366113	363505	2608	2608	0.71234837
CAC	506091	490651	15440	15440	3.05083473
AGC	437127	418155	18972	18972	4.34015744
GGC	395923	366156	29767	29767	7.5183811
TGC	481034	436896	44138	44138	9.17565079
CGC	97695	96550	1145	1145	1.17201494
	33248880			4207803	
				0.126554729	

The codon changes between chimp and human amount to -

12.65% of human chromosome 15

Chimp Chromosome 17

Chimp chromosome 17 maps on to human chromosome 18 – (complete human genome 2022)

Absolute Differences require 3,082,519 codon changes.

Codon	Human 18	Chimp 17	Number of Differences	Absolute Differences	% Difference
TTT	1094207	1109683	-15476	15476	-1.41435761
TTC	558985	660576	-101591	101591	-18.1741907
TTA	557150	637174	-80024	80024	-14.3630979
TTG	551247	540737	10510	10510	1.90658634
TCT	609269	639831	-30562	30562	-5.01617512
TCC	390389	503932	-113543	113543	-29.0845797
TCA	532555	588962	-56407	56407	-10.5917699
TCG	60157	71678	-11521	11521	-19.1515534
CTT	556355	564482	-8127	8127	-1.46075797
CTC	427102	463951	-36849	36849	-8.62768144
CTA	351367	377068	-25701	25701	-7.31457422
CTG	506865	574880	-68015	68015	-13.4187604
CCT	441134	477175	-36041	36041	-8.17007984
CCC	312727	354005	-41278	41278	-13.199372
CCA	444318	582467	-138149	138149	-31.0923708
CCG	64829	82583	-17754	17754	-27.3858921
ATT	705061	835721	-130660	130660	-18.5317299
ATC	359774	408563	-48789	48789	-13.5610133
ATA	576517	763455	-186938	186938	-32.4254098
ATG	486813	543772	-56959	56959	-11.700386
ACT	439879	490773	-50894	50894	-11.5699999
ACC	286387	331250	-44863	44863	-15.6651664
ACA	565074	648464	-83390	83390	-14.7573592
ACG	67556	82206	-14650	14650	-21.6857126
GTT	409422	437103	-27681	27681	-6.76099477
GTC	242572	269723	-27151	27151	-11.1929654
GTA	312518	372307	-59789	59789	-19.131378
GTG	401140	424559	-23419	23419	-5.83811138
GCT	352143	372151	-20008	20008	-5.68178268
GCC	277861	307213	-29352	29352	-10.5635552
GCA	389508	401243	-11735	11735	-3.01277509
GCG	62326	66613	-4287	4287	-6.87834932
AAA	1053936	1249663	-195727	195727	-18.5710518
GAA	579147	587145	-7998	7998	-1.38099653
TAA	566300	651840	-85540	85540	-15.105068
CAA	498918	593726	-94808	94808	-19.0027219
AGA	611025	635014	-23989	23989	-3.92602594
GGA	428328	427938	390	390	0.09105172
TGA	535232	574444	-39212	39212	-7.32616884
CGA	52822	69029	-16207	16207	-30.6822915
AAG	543546	586260	-42714	42714	-7.85839653
GAG	435181	462839	-27658	27658	-6.35551644
TAG	357298	356832	466	466	0.13042334

CAG	534835	561371	-26536	26536	-4.96153019
AGG	449150	478388	-29238	29238	-6.5096293
GGG	311578	347289	-35711	35711	-11.4613355
TGG	482483	489140	-6657	6657	-1.37973773
CGG	67819	84063	-16244	16244	-23.9519899
AAT	679482	813490	-134008	134008	-19.7220824
GAT	365537	384028	-18491	18491	-5.05858504
TAT	574085	745659	-171574	171574	-29.8865151
CAT	511400	608462	-97062	97062	-18.9796637
AGT	440376	482206	-41830	41830	-9.49870111
GGT	290923	322352	-31429	31429	-10.8032022
TGT	558321	620711	-62390	62390	-11.1745752
CGT	74284	79596	-5312	5312	-7.15093425
AAC	420731	431162	-10431	10431	-2.47925634
GAC	249793	269710	-19917	19917	-7.97340198
TAC	299455	392335	-92880	92880	-31.0163464
CAC	387465	457336	-69871	69871	-18.0328546
AGC	368774	371050	-2276	2276	-0.61718017
GGC	280581	305526	-24945	24945	-8.89048082
TGC	372728	400723	-27995	27995	-7.510839
CGC	59156	70056	-10900	10900	-18.4258571
	26833896			3082519	
				0.114874076	

Unknown Codons:

A significant number of codons in chimp chromosome 17 are NNN, totalling **333301** codons. NNN means not sequenced (or hidden).

A significant number of codons in human chromosome 18 are NNN, totalling **93,802** codons. NNN means not sequenced (or hidden).

Since I don't know what codons these NNN represent, then the absolute number of codon changes will be a minimum of

$$3082519 - 333301 = 2,749,218$$

and a maximum of

$$3082519 + 333301 = 3,415,820$$

The codon changes between chimp and human amount to -

Minimum 10.24%

Maximum 12.72%

Chimp Chromosome 18

Chimp chromosome 18 maps on to human chromosome 16 (complete genome 2022)

Absolute Differences require **3,850,357** codon changes.

Codon	Human 16	Chimp 18	Number of Differences	Absolute Differences	% Difference
TTT	1055880	1099911	-44031	44031	-4.17007615
TTC	978841	647449	331392	331392	33.8555496
TTA	498445	532033	-33588	33588	-6.73855691
TTG	605327	552801	52526	52526	8.67729343
TCT	639584	660476	-20892	20892	-3.26649822
TCC	736443	586022	150421	150421	20.4253418
TCA	641741	570288	71453	71453	11.1342426
TCG	231213	96243	134970	134970	58.3747454
CTT	567967	553316	14651	14651	2.57955128
CTC	558755	554658	4097	4097	0.73323729
CTA	342515	358550	-16035	16035	-4.68154679
CTG	646868	676179	-29311	29311	-4.53121812
CCT	580165	578760	1405	1405	0.24217249
CCC	465544	470092	-4548	4548	-0.97692162
CCA	812465	695980	116485	116485	14.337233
CCG	127547	132541	-4994	4994	-3.91541941
ATT	1099306	722515	376791	376791	34.2753519
ATC	387500	416599	-29099	29099	-7.50941935
ATA	464316	614110	-149794	149794	-32.2612187
ATG	681574	604198	77376	77376	11.3525457
ACT	456155	450017	6138	6138	1.34559525
ACC	360965	383515	-22550	22550	-6.24714307
ACA	552161	632583	-80422	80422	-14.5649548
ACG	101931	99355	2576	2576	2.52719977
GTT	417373	460326	-42953	42953	-10.2912742
GTC	322509	291338	31171	31171	9.66515663
GTA	287691	357887	-70196	70196	-24.3997901
GTG	504999	546356	-41357	41357	-8.18952117
GCT	440622	455788	-15166	15166	-3.44195251
GCC	423702	438716	-15014	15014	-3.54352823
GCA	447292	467172	-19880	19880	-4.44452394
GCG	101487	130780	-29293	29293	-28.8637954
AAA	939564	989549	-49985	49985	-5.32002078
GAA	531684	574895	-43211	43211	-8.12719585
TAA	476666	497465	-20799	20799	-4.36343268
CAA	564923	519647	45276	45276	8.01454357
AGA	620380	719915	-99535	99535	-16.0441987
GGA	502028	538564	-36536	36536	-7.27768172
TGA	799603	565144	234459	234459	29.321926
CGA	228283	90610	137673	137673	60.3080387
AAG	527389	533283	-5894	5894	-1.11758114
GAG	576991	566196	10795	10795	1.87091306
TAG	335599	411594	-75995	75995	-22.6445848

CAG	655913	711921	-56008	56008	-8.53893733
AGG	563051	578167	-15116	15116	-2.68465912
GGG	461649	476790	-15141	15141	-3.2797645
TGG	615307	666842	-51535	51535	-8.37549386
CGG	121266	150951	-29685	29685	-24.479244
AAT	655169	642628	12541	12541	1.91416261
GAT	740062	477305	262757	262757	35.504728
TAT	487689	609132	-121443	121443	-24.9017304
CAT	745800	627553	118247	118247	15.855055
AGT	477662	459731	17931	17931	3.75390967
GGT	373290	408515	-35225	35225	-9.43636315
TGT	566636	684682	-118046	118046	-20.8327745
CGT	113154	104364	8790	8790	7.76817435
AAC	388574	415280	-26706	26706	-6.87282217
GAC	302436	297551	4885	4885	1.61521777
TAC	293017	344137	-51120	51120	-17.4460867
CAC	485779	509411	-23632	23632	-4.86476361
AGC	436019	469287	-33268	33268	-7.62994273
GGC	424039	447461	-23422	23422	-5.52354854
TGC	455429	465936	-10507	10507	-2.30705555
CGC	98914	112533	-13619	13619	-13.7685262
	32102848			3850357	
				0.119938175	

The codon changes between chimp and human amount to -

11.99% of human chromosome 16

Chimp Chromosome 19

Chimp chromosome 19 maps on to human chromosome 17 – (complete human genome 2022)

Absolute Differences require **5,119,961** codon changes.

Codon	Human 17	Chimp 19	Number of Differences	Absolute Differences	% Difference
TTT	937051	1010492	-73441	73441	-7.83746029
TTC	532960	577137	-44177	44177	-8.28898979
TTA	434103	494035	-59932	59932	-13.8059401
TTG	515498	512530	2968	2968	0.57575393
TCT	608546	796751	-188205	188205	-30.9269965
TCC	491799	558964	-67165	67165	-13.6570021
TCA	527462	571870	-44408	44408	-8.4191847
TCG	94525	96215	-1690	1690	-1.7878868
CTT	533562	539253	-5691	5691	-1.06660519
CTC	563686	599797	-36111	36111	-6.40622616
CTA	318905	491894	-172989	172989	-54.244681
CTG	649571	771478	-121907	121907	-18.7673095
CCT	579975	631912	-51937	51937	-8.95504117
CCC	475917	512451	-36534	36534	-7.67654864
CCA	580207	693266	-113059	113059	-19.4859766
CCG	126327	182812	-56485	56485	-44.7133234
ATT	566869	606692	-39823	39823	-7.02507987
ATC	346196	540841	-194645	194645	-56.223931
ATA	425161	680526	-255365	255365	-60.063129
ATG	460271	634897	-174626	174626	-37.9398224
ACT	438608	478575	-39967	39967	-9.11223689
ACC	362252	445053	-82801	82801	-22.8572927
ACA	525358	737211	-211853	211853	-40.3254543
ACG	96782	114916	-18134	18134	-18.7369552
GTT	377214	435636	-58422	58422	-15.4877603
GTC	278030	305036	-27006	27006	-9.71334029
GTA	277219	375567	-98348	98348	-35.4766448
GTG	480698	527264	-46566	46566	-9.68716325
GCT	439048	499567	-60519	60519	-13.7841421
GCC	435393	503430	-68037	68037	-15.6265719
GCA	448361	474708	-26347	26347	-5.87629165
GCG	107470	132357	-24887	24887	-23.1571601
AAA	925565	1179998	-254433	254433	-27.4894794
GAA	538409	677643	-139234	139234	-25.8602661
TAA	445432	548559	-103127	103127	-23.152131
CAA	479447	562293	-82846	82846	-17.2794907
AGA	602525	691663	-89138	89138	-14.7940749
GGA	516943	616937	-99994	99994	-19.3433319
TGA	534688	559954	-25266	25266	-4.72537255
CGA	89260	107170	-17910	17910	-20.0649787
AAG	514964	565374	-50410	50410	-9.7890338
GAG	556630	585990	-29360	29360	-5.27459893
TAG	322719	396106	-73387	73387	-22.7402167

CAG	661853	710258	-48405	48405	-7.31355754
AGG	571526	606221	-34695	34695	-6.07058996
GGG	479223	493656	-14433	14433	-3.01175027
TGG	611060	729152	-118092	118092	-19.3257618
CGG	129700	149950	-20250	20250	-15.612953
AAT	552498	725628	-173130	173130	-31.33586
GAT	364044	417316	-53272	53272	-14.633396
TAT	417587	697558	-279971	279971	-67.0449511
CAT	466273	617993	-151720	151720	-32.5388774
AGT	432992	466239	-33247	33247	-7.67843286
GGT	361383	394243	-32860	32860	-9.09284609
TGT	520820	669180	-148360	148360	-28.4858492
CGT	96766	109013	-12247	12247	-12.6563049
AAC	392900	495262	-102362	102362	-26.0529397
GAC	286326	294453	-8127	8127	-2.83837304
TAC	268921	400839	-131918	131918	-49.0545551
CAC	474017	582526	-108509	108509	-22.8913731
AGC	446491	491232	-44741	44741	-10.0205827
GGC	434206	472968	-38762	38762	-8.92709912
TGC	438235	484603	-46368	46368	-10.5806246
CGC	109333	158675	-49342	49342	-45.1300156
	28077760			5119961	
				0.18234934	

The codon changes between chimp and human amount to -

18.23%

Chimp Chromosome 20

Chimp chromosome 20 maps on to human chromosome 19 – (complete human genome 2022)

Absolute Differences require **2,218,337** codon changes.

Codon	Human 19	Chimp 20	Number of Differences	Absolute Differences	% Difference
TTT	650766	765934	-115168	115168	-17.6972983
TTC	369061	409617	-40556	40556	-10.9889693
TTA	261499	325332	-63833	63833	-24.4104184
TTG	371338	375038	-3700	3700	-0.99639681
TCT	433932	470592	-36660	36660	-8.44832831
TCC	370603	415118	-44515	44515	-12.0115056
TCA	397434	391602	5832	5832	1.46741346
TCG	77729	84150	-6421	6421	-8.2607521
CTT	376951	362272	14679	14679	3.89414009
CTC	449555	444036	5519	5519	1.22765846
CTA	205775	239784	-34009	34009	-16.5272749
CTG	497666	518847	-21181	21181	-4.25606732
CCT	457744	447685	10059	10059	2.19751652
CCC	394148	394616	-468	468	-0.11873712
CCA	436147	505444	-69297	69297	-15.8884505
CCG	120848	127839	-6991	6991	-5.784953
ATT	354843	421880	-67037	67037	-18.892017
ATC	243012	289464	-46452	46452	-19.1151054
ATA	264505	424663	-160158	160158	-60.5500841
ATG	305009	394443	-89434	89434	-29.3217577
ACT	312345	312848	-503	503	-0.16103988
ACC	278626	298723	-20097	20097	-7.2128947
ACA	382532	462348	-79816	79816	-20.8651825
ACG	80840	84937	-4097	4097	-5.06803563
GTT	267129	325003	-57874	57874	-21.665188
GTC	218040	217078	962	962	0.44120345
GTA	189476	257322	-67846	67846	-35.8071735
GTG	394130	437848	-43718	43718	-11.0922792
GCT	326495	332087	-5592	5592	-1.7127368
GCC	364836	368263	-3427	3427	-0.93932616
GCA	328051	338412	-10361	10361	-3.15835038
GCG	108063	137359	-29296	29296	-27.1101117
AAA	614004	652138	-38134	38134	-6.21070873
GAA	364854	362297	2557	2557	0.70082828
TAA	261799	290802	-29003	29003	-11.0783464
CAA	333420	341883	-8463	8463	-2.53824006
AGA	457968	541828	-83860	83860	-18.3113231
GGA	388760	403562	-14802	14802	-3.80749048
TGA	379316	376872	2444	2444	0.64431767
CGA	75921	77659	-1738	1738	-2.28922169
AAG	341360	343207	-1847	1847	-0.54107101
GAG	451097	453093	-1996	1996	-0.4424769
TAG	222409	296335	-73926	73926	-33.2387628

CAG	528917	565193	-36276	36276	-6.85854302
AGG	447293	451776	-4483	4483	-1.00225132
GGG	401634	406716	-5082	5082	-1.26533112
TGG	463187	496306	-33119	33119	-7.15024385
CGG	121476	149664	-28188	28188	-23.2045836
AAT	343863	368205	-24342	24342	-7.07898204
GAT	260282	358558	-98276	98276	-37.7575092
TAT	260164	414807	-154643	154643	-59.4405836
CAT	305255	391443	-86188	86188	-28.2347545
AGT	307928	316016	-8088	8088	-2.62658803
GGT	278765	316606	-37841	37841	-13.5745162
TGT	396828	513563	-116735	116735	-29.417027
CGT	83071	89172	-6101	6101	-7.34431992
AAC	277616	283210	-5594	5594	-2.01501354
GAC	224193	228602	-4409	4409	-1.96660913
TAC	174970	246001	-71031	71031	-40.5961022
CAC	377034	400252	-23218	23218	-6.15806532
AGC	330114	350993	-20879	20879	-6.32478477
GGC	360816	373753	-12937	12937	-3.58548401
TGC	328299	334874	-6575	6575	-2.0027475
CGC	106931	116935	-10004	10004	-9.35556574
	20558672			2218337	
				0.107902738	

The codon changes between chimp and human amount to -

10.79%

Chimp Chromosome 21

Chimp chromosome 21 maps on to human chromosome 20 – (complete human genome 2022)

Absolute Differences require 3,966,329 codon changes.

Codon	Human 20	Chimp 21	Number of Differences	Absolute Differences	% Difference
TTT	769277	912856	-143579	143579	-18.6641483
TTC	426583	500845	-74262	74262	-17.40857
TTA	363480	445356	-81876	81876	-22.525586
TTG	420937	437984	-17047	17047	-4.04977467
TCT	484555	601853	-117298	117298	-24.2073655
TCC	366316	432303	-65987	65987	-18.0136822
TCA	427962	447470	-19508	19508	-4.55834864
TCG	58783	65435	-6652	6652	-11.3161969
CTT	433946	448919	-14973	14973	-3.45042932
CTC	409479	430502	-21023	21023	-5.13408502
CTA	254012	340920	-86908	86908	-34.2141316
CTG	484898	544928	-60030	60030	-12.3799232
CCT	424023	443342	-19319	19319	-4.55612078
CCC	343385	346867	-3482	3482	-1.01402216
CCA	431880	523744	-91864	91864	-21.2707233
CCG	76136	108174	-32038	32038	-42.0799622
ATT	466102	549189	-83087	83087	-17.8259265
ATC	282192	388110	-105918	105918	-37.5340194
ATA	363590	623002	-259412	259412	-71.3473968
ATG	416079	534741	-118662	118662	-28.5191033
ACT	342997	365691	-22694	22694	-6.6163844
ACC	266745	317272	-50527	50527	-18.9420608
ACA	430541	596288	-165747	165747	-38.4973789
ACG	67690	77462	-9772	9772	-14.4364012
GTT	311345	385413	-74068	74068	-23.7896867
GTC	218487	227148	-8661	8661	-3.96408024
GTA	221642	335236	-113594	113594	-51.2511167
GTG	369844	442822	-72978	72978	-19.7321033
GCT	329759	359833	-30074	30074	-9.11999369
GCC	300389	326601	-26212	26212	-8.7260186
GCA	346623	364041	-17418	17418	-5.02505604
GCG	65514	106841	-41327	41327	-63.0811735
AAA	744573	853038	-108465	108465	-14.5674098
GAA	472136	495729	-23593	23593	-4.99707711
TAA	363506	434132	-70626	70626	-19.4291153
CAA	398151	416809	-18658	18658	-4.68616178
AGA	483924	614296	-130372	130372	-26.940594
GGA	418456	448411	-29955	29955	-7.15845871
TGA	430686	438535	-7849	7849	-1.82244141
CGA	57562	65346	-7784	7784	-13.5228102
AAG	424737	431426	-6689	6689	-1.57485691
GAG	413363	431682	-18319	18319	-4.43169805
TAG	259974	361323	-101349	101349	-38.984283

CAG	497499	564065	-66566	66566	-13.3801274
AGG	427734	439687	-11953	11953	-2.79449377
GGG	342062	351071	-9009	9009	-2.63373307
TGG	480385	538950	-58565	58565	-12.1912633
CGG	77988	116635	-38647	38647	-49.5550598
AAT	492199	545464	-53265	53265	-10.8218424
GAT	289411	408630	-119219	119219	-41.1936658
TAT	362778	620036	-257258	257258	-70.9133409
CAT	383672	523860	-140188	140188	-36.5385016
AGT	345513	370577	-25064	25064	-7.25414094
GGT	268393	320563	-52170	52170	-19.4379138
TGT	441051	620658	-179607	179607	-40.7225015
CGT	66697	79077	-12380	12380	-18.5615545
AAC	316461	370241	-53780	53780	-16.9941952
GAC	218896	232005	-13109	13109	-5.98868869
TAC	215268	327424	-112156	112156	-52.1006373
CAC	357928	428810	-70882	70882	-19.8034242
AGC	335965	365687	-29722	29722	-8.84675487
GGC	301005	325525	-24520	24520	-8.14604409
TGC	339705	365701	-25996	25996	-7.65252204
CGC	65211	97828	-32617	32617	-50.0176351
	22068080			3966329	
				0.179731495	

The codon changes between chimp and human amount to -

17.97%

Chimp Chromosome 22

Chimp chromosome 22 maps on to human chromosome 21 (complete human genome 2022)

Absolute Differences require 2,147,623 codon changes.

Codon	Human 21	Chimp 22	Number of Differences	Absolute Differences	% Difference
TTT	537798	643069	-105271	105271	-19.5744499
TTC	307709	384208	-76499	76499	-24.8608263
TTA	287545	368333	-80788	80788	-28.0957763
TTG	263905	278350	-14445	14445	-5.47356056
TCT	357778	338718	19060	19060	5.32732588
TCC	249046	300923	-51877	51877	-20.8302884
TCA	285183	304938	-19755	19755	-6.927131
TCG	45743	43613	2130	2130	4.65645017
CTT	284061	277113	6948	6948	2.44595351
CTC	277407	247642	29765	29765	10.729722
CTA	180145	183932	-3787	3787	-2.10219545
CTG	304569	326885	-22316	22316	-7.32707531
CCT	253574	253851	-277	277	-0.10923833
CCC	211668	199567	12101	12101	5.71697186
CCA	279532	337897	-58365	58365	-20.8795415
CCG	67598	55395	12203	12203	18.0523092
ATT	368419	483890	-115471	115471	-31.3423032
ATC	200900	209740	-8840	8840	-4.4001991
ATA	324841	465400	-140559	140559	-43.2700921
ATG	294391	335305	-40914	40914	-13.8978433
ACT	237674	247508	-9834	9834	-4.13760024
ACC	171229	174562	-3333	3333	-1.94651607
ACA	304891	394961	-90070	90070	-29.5417051
ACG	49554	50677	-1123	1123	-2.26621463
GTT	206284	267371	-61087	61087	-29.6130577
GTC	150706	147533	3173	3173	2.10542381
GTA	169520	231101	-61581	61581	-36.3266871
GTG	234619	273683	-39064	39064	-16.6499729
GCT	195700	194854	846	846	0.43229433
GCC	180522	170706	9816	9816	5.4375644
GCA	206973	216928	-9955	9955	-4.80980611
GCG	55561	56354	-793	793	-1.42726013
AAA	554091	613216	-59125	59125	-10.6706299
GAA	320456	297056	23400	23400	7.30209452
TAA	290126	331914	-41788	41788	-14.4033971
CAA	278760	293181	-14421	14421	-5.17326733
AGA	308727	399622	-90895	90895	-29.4418694
GGA	258361	224226	34135	34135	13.2121334
TGA	283217	294986	-11769	11769	-4.15547089
CGA	45291	40711	4580	4580	10.1123844
AAG	280823	288816	-7993	7993	-2.84627684
GAG	242071	247711	-5640	5640	-2.32989495
TAG	176105	219670	-43565	43565	-24.7380824

CAG	281039	343471	-62432	62432	-22.2147104
AGG	248287	253636	-5349	5349	-2.15436169
GGG	204432	194806	9626	9626	4.70865618
TGG	293379	275747	17632	17632	6.00997345
CGG	65436	68933	-3497	3497	-5.34415307
AAT	396109	415171	-19062	19062	-4.81231176
GAT	192696	267829	-75133	75133	-38.9904305
TAT	320563	449802	-129239	129239	-40.3162561
CAT	277760	362339	-84579	84579	-30.4503888
AGT	231387	245786	-14399	14399	-6.22290794
GGT	168070	196474	-28404	28404	-16.9001011
TGT	309441	427585	-118144	118144	-38.1798146
CGT	52000	52039	-39	39	-0.075
AAC	211608	220069	-8461	8461	-3.99843106
GAC	140451	145953	-5502	5502	-3.91738044
TAC	175385	246074	-70689	70689	-40.3050432
CAC	235012	256100	-21088	21088	-8.97315882
AGC	189989	200545	-10556	10556	-5.55611114
GGC	178624	177718	906	906	0.50721068
TGC	213947	217299	-3352	3352	-1.56674317
CGC	55488	45311	10177	10177	18.3409025
	15024176			2147623	
				0.142944478	

Unknown Codons:

A significant number of codons in chimp chromosome 22 are NNN, totalling **333301** codons. NNN means not sequenced (or hidden).

Since I don't know what codons these NNN represent, then the absolute number of codon changes will be a minimum of

$$2,147,623 - 333301 = 1,814,322$$

and a maximum of

$$2,147,623 + 333301 = 2,480,924$$

The codon changes between chimp and human amount to -

Minimum 12.07%

Maximum 16.51%

Chimp Chromosome 23

Chimp chromosome 23 maps on to human chromosome 22 (complete human genome 2022)

Absolute Differences require **3,009,817** codon changes.

Codon	Human 22	Chimp 23	Number of Differences	Absolute Differences	% Difference
TTT	486494	619277	-132783	132783	-27.2938618
TTC	332999	387460	-54461	54461	-16.3547038
TTA	231217	347025	-115808	115808	-50.0862826
TTG	272403	271225	1178	1178	0.43244751
TCT	380868	379077	1791	1791	0.47024166
TCC	324868	363424	-38556	38556	-11.8682049
TCA	322898	331837	-8939	8939	-2.76836648
TCG	57404	56819	585	585	1.01909275
CTT	290969	275061	15908	15908	5.46724909
CTC	345533	319610	25923	25923	7.5023225
CTA	190711	197394	-6683	6683	-3.50425513
CTG	420883	460811	-39928	39928	-9.48672196
CCT	338126	325246	12880	12880	3.80923088
CCC	297807	283511	14296	14296	4.80042444
CCA	372289	417894	-45605	45605	-12.2498919
CCG	87444	82414	5030	5030	5.75225287
ATT	327847	430042	-102195	102195	-31.1715526
ATC	229207	243955	-14748	14748	-6.43435846
ATA	288000	535493	-247493	247493	-85.9350694
ATG	318602	350963	-32361	32361	-10.1571867
ACT	264460	292674	-28214	28214	-10.6685321
ACC	216589	214029	2560	2560	1.18196215
ACA	329307	477178	-147871	147871	-44.9036917
ACG	66041	70453	-4412	4412	-6.68069835
GTT	219937	300371	-80434	80434	-36.5713818
GTC	180533	180848	-315	315	-0.17448334
GTA	166727	280498	-113771	113771	-68.2378979
GTG	312843	350706	-37863	37863	-12.1028759
GCT	262184	257029	5155	5155	1.96617643
GCC	258276	248157	10119	10119	3.91790178
GCA	263432	266128	-2696	2696	-1.02341401
GCG	70870	91103	-20233	20233	-28.5494568
AAA	524470	692190	-167720	167720	-31.9789502
GAA	347187	311660	35527	35527	10.232814
TAA	231270	309876	-78606	78606	-33.9888442
CAA	302868	351904	-49036	49036	-16.1905517
AGA	351649	475028	-123379	123379	-35.0858384
GGA	340134	265571	74563	74563	21.9216544
TGA	324206	323132	1074	1074	0.33127086
CGA	59783	59339	444	444	0.74268605
AAG	305713	314135	-8422	8422	-2.7548714
GAG	332052	340542	-8490	8490	-2.55682845
TAG	182462	252113	-69651	69651	-38.1728798

CAG	383419	454522	-71103	71103	-18.5444644
AGG	350117	331419	18698	18698	5.34050046
GGG	299769	276686	23083	23083	7.70026254
TGG	382521	342951	39570	39570	10.3445301
CGG	84254	103263	-19009	19009	-22.5615401
AAT	359432	417291	-57859	57859	-16.0973425
GAT	224587	297155	-72568	72568	-32.3117545
TAT	288158	489054	-200896	200896	-69.7173079
CAT	294176	355852	-61676	61676	-20.9656804
AGT	258187	290784	-32597	32597	-12.6253452
GGT	214429	249959	-35530	35530	-16.5695871
TGT	334970	505546	-170576	170576	-50.9227692
CGT	68637	67214	1423	1423	2.07322581
AAC	219094	240215	-21121	21121	-9.64015445
GAC	171533	171009	524	524	0.30548058
TAC	176495	310623	-134128	134128	-75.995354
CAC	309710	330339	-20629	20629	-6.66074715
AGC	244598	265597	-20999	20999	-8.58510699
GGC	263374	261087	2287	2287	0.86834691
TGC	280611	264742	15869	15869	5.65515963
CGC	68967	70933	-1966	1966	-2.85063871
	17106600			3009817	
				0.175944782	

Unknown Codons:

A significant number of codons in chimp chromosome 23 are NNN, totalling **333301** codons. NNN means not sequenced (or hidden).

Since I don't know what codons these NNN represent, then the absolute number of codon changes will be a minimum of

$$3009817 - 333,301 = 2,676,516$$

and a maximum of

$$3009817 + 333,301 = 3,343,118$$

The codon changes between chimp and human amount to -

Minimum 15.64%

Maximum 19.54%

Chimp Chromosome Y

Chimp chromosome Y maps on to human chromosome Y – (complete human genome 2022)

Absolute Differences require **9,544,788** codon changes.

Codon	Human Y	Chimp Y	Number of Differences	Absolute Differences	% Difference
TTT	505845	406351	99494	99494	19.6688709
TTC	286982	423281	-136299	136299	-47.4939195
TTA	382718	205774	176944	176944	46.2335192
TTG	323945	226462	97483	97483	30.092454
TCT	274352	243049	31303	31303	11.4097947
TCC	222757	374771	-152014	152014	-68.2420754
TCA	310415	235056	75359	75359	24.2768552
TCG	154932	40832	114100	114100	73.6452121
CTT	235760	218700	17060	17060	7.23617238
CTC	227693	199554	28139	28139	12.358307
CTA	195195	134410	60785	60785	31.1406542
CTG	278825	216520	62305	62305	22.3455572
CCT	209113	198655	10458	10458	5.00112379
CCC	134883	140344	-5461	5461	-4.04869405
CCA	257943	385962	-128019	128019	-49.6307324
CCG	30058	32185	-2127	2127	-7.07631912
ATT	547990	453548	94442	94442	17.2342561
ATC	305272	159165	146107	146107	47.8612516
ATA	918375	219721	698654	698654	76.0750238
ATG	942902	230616	712286	712286	75.5418909
ACT	301565	191619	109946	109946	36.458475
ACC	146495	124185	22310	22310	15.2291887
ACA	367314	237373	129941	129941	35.3759998
ACG	92257	29909	62348	62348	67.5807798
GTT	208939	182239	26700	26700	12.7788493
GTC	141908	111327	30581	30581	21.5498774
GTA	257075	117819	139256	139256	54.1694058
GTG	213436	193394	20042	20042	9.39016848
GCT	152274	138141	14133	14133	9.28129556
GCC	128477	117729	10748	10748	8.3656997
GCA	249888	166764	83124	83124	33.2645025
GCG	33025	24177	8848	8848	26.7918244
AAA	729230	387151	342079	342079	46.909617
GAA	1077097	229639	847458	847458	78.6798218
TAA	464696	192438	272258	272258	58.5884105
CAA	355362	222577	132785	132785	37.3661224
AGA	355217	247869	107348	107348	30.2204005
GGA	849856	188697	661159	661159	77.7965914
TGA	368650	231028	137622	137622	37.3313441
CGA	175451	27407	148044	148044	84.3791144
AAG	348453	209006	139447	139447	40.0188835
GAG	233074	184823	48251	48251	20.7020088
TAG	234465	136032	98433	98433	41.9819589

CAG	249719	222268	27451	27451	10.9927559
AGG	302281	185635	116646	116646	38.588598
GGG	163378	140566	22812	22812	13.9627122
TGG	787413	220694	566719	566719	71.9722687
CGG	67896	39104	28792	28792	42.4060328
AAT	1283044	285121	997923	997923	77.7777691
GAT	227358	177473	49885	49885	21.9411677
TAT	841703	221638	620065	620065	73.667909
CAT	363897	379847	-15950	15950	-4.38310841
AGT	250126	184369	65757	65757	26.2895501
GGT	159356	141205	18151	18151	11.3902206
TGT	369650	243108	126542	126542	34.232923
CGT	41726	37345	4381	4381	10.4994488
AAC	267799	151209	116590	116590	43.5363836
GAC	210127	104414	105713	105713	50.3090988
TAC	215493	127240	88253	88253	40.9539985
CAC	215833	200753	15080	15080	6.98688338
AGC	157720	135206	22514	22514	14.274664
GGC	148292	115602	32690	32690	22.0443449
TGC	232055	172640	59415	59415	25.6038439
CGC	25216	23457	1759	1759	6.9757297
	20810241			9544788	
				0.458658215	

This difference amounts to

45.86%

Chromosome X

Chimp chromosome X maps on to human chromosome X – (complete human genome)

Absolute Differences require **286,174** codon changes.

Codon	Human X	Chimp X	Number of Differences	Absolute Differences	% Difference
TTT	2055480	2042453	13027	13027	0.63376924
TTC	1062383	1047026	15357	15357	1.44552388
TTA	1092526	1093278	-752	752	-0.06883131
TTG	1022810	1019687	3123	3123	0.3053353
TCT	1155801	1155783	18	18	0.00155736
TCC	774749	767914	6835	6835	0.88222121
TCA	1024281	1012187	12094	12094	1.18073068
TCG	105931	103432	2499	2499	2.3590828
CTT	1041570	1035600	5970	5970	0.57317319
CTC	812762	807075	5687	5687	0.69971283
CTA	691854	697096	-5242	5242	-0.75767431
CTG	966951	968287	-1336	1336	-0.13816626
CCT	850421	847396	3025	3025	0.35570617
CCC	607600	613698	-6098	6098	-1.0036208
CCA	921522	919082	2440	2440	0.26477935
CCG	117187	118079	-892	892	-0.76117658
ATT	1338040	1338222	-182	182	-0.01360198
ATC	718660	720348	-1688	1688	-0.23488159
ATA	1164405	1172428	-8023	8023	-0.68902143
ATG	983543	986589	-3046	3046	-0.30969668
ACT	830492	827563	2929	2929	0.35268251
ACC	577459	583668	-6209	6209	-1.07522785
ACA	1063186	1064421	-1235	1235	-0.1161603
ACG	118889	117446	1443	1443	1.21373718
GTT	796718	785171	11547	11547	1.44932084
GTC	470612	467985	2627	2627	0.55820931
GTA	605334	608973	-3639	3639	-0.60115573
GTG	740450	735338	5112	5112	0.69039098
GCT	674397	673756	641	641	0.09504787
GCC	532950	535975	-3025	3025	-0.56759546
GCA	711208	705987	5221	5221	0.7341031
GCG	97190	96371	819	819	0.84267929
AAA	2051267	2033886	17381	17381	0.84732997
GAA	1056065	1045726	10339	10339	0.97901171
TAA	1081827	1089687	-7860	7860	-0.7265487
CAA	1037796	1027121	10675	10675	1.0286222
AGA	1152143	1144830	7313	7313	0.63473024
GGA	758923	764210	-5287	5287	-0.69664511
TGA	1018621	1011160	7461	7461	0.73246085
CGA	107100	104475	2625	2625	2.45098039
AAG	1047262	1038159	9103	9103	0.86921897
GAG	813246	807810	5436	5436	0.66843243
TAG	690086	688975	1111	1111	0.16099443

CAG	961358	959034	2324	2324	0.24174137
AGG	853124	854033	-909	909	-0.10654958
GGG	606663	610974	-4311	4311	-0.71060869
TGG	907486	913686	-6200	6200	-0.68320613
CGG	112000	112672	-672	672	-0.6
AAT	1348347	1344656	3691	3691	0.27374259
GAT	707271	704848	2423	2423	0.34258438
TAT	1171533	1179737	-8204	8204	-0.70027904
CAT	980046	982840	-2794	2794	-0.28508866
AGT	837659	831628	6031	6031	0.71998271
GGT	582014	580910	1104	1104	0.18968616
TGT	1065936	1066156	-220	220	-0.02063914
CGT	122842	118527	4315	4315	3.51264226
AAC	779635	776746	2889	2889	0.37055802
GAC	464020	463914	106	106	0.02284384
TAC	610593	613852	-3259	3259	-0.53374343
CAC	735707	737253	-1546	1546	-0.210138
AGC	666142	665484	658	658	0.09877774
GGC	533978	533312	666	666	0.12472424
TGC	719682	714572	5110	5110	0.71003582
CGC	95972	98342	-2370	2370	-2.46947026
	51403705			286174	
				0.005567186	

The codon changes between chimp and human amount to -

0.56%

X and Y Chromosomes - differences between chimps and humans

In the chart above for the Y chromosome, you can see that there are 9,544,788 changes of codon between man and chimp. Since the total number of codons in the human Y chromosome is 20,810,241, then 9,544,788 amounts to a staggering 45.86% change.

In comparison, in the chart above for the X chromosome, you can see that there are 286,174 changes between chimp and human. Since the total number of codons in the human X chromosome is 51,403,705, a difference of 286,174 codons amounts to only 0.56% change.

I am so startled by this discovery. Male humans are quite separate from apes – as if they were not made in the image of their animal neighbours. We really are an innovation or aberration, depending on your point of view.

Perhaps X chromosome - being vital for reproduction, was more conserved, whilst the Y chromosome was freer to vary, and adapt to a changing hostile environment.

Y Chromosome Not Alone

In 11 of the human chromosomes more than 10% of the codons have been changed compared to the chimp codons. So, it is not just the Y chromosomes that diverge from the image of our chimpanzee neighbours – many other chromosomes do too.

Building Blocks and Regulation

The building blocks of our anatomy, the proteins, are coded for by the coding regions in DNA. Science has established that these coding regions are about 98% identical. This makes sense because our bodies are made of flesh, bone, muscle, sinew, nerve, blood, etc and these are the same tissues for us as for chimpanzees, so would utilize the same building blocks.

What is different is the way in which these building blocks are organized.

What this study indicates is that there are much greater differences within the non-coding regions of DNA compared to the coding regions, and the percentage of different codons varies from 0.5% to 45% depending upon the chromosome.

The building blocks are the same, but how those blocks are used defines the difference between one species and another. The “idea” or “design” for our particular species (the way the blocks are organised) resides in the regulatory sequences of non-coding DNA. In this respect, we are significantly different from chimpanzees.

Social Implications of a Significant Difference

It looks like we are significantly different from chimpanzees. We have all met people whose violence and cold exploitation of others was excused by the idea that “well, we are just animals, and nature is red in tooth and claw – its survival of the fittest”. If we are different from apes, then perhaps they should assume a more authentic and uniquely human behaviour, befitting their separate genetic identity.

Given a 45% difference in the Y chromosome between man and chimps, the average man can no longer be confident in modelling his public or private behaviour on that of monkeys or beasts.

These discoveries place modern “ape-men” on the brink of a significant existential crisis. The emerging differences between ape and man challenge the core of their cherished identity.

Further Research

1. Does the genotype differ less between different apes compared to between apes and humans. If we are apes, then the genetic distance between us and apes should not be greater than the genetic distance between different kinds of apes.
2. Does the genotype differ the same between apes and dogs as between apes and humans.
3. Does our phenotype differ significantly from apes.

Measuring Sequence Identity

In this paper, [Chimpanzee DNA Sequences Queried Against Human Genome | Answers Research Journal](#), the authors look for words of length 7 nucleotides within DNA of chimp and human. Rather than counting codons, I could count the frequencies of every word of length 7 nucleotides.

However, to do so would mean that there were 4^7 possible words to count = 16384 words. One way to do this would be to create an array of two columns – column 1 would have all possible words, and column 2 would be incremented by 1 each time a word appeared.

If Chimp DNA is 98% identical to human DNA, then the frequency of 7 letter words should also be 98% similar. The advantage of this approach is that I can cover each chromosome fully.

In a sense, the counts I have carried out above are for codons (three letter words), so extending this to 4 letter words or more is a natural progression.

ASCII is a numerical coding system for 256 characters. There are 256 possible 4-letter words.

In those chromosomes that have similar frequencies of codons, we might expect that there will be similar frequencies of 4 letter words too.

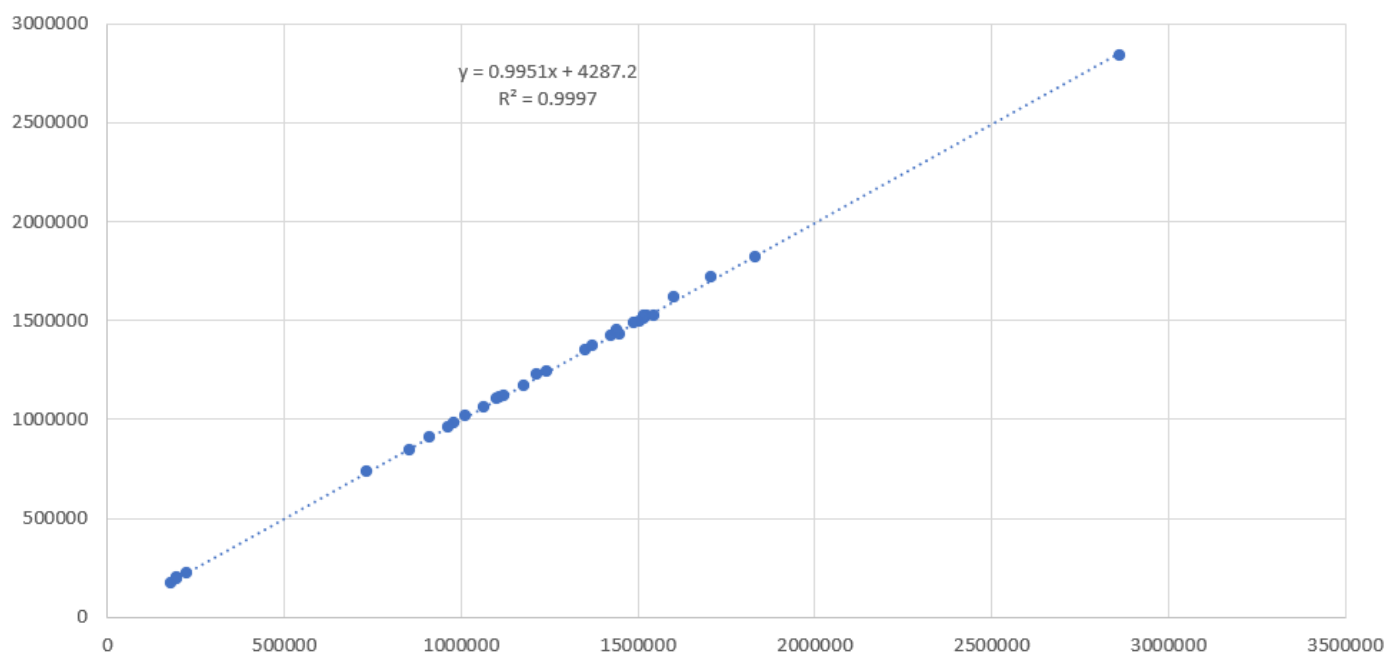
APPENDIX A

In this appendix I observe a beautiful mathematical ratio maintained in the codon counts of humans compared to chimps. It is observed that the frequency of any codon is equal to the frequency of its reverse compliment.

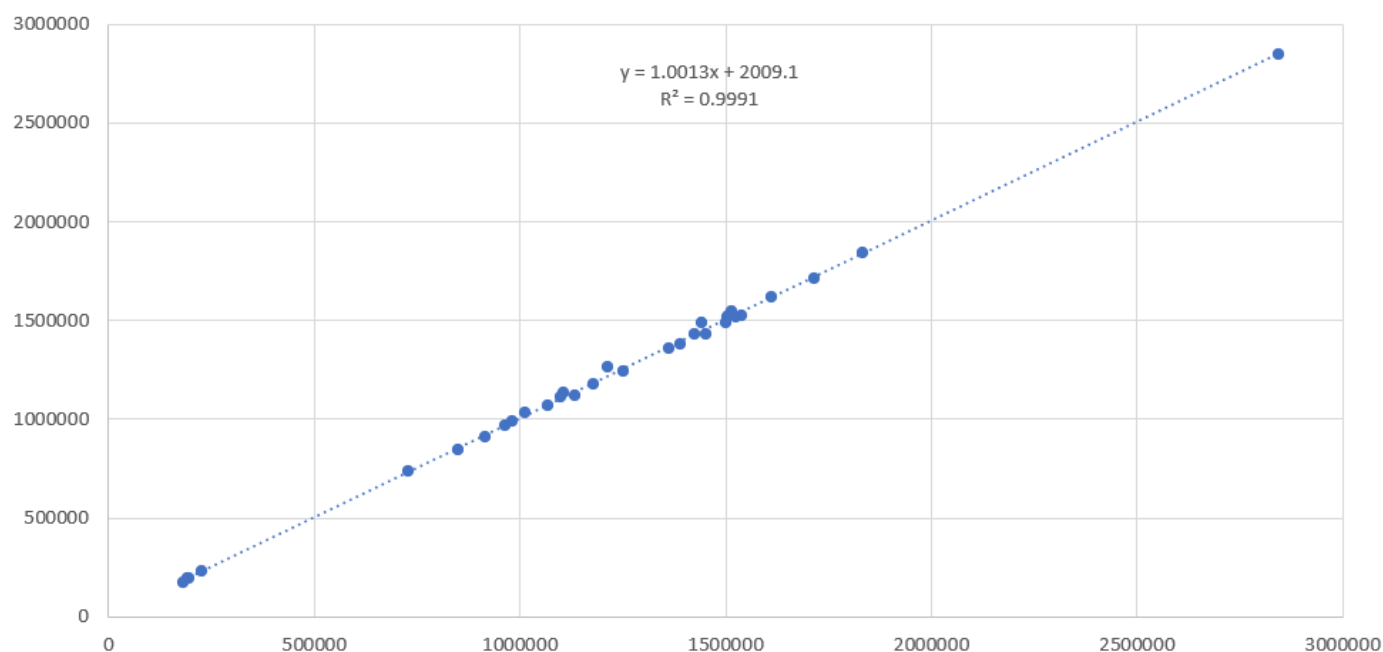
Chromosomes 5 to 22 of chimps and chimp chromosome Y show a divergence from this ratio. However, the ratio is maintained closely by chimp chromosomes 1 to 5 and by chimp chromosome X.

In contrast, chromosomes 1 to 22 of humans, and chromosome X of humans closely adhere to this ratio, and only chromosome Y of humans shows a strong divergence.

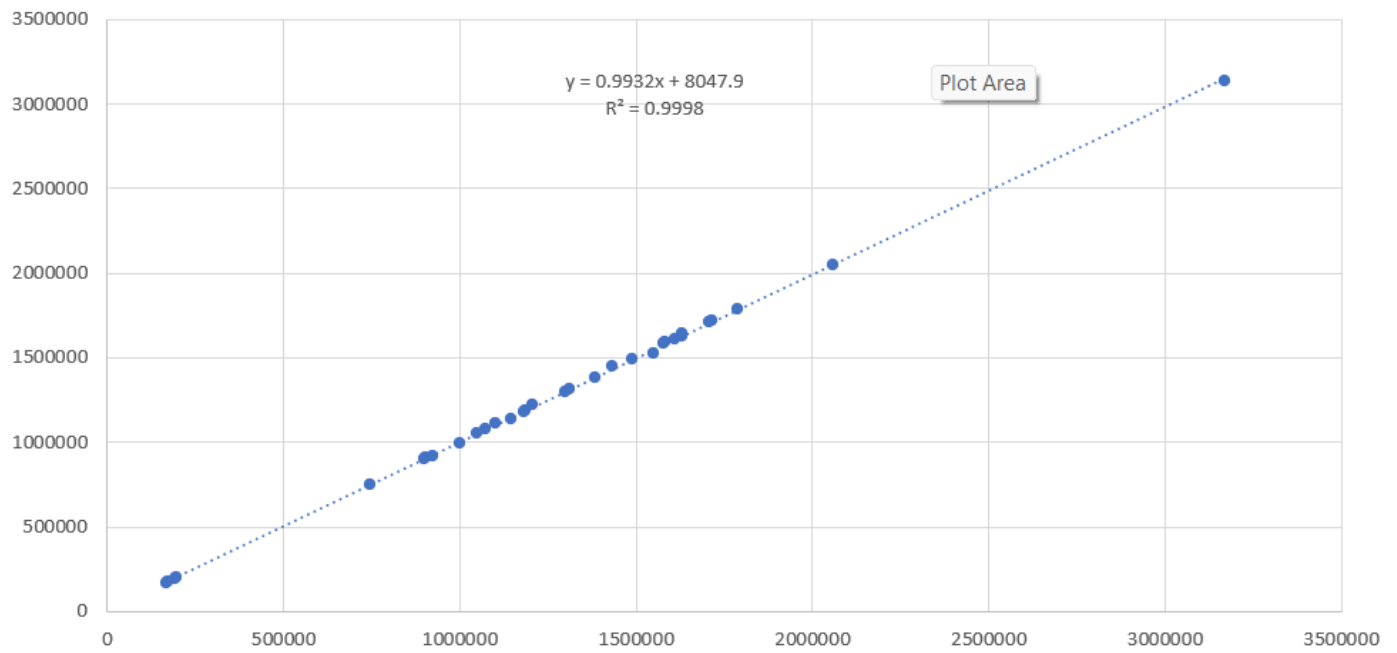
Chromosome 1 (Human)
Correlation between frequency of 32 codons and their reverse compliments



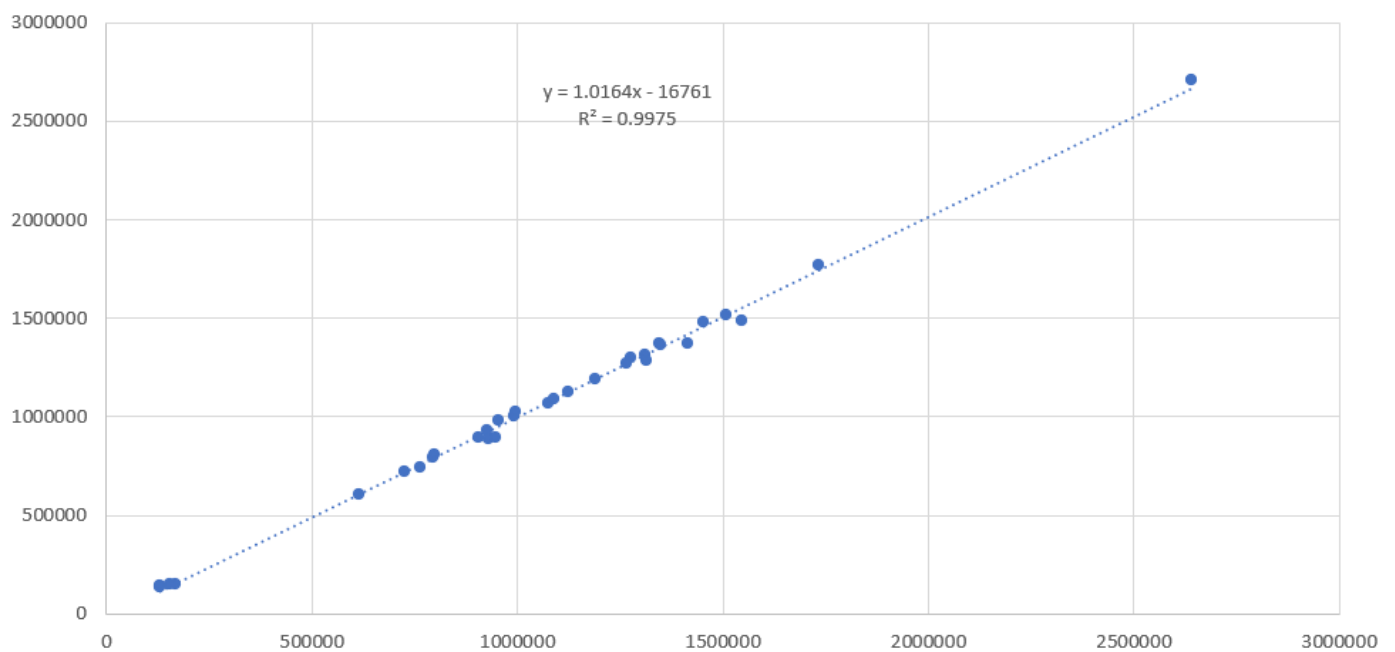
Chromosome 1 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



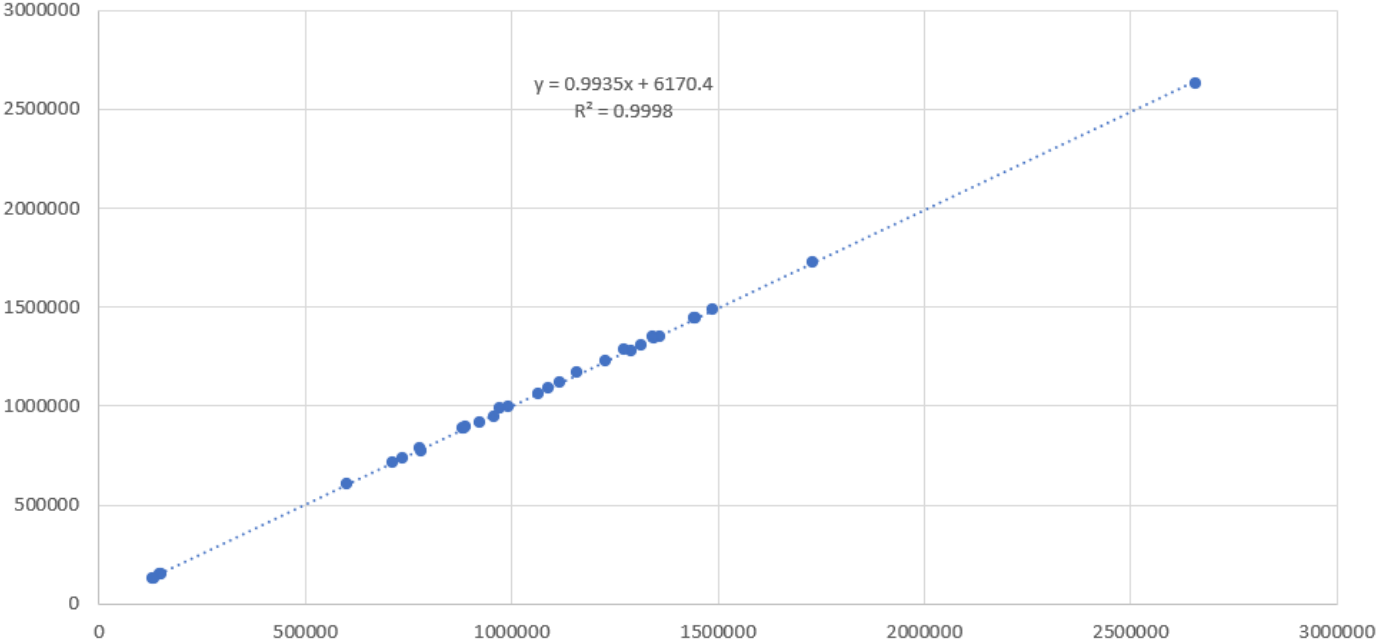
Chromosome 2 (Human)
Correlation between frequency of 32 codons and their reverse compliments



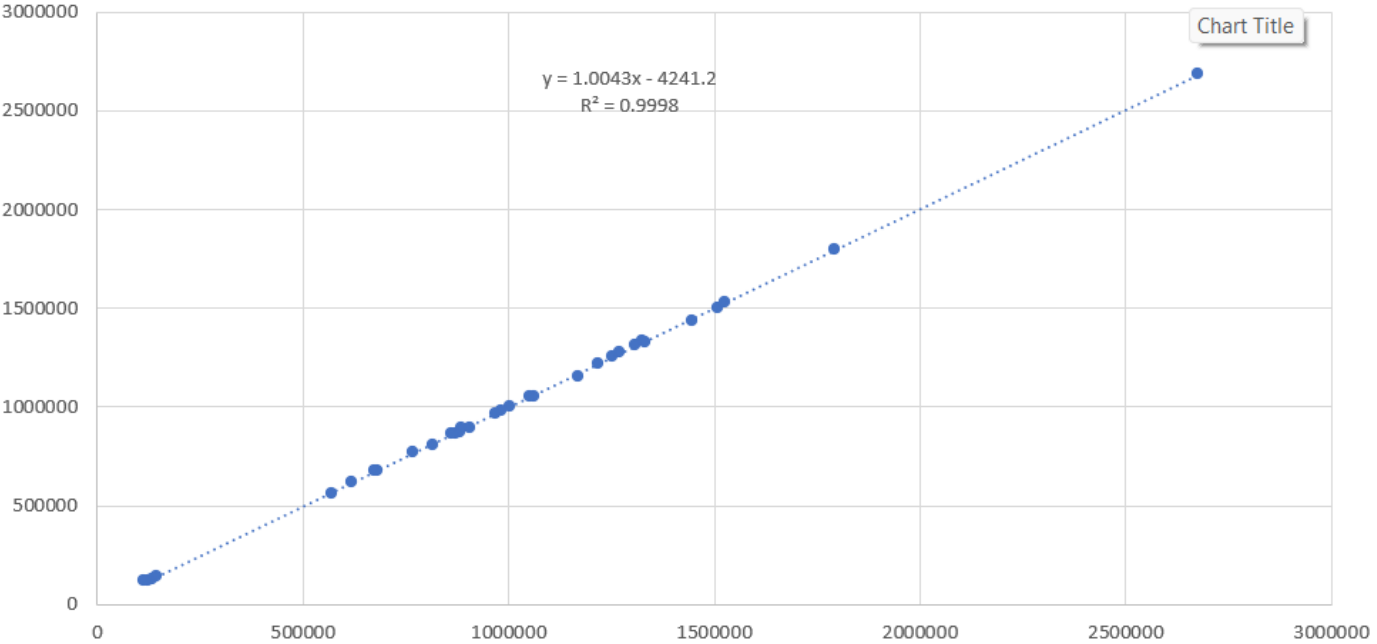
Chromosome 2 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



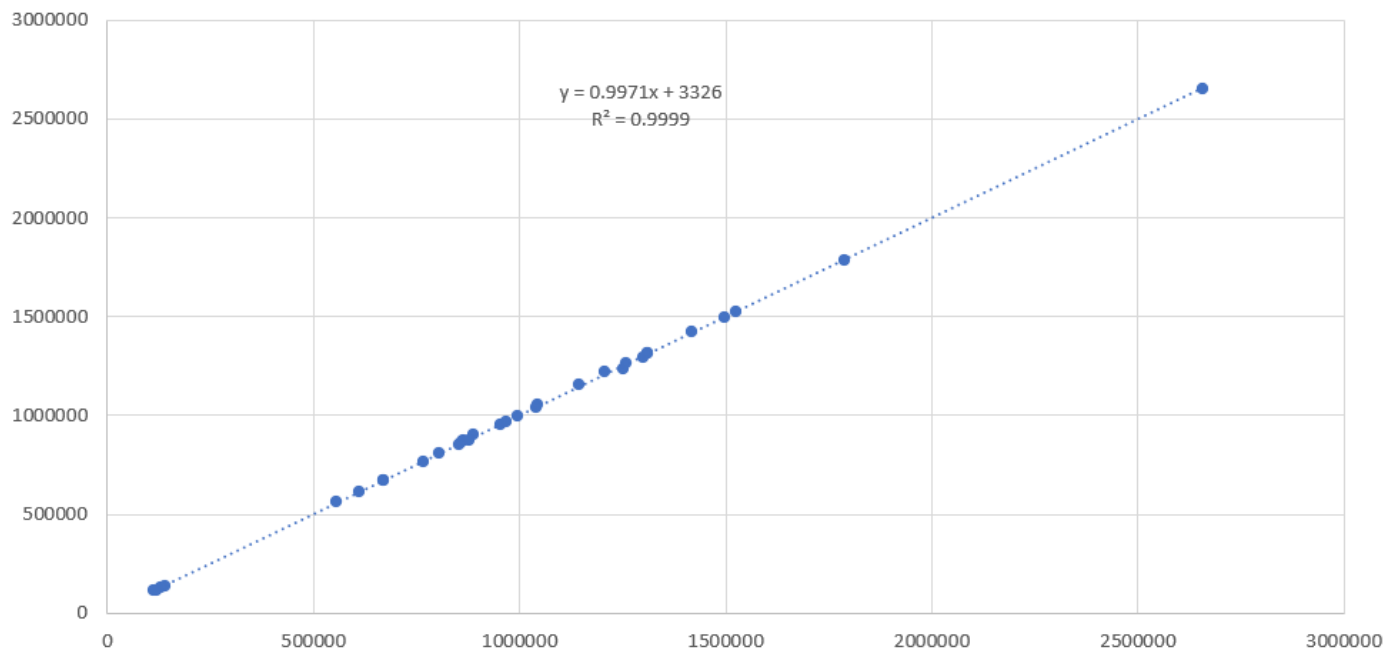
Chromosome 3 (Human)
Correlation between frequency of 32 codons and their reverse compliments



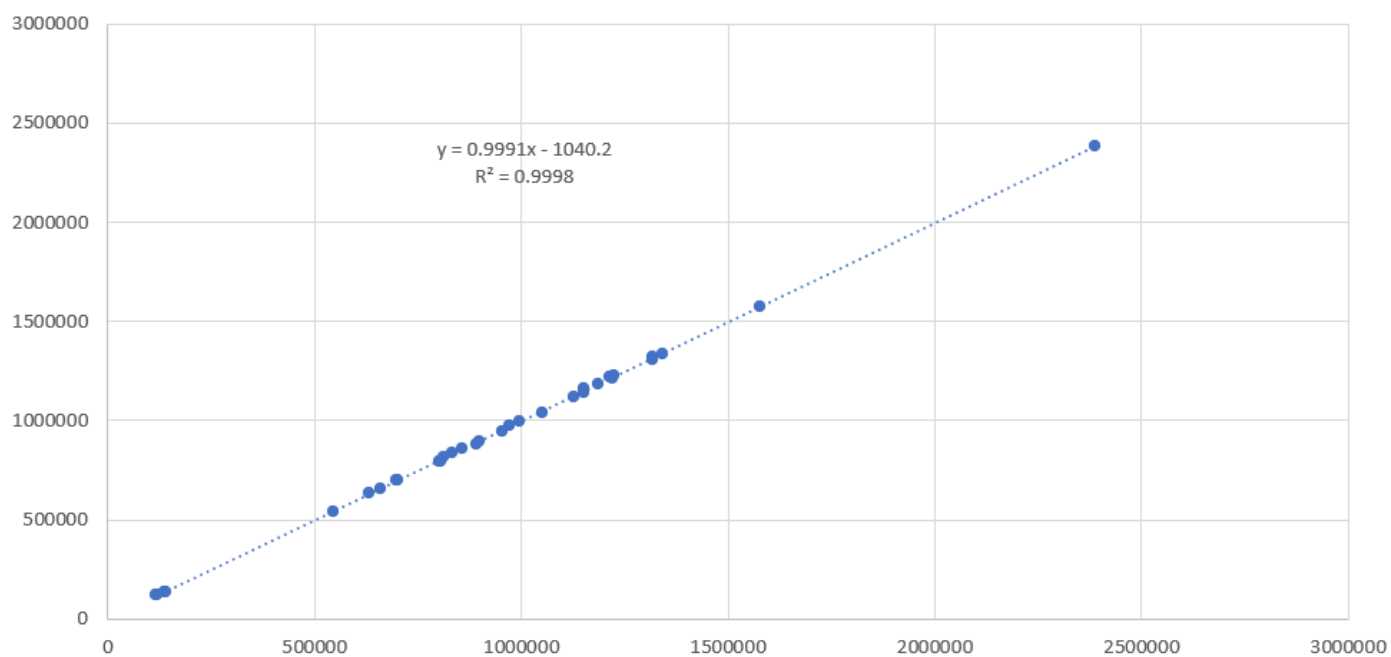
Chromosome 3 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



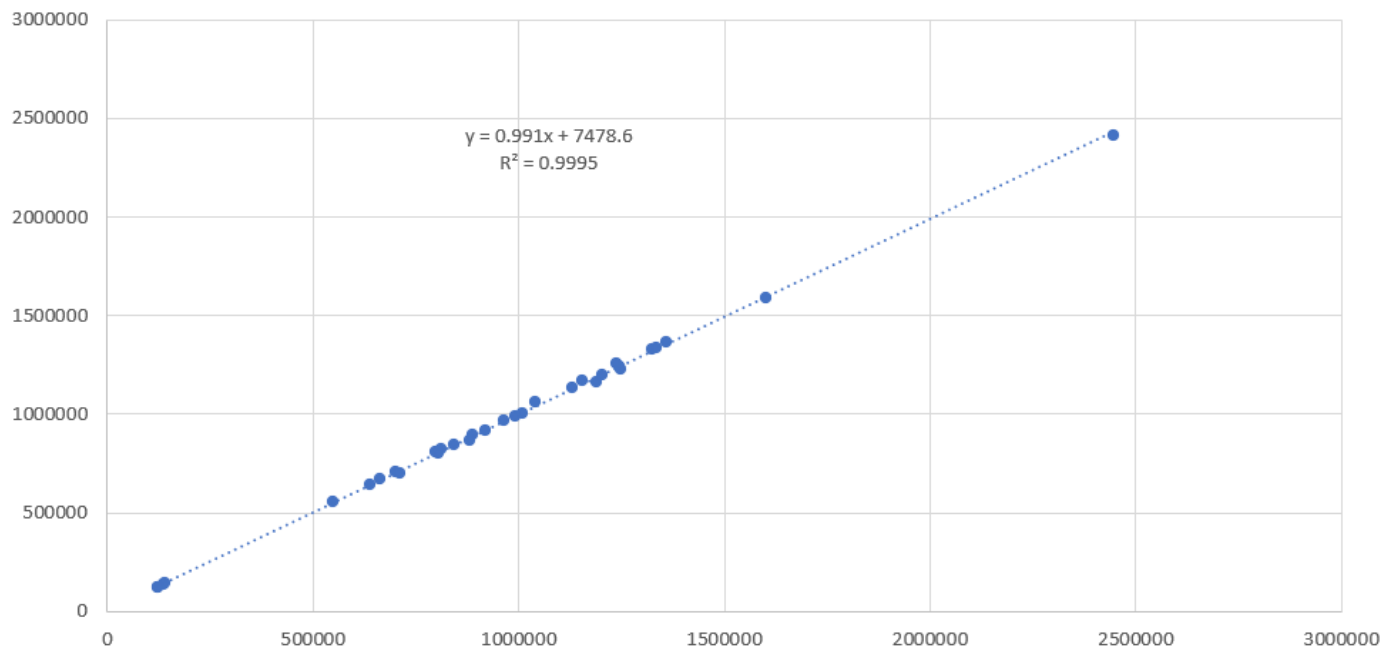
Chromosome 4 (Human)
Correlation between frequency of 32 codons and their reverse compliments



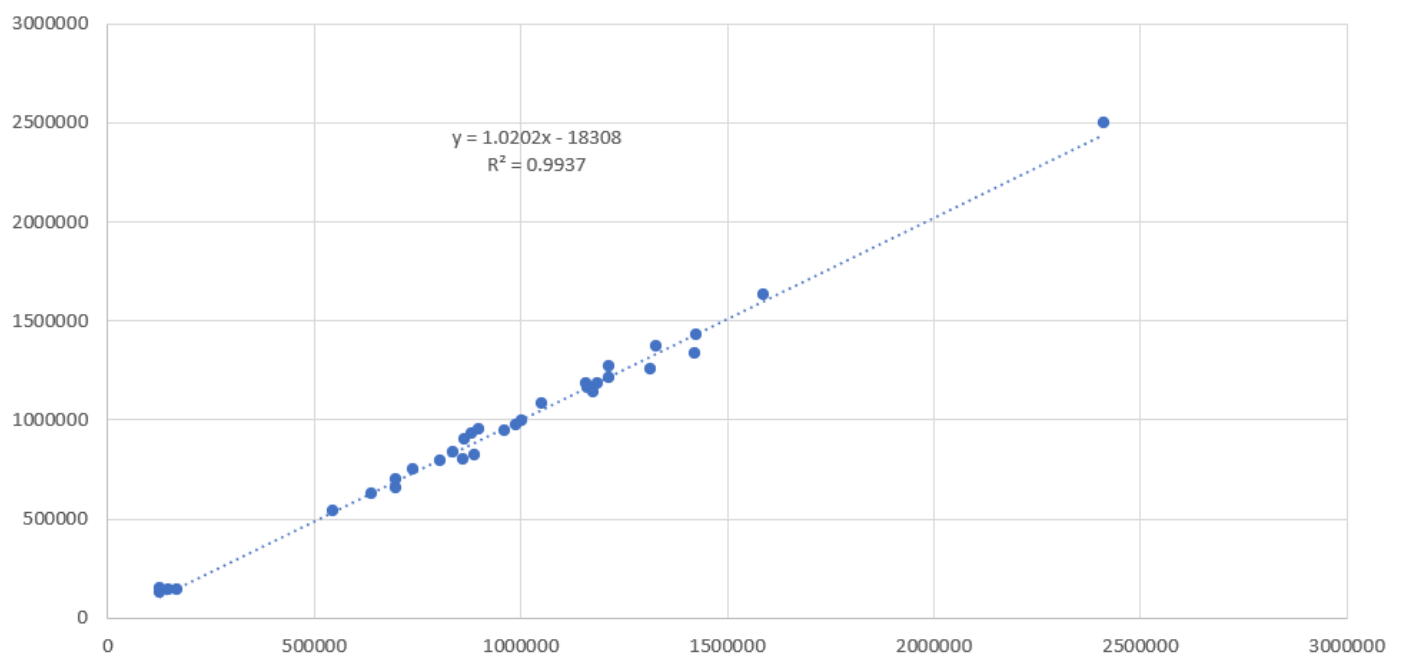
Chromosome 4 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



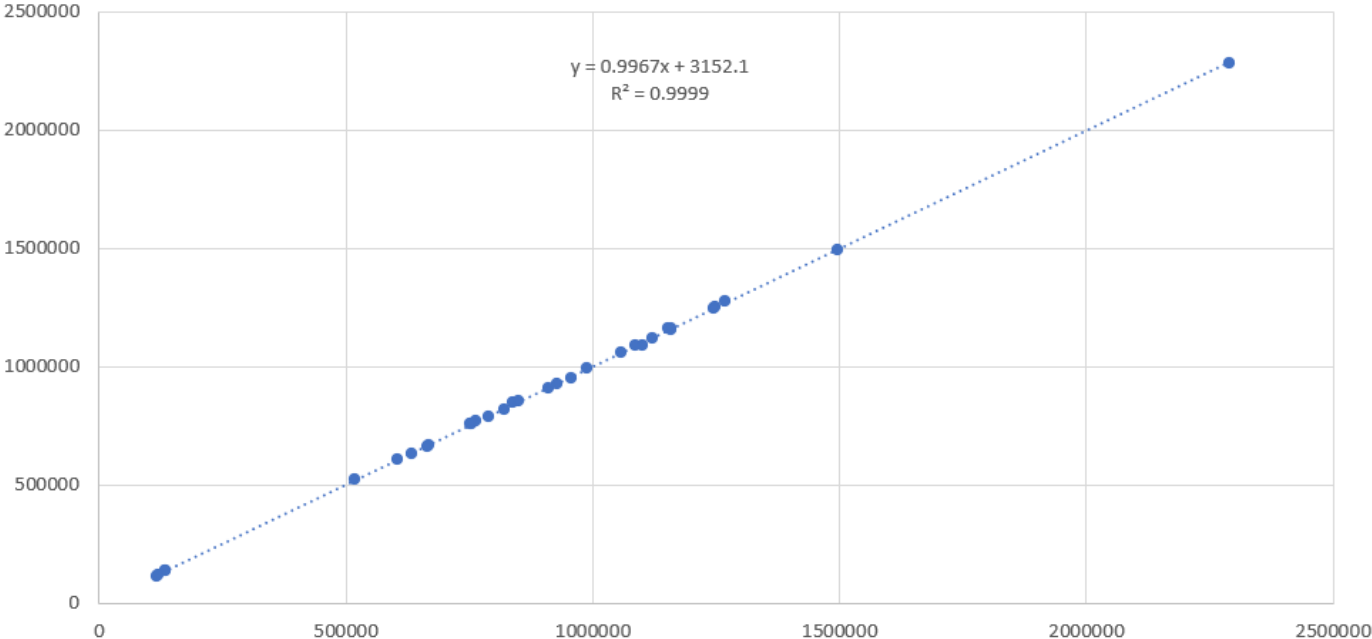
Chromosome 5 (Human)
Correlation between frequency of 32 codons and their reverse compliments



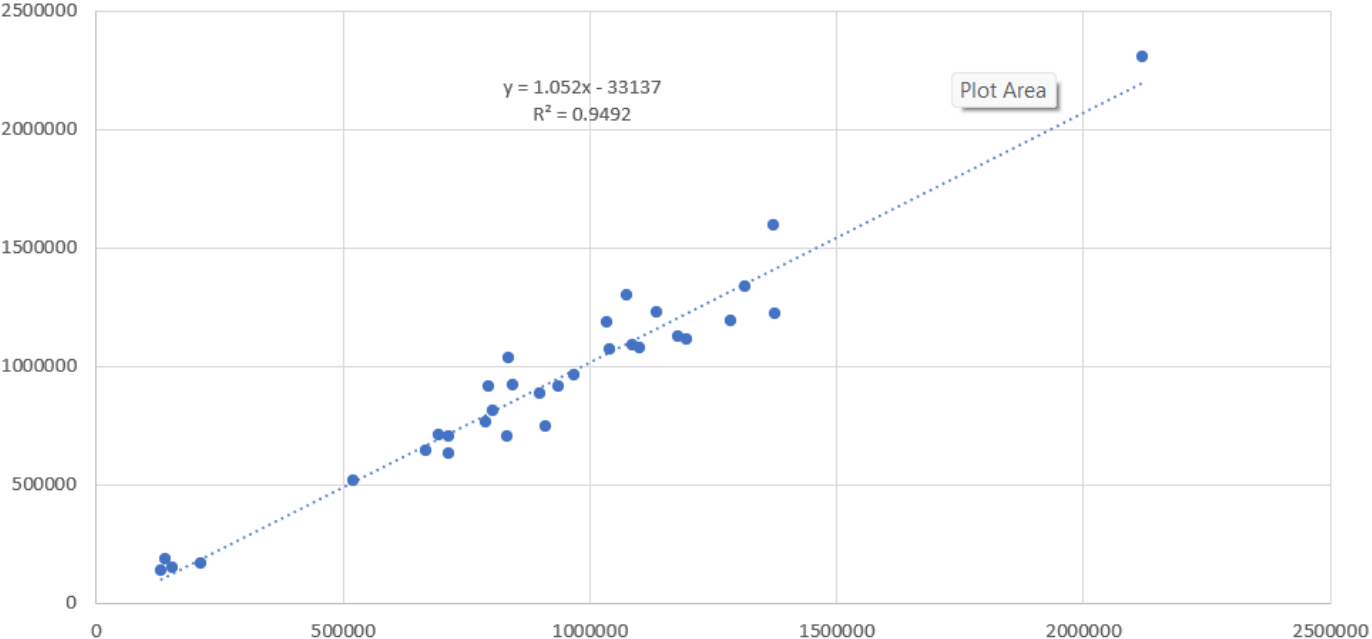
Chromosome 5 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



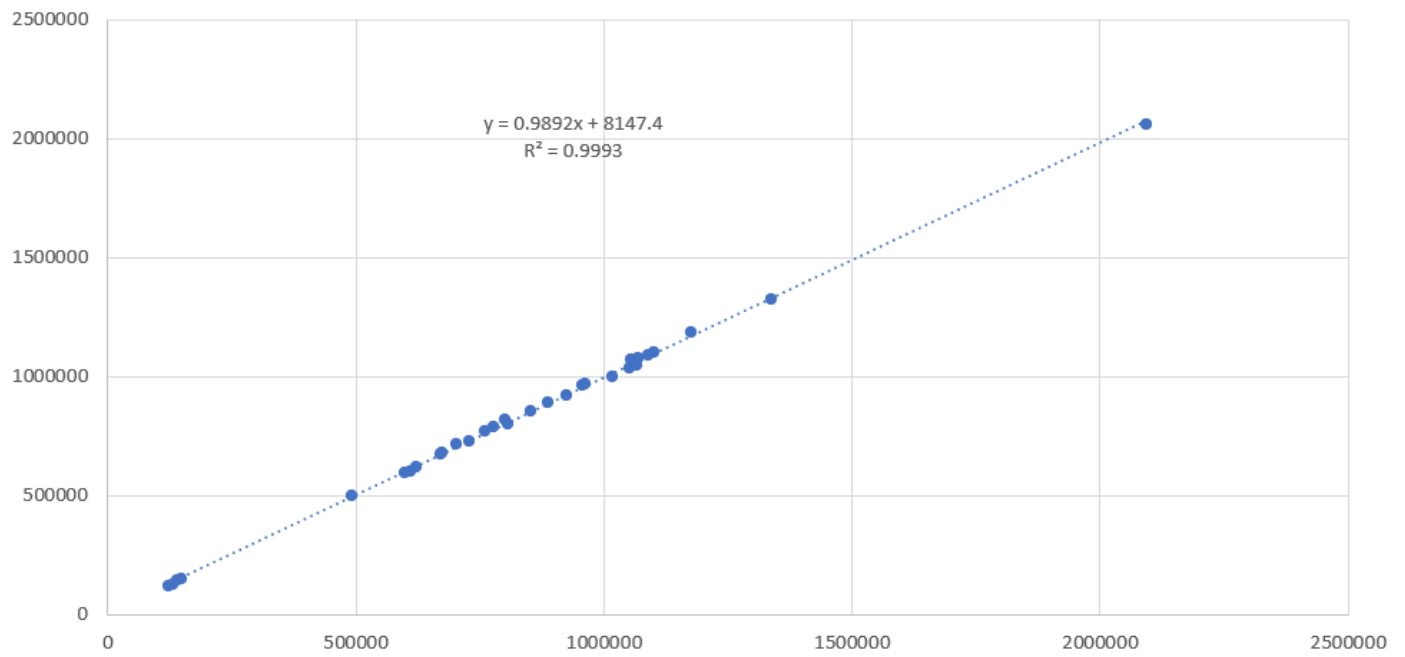
Chromosome 6 (Human)
Correlation between frequency of 32 codons and their reverse compliments



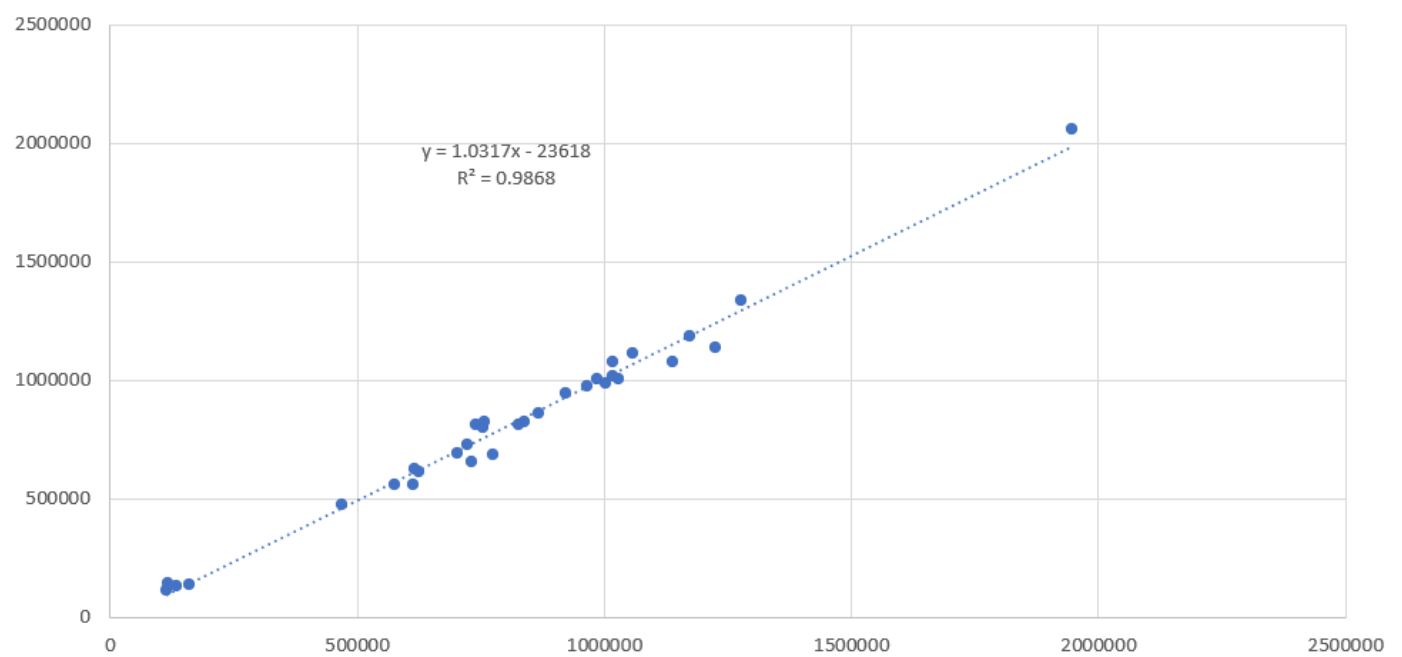
Chromosome 6 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



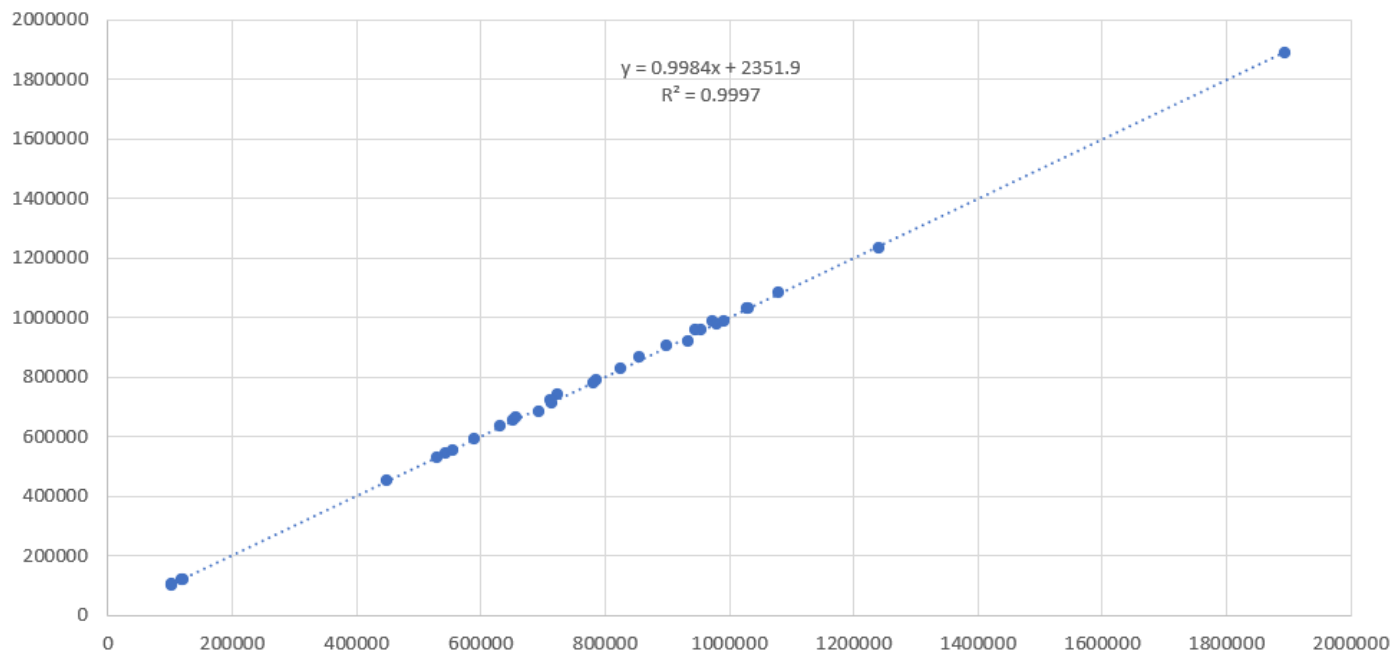
Chromosome 7 (Human)
Correlation between frequency of 32 codons and their reverse compliments



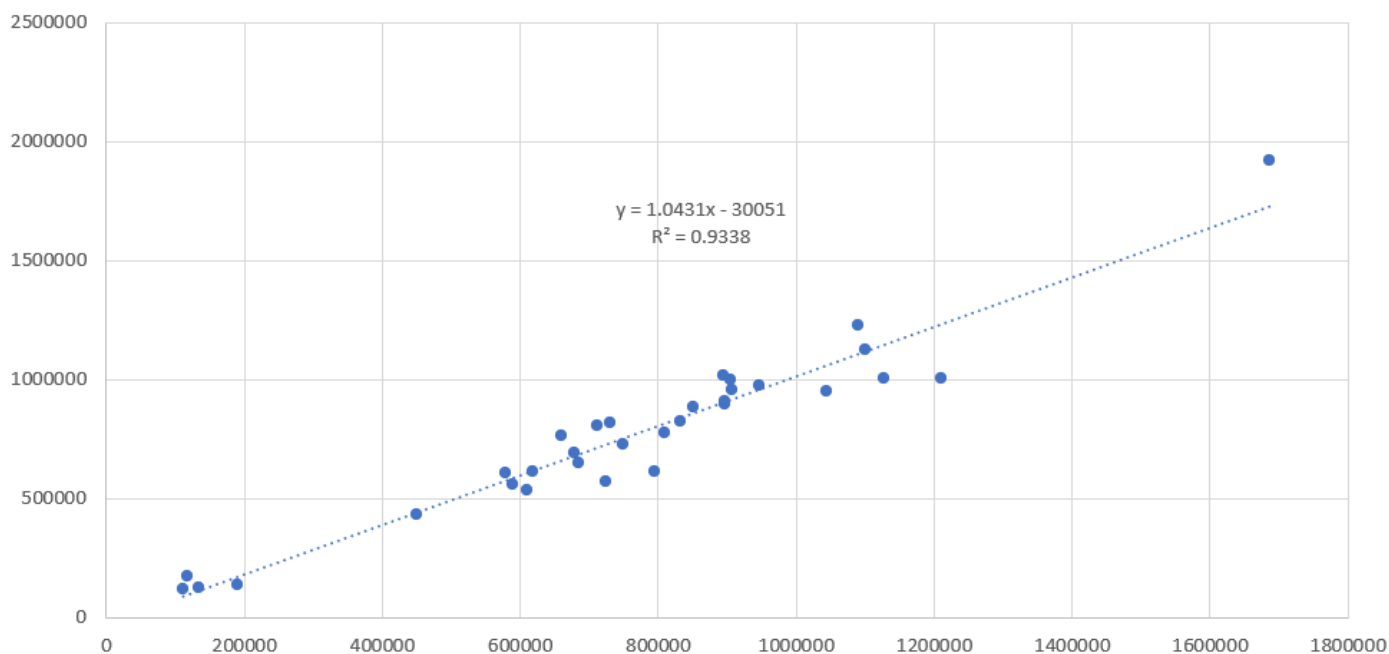
Chromosome 7 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



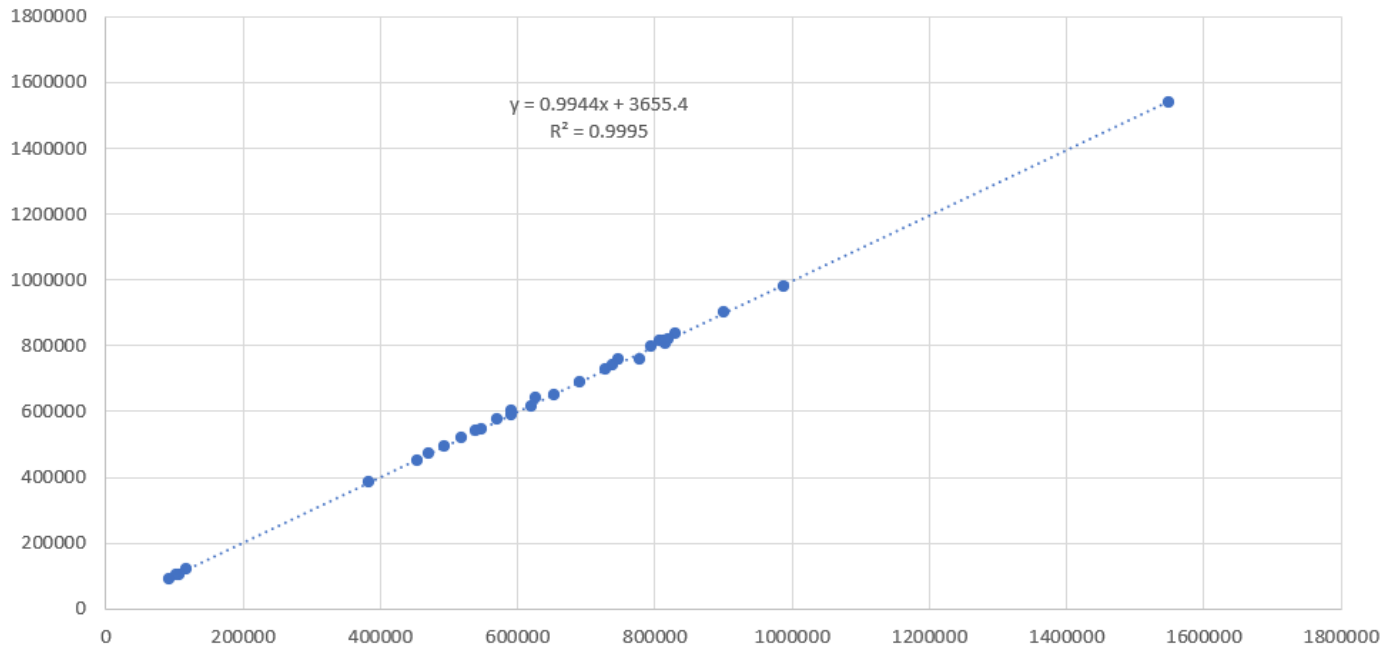
Chromosome 8 (Human)
Correlation between frequency of 32 codons and their reverse compliments



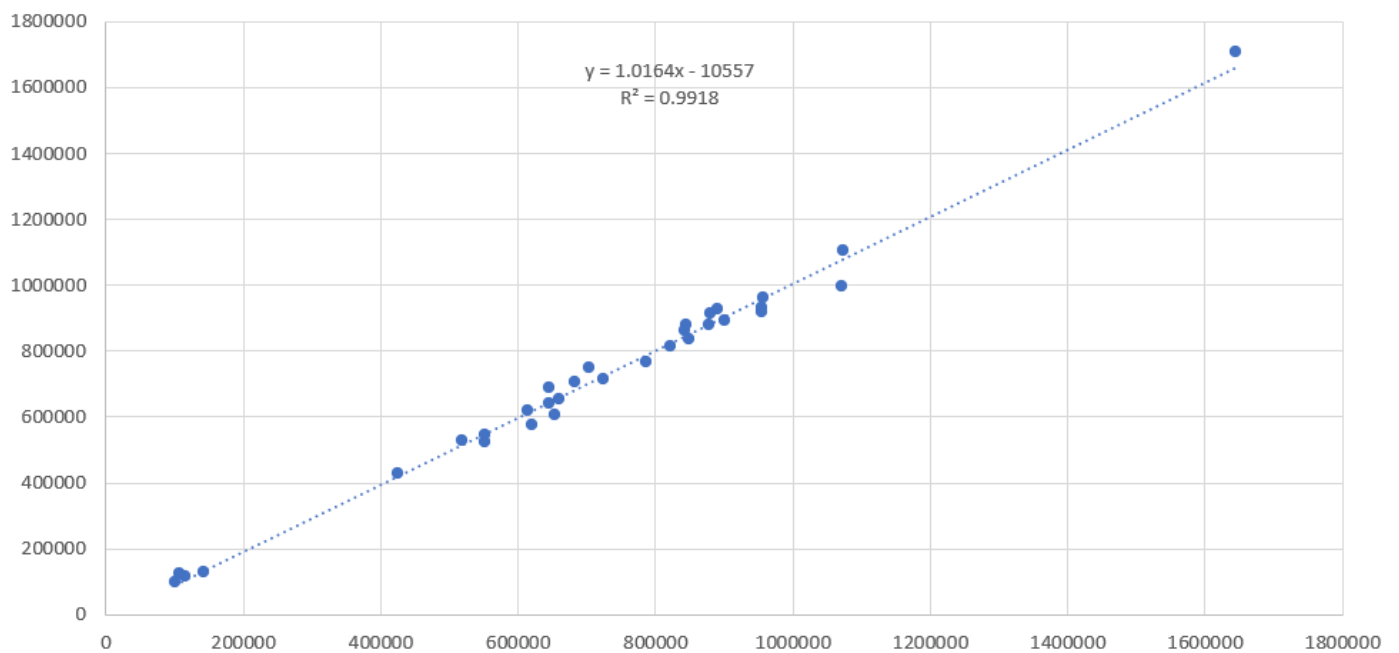
Chromosome 8 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



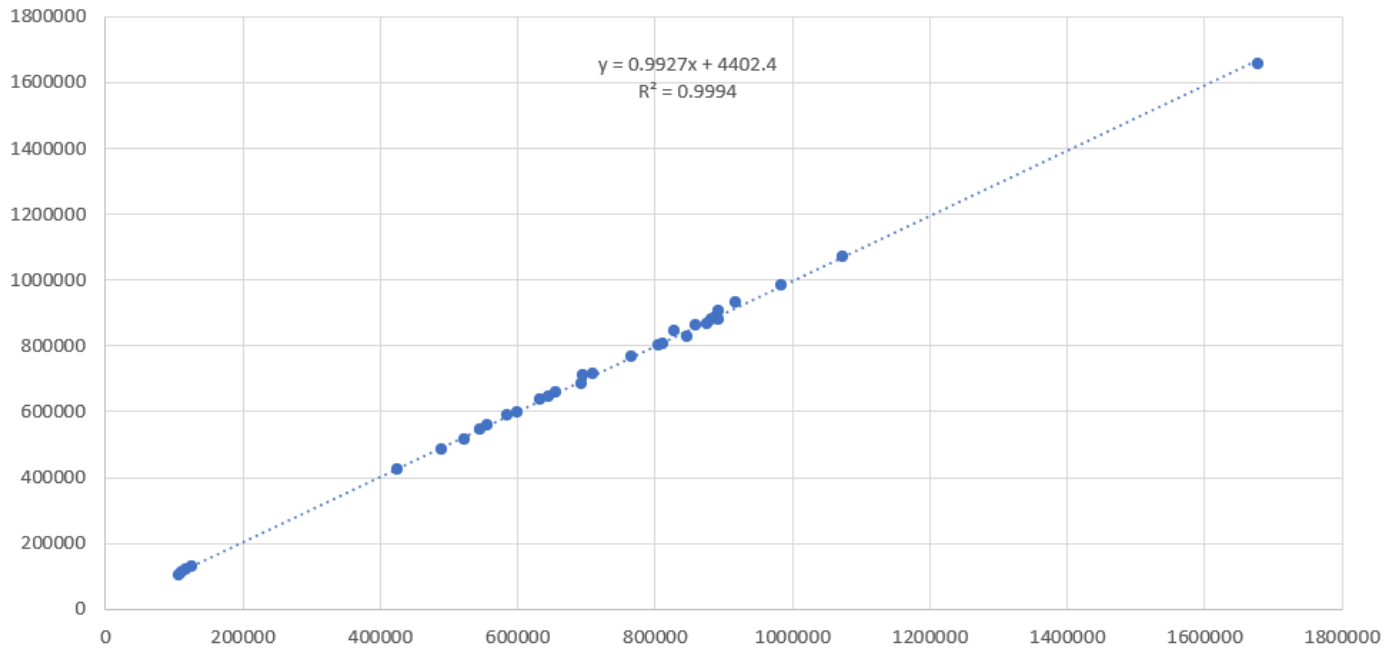
Chromosome 9 (Human)
Correlation between frequency of 32 codons and their reverse compliments



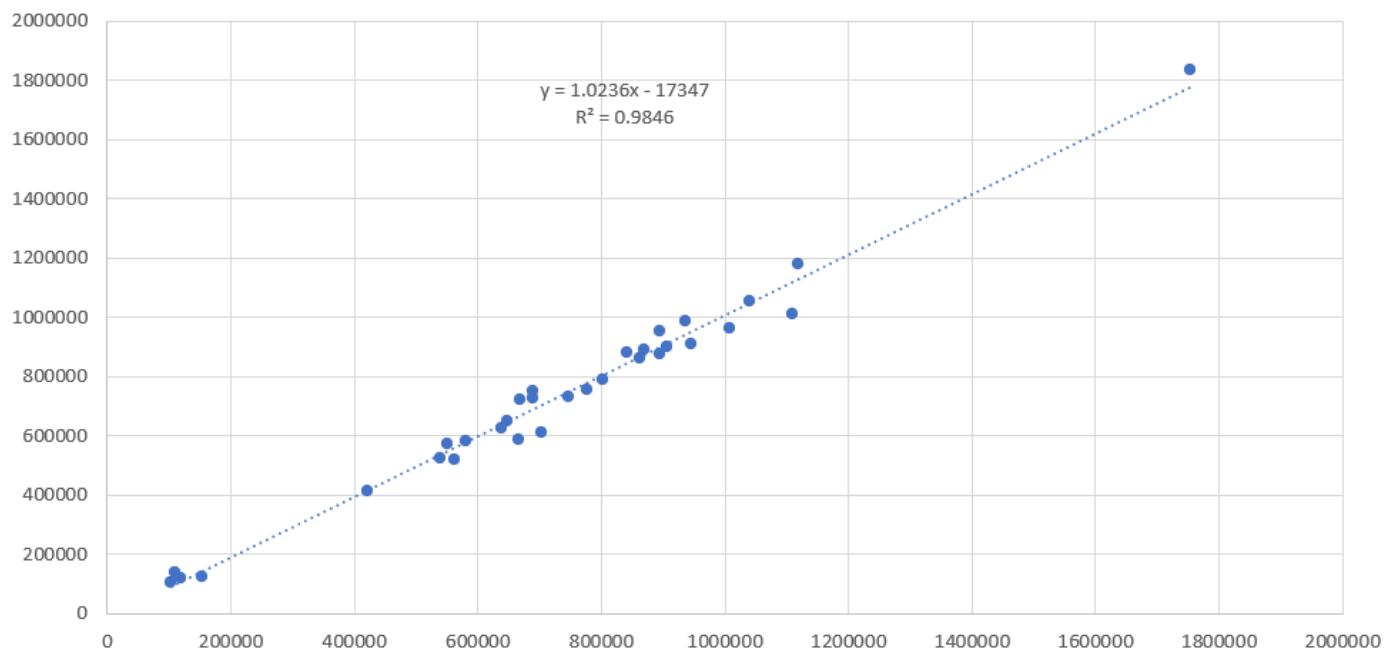
Chromosome 9 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



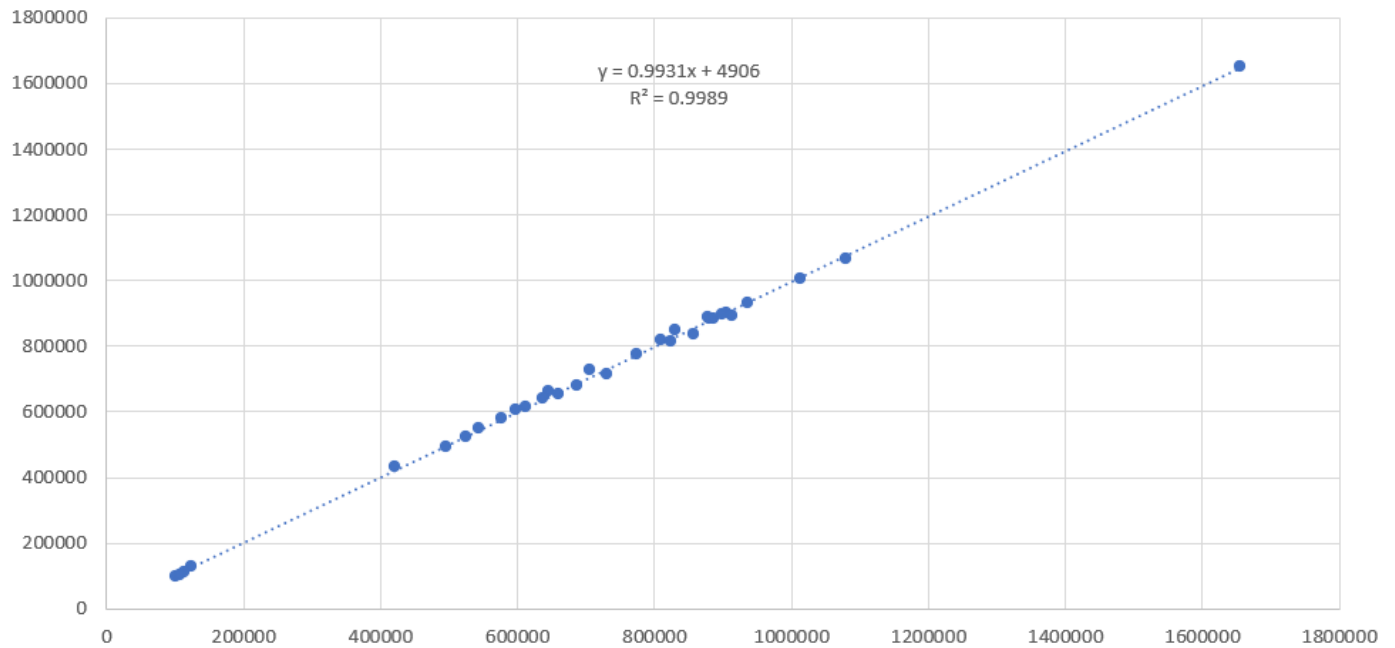
Chromosome 10 (Human)
Correlation between frequency of 32 codons and their reverse compliments



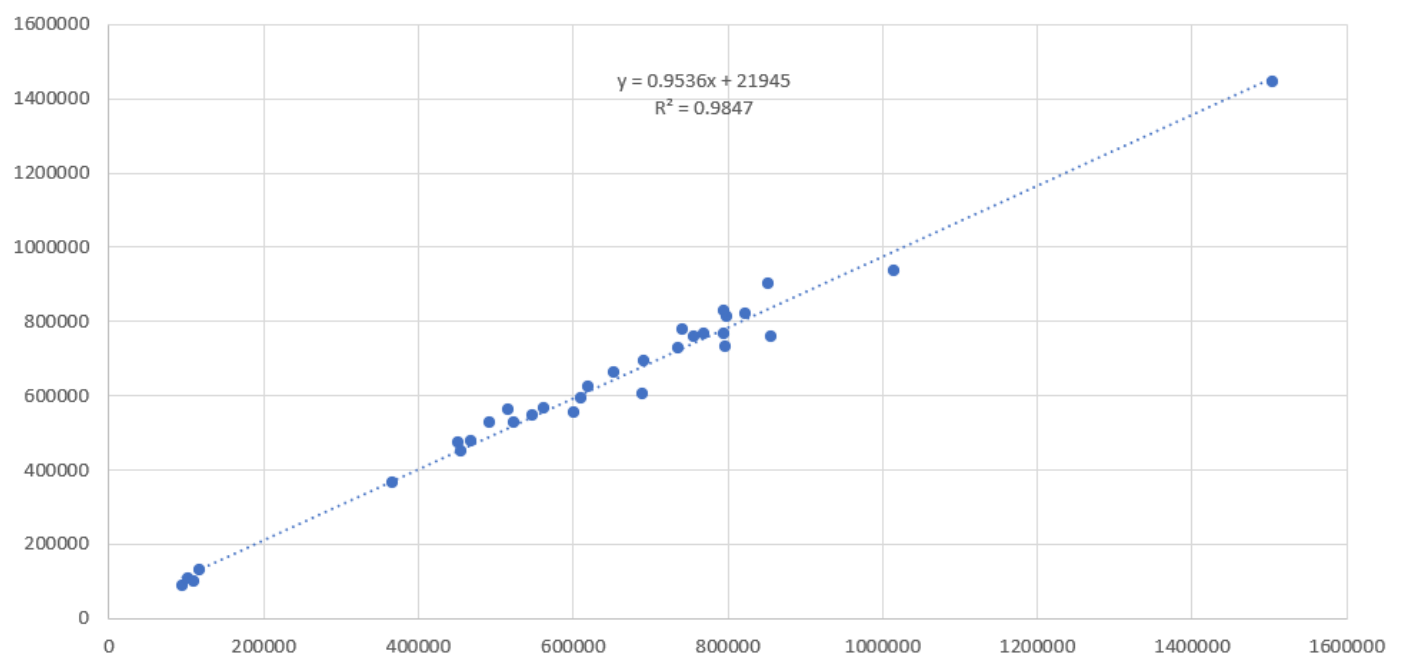
Chromosome 10 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



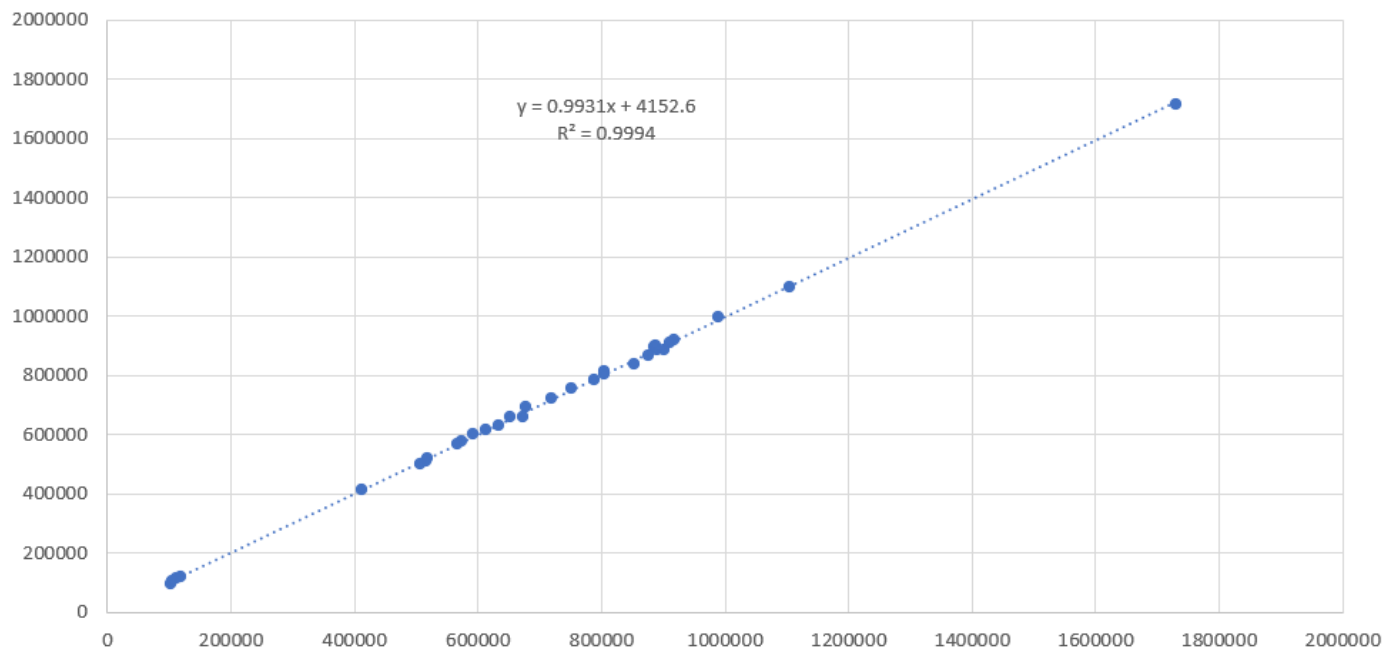
Chromosome 11 (Human)
Correlation between frequency of 32 codons and their reverse compliments



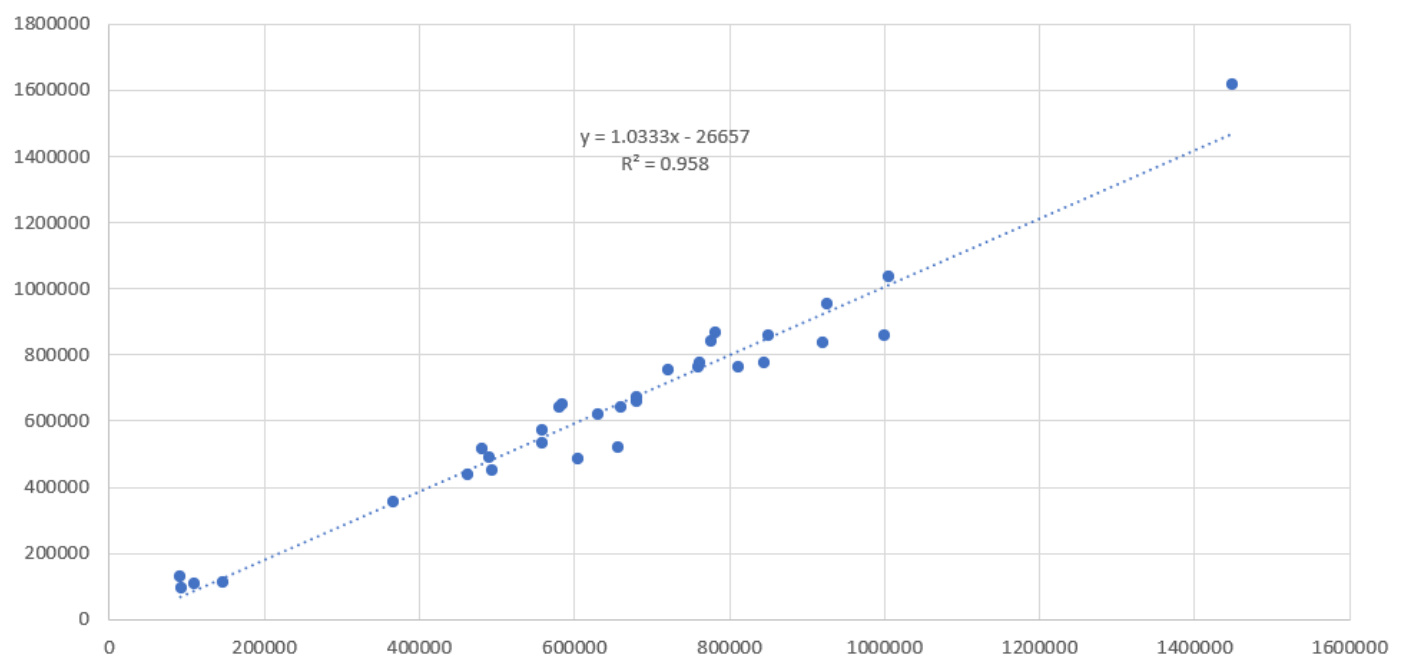
Chromosome 11 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



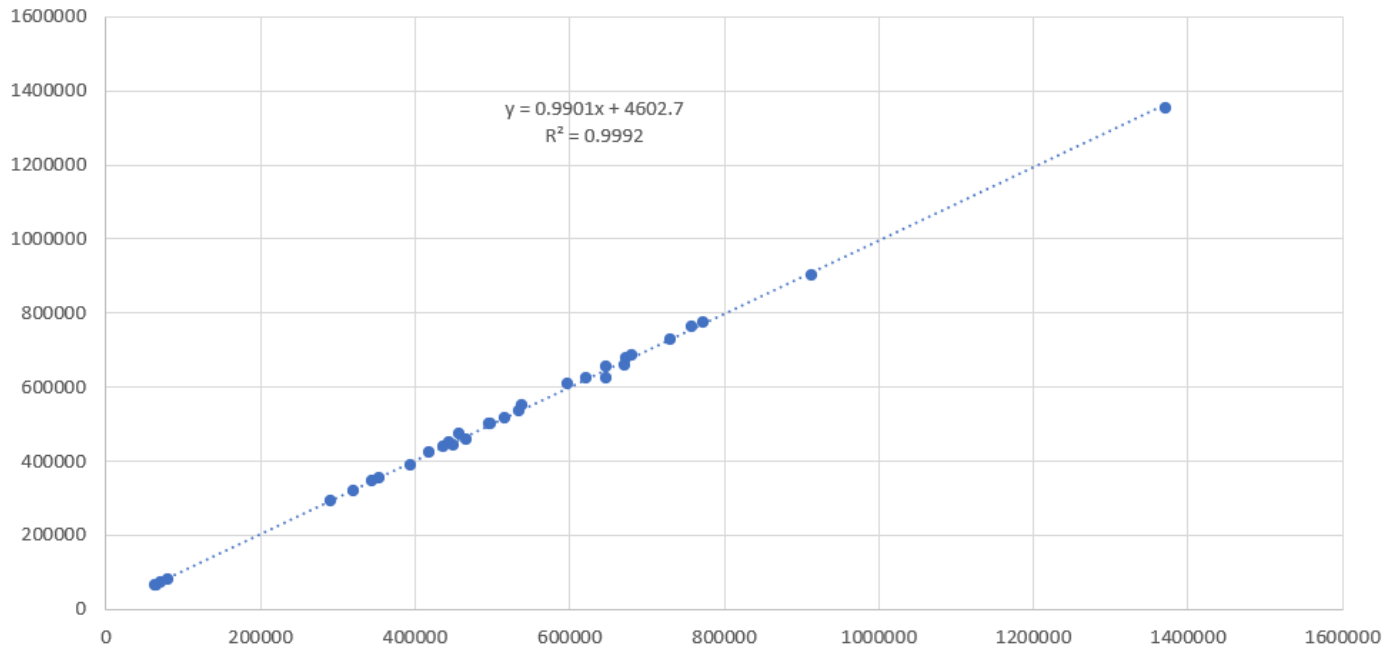
Chromosome 12 (Human)
Correlation between frequency of 32 codons and their reverse compliments



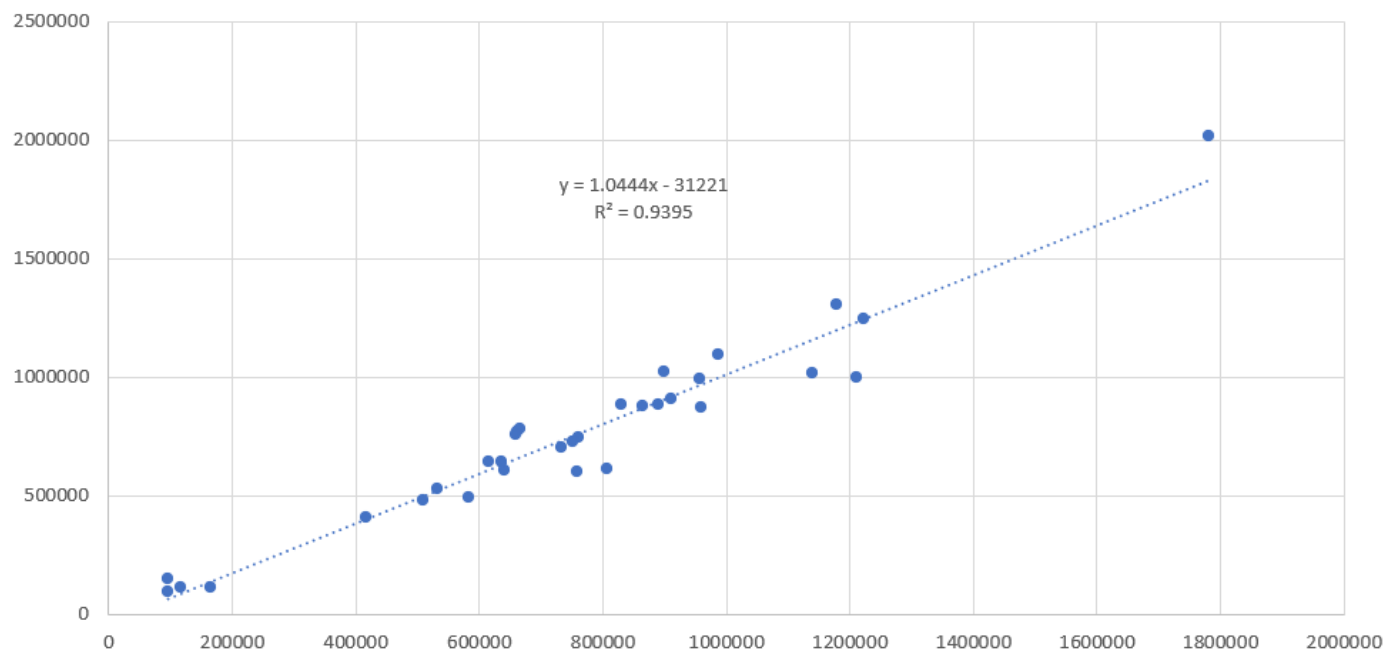
Chromosome 12 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



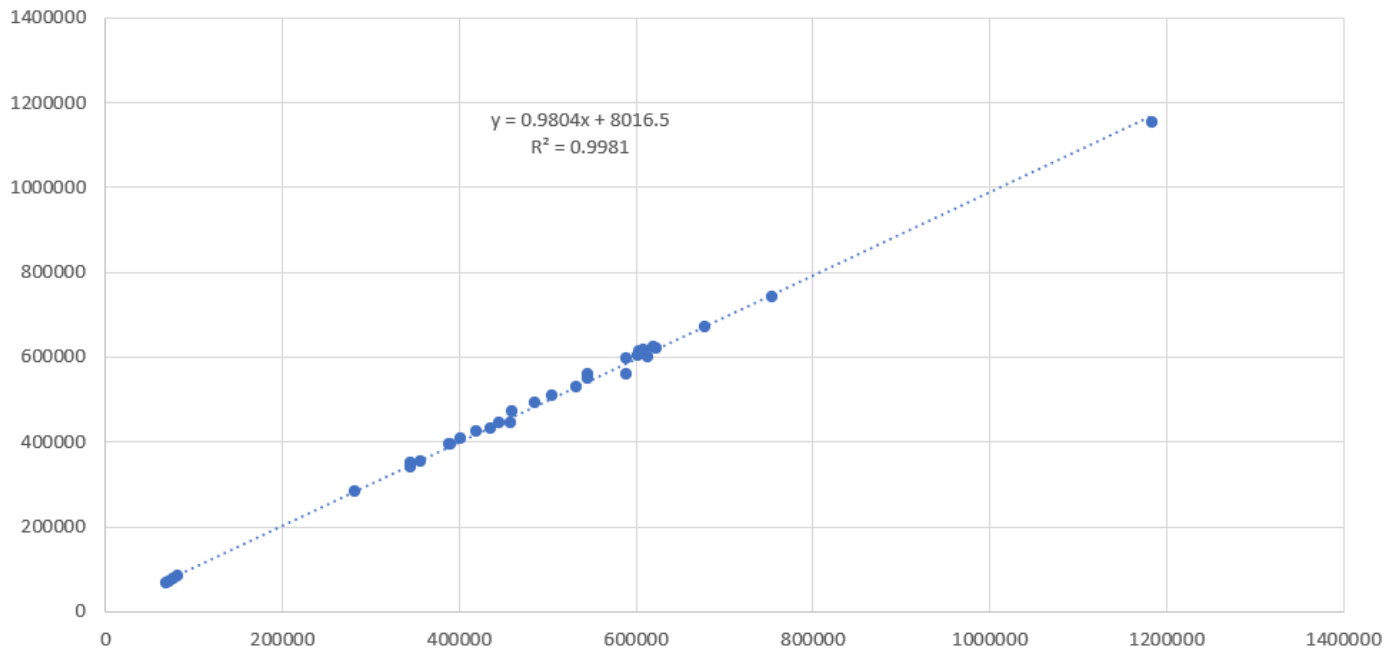
Chromosome 13 (Human)
Correlation between frequency of 32 codons and their reverse compliments



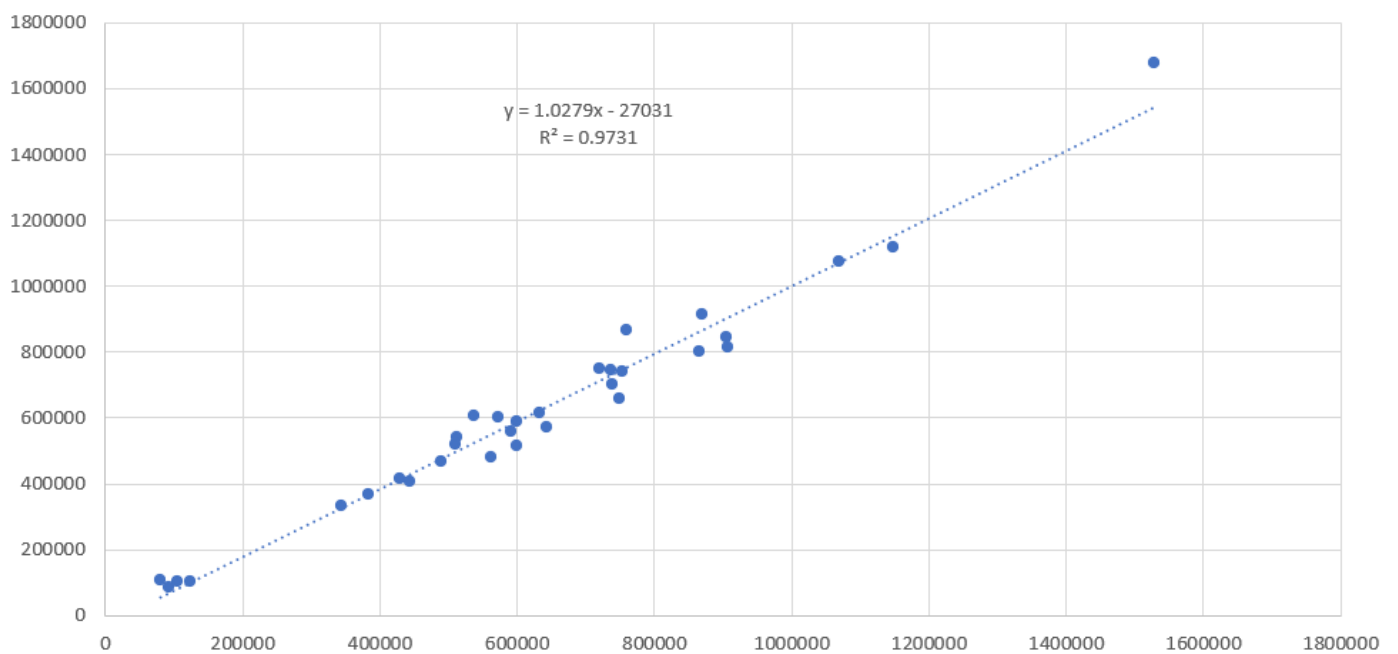
Chromosome 13 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



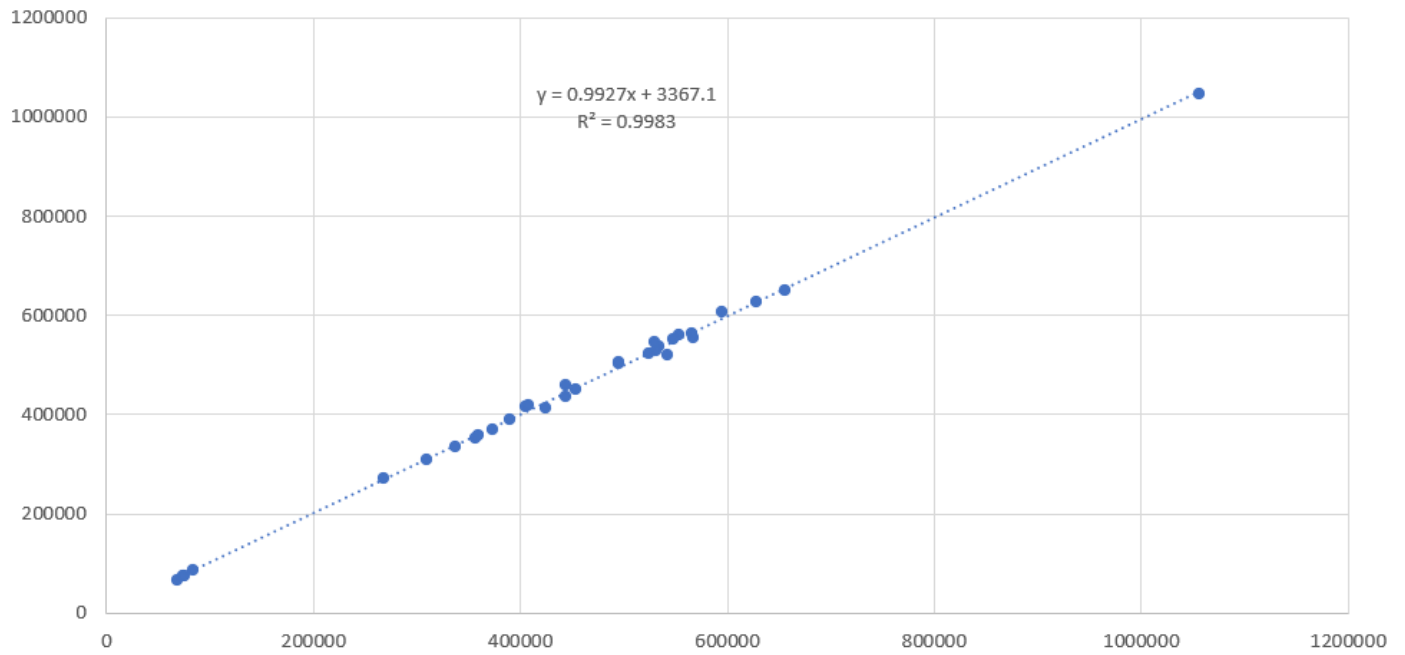
Chromosome 14 (Human)
Correlation between frequency of 32 codons and their reverse compliments



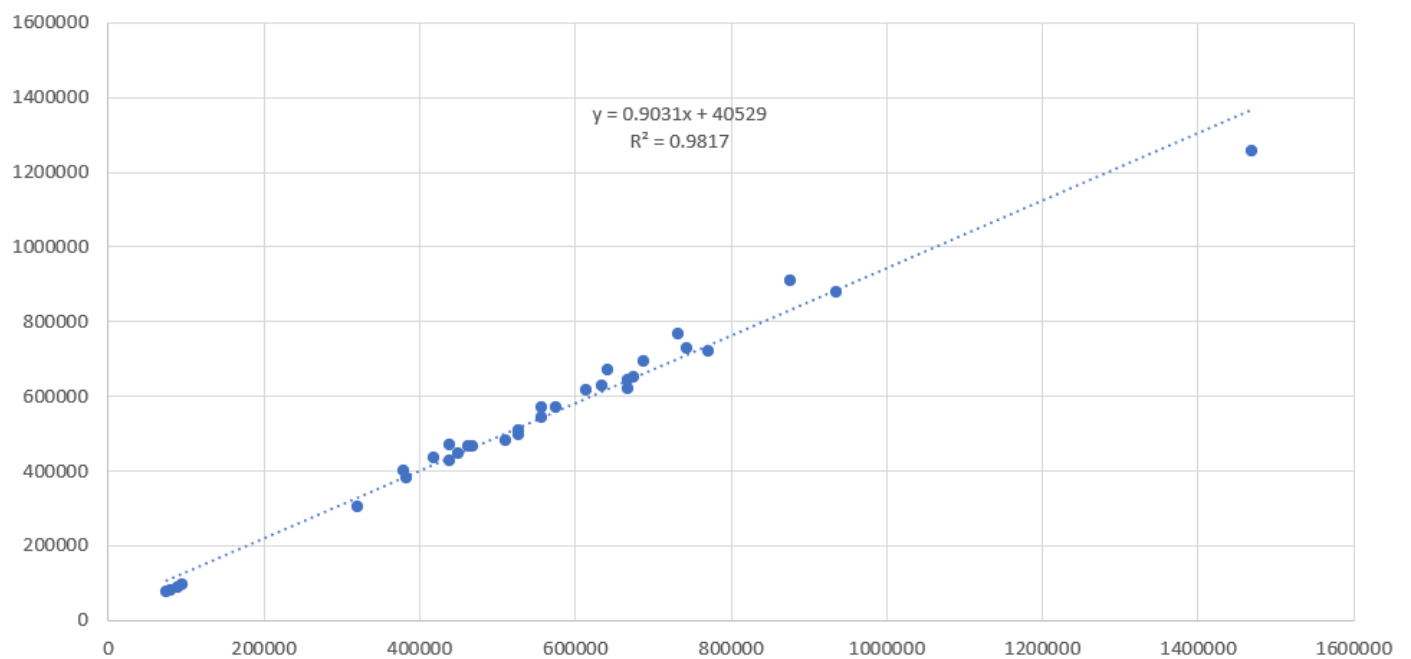
Chromosome 14 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



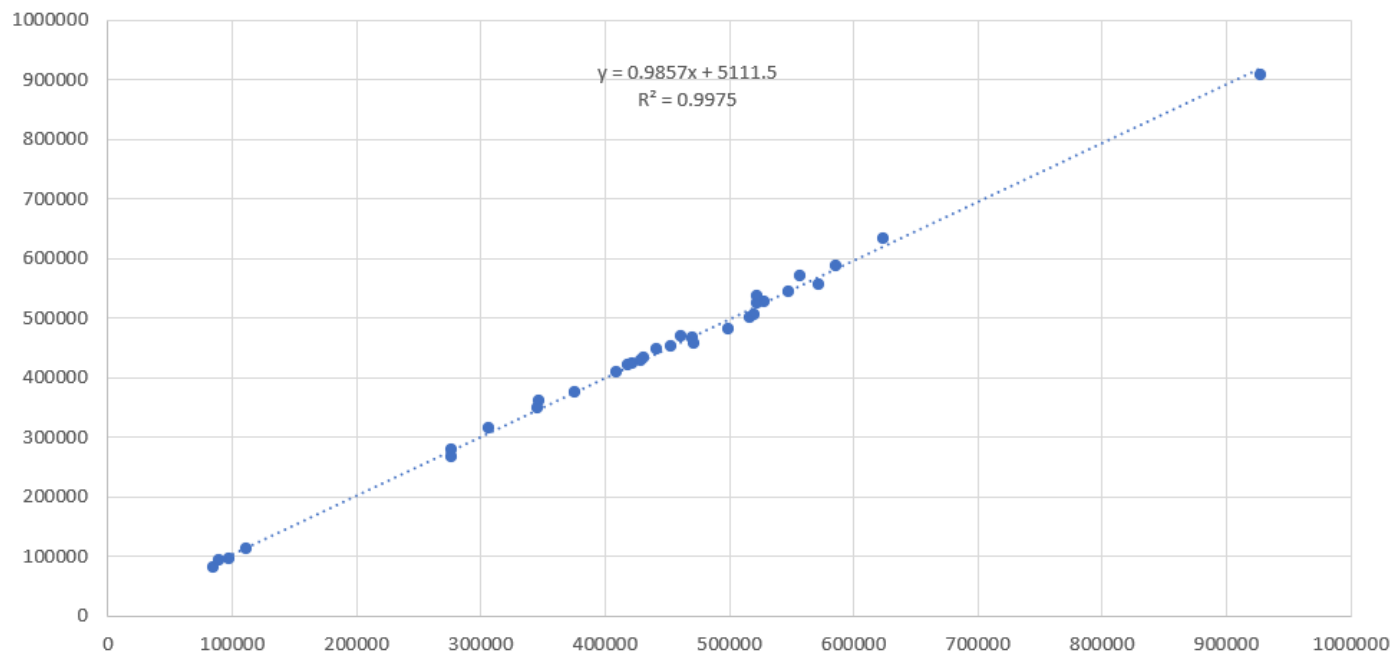
Chromosome 15 (Human)
Correlation between frequency of 32 codons and their reverse compliments



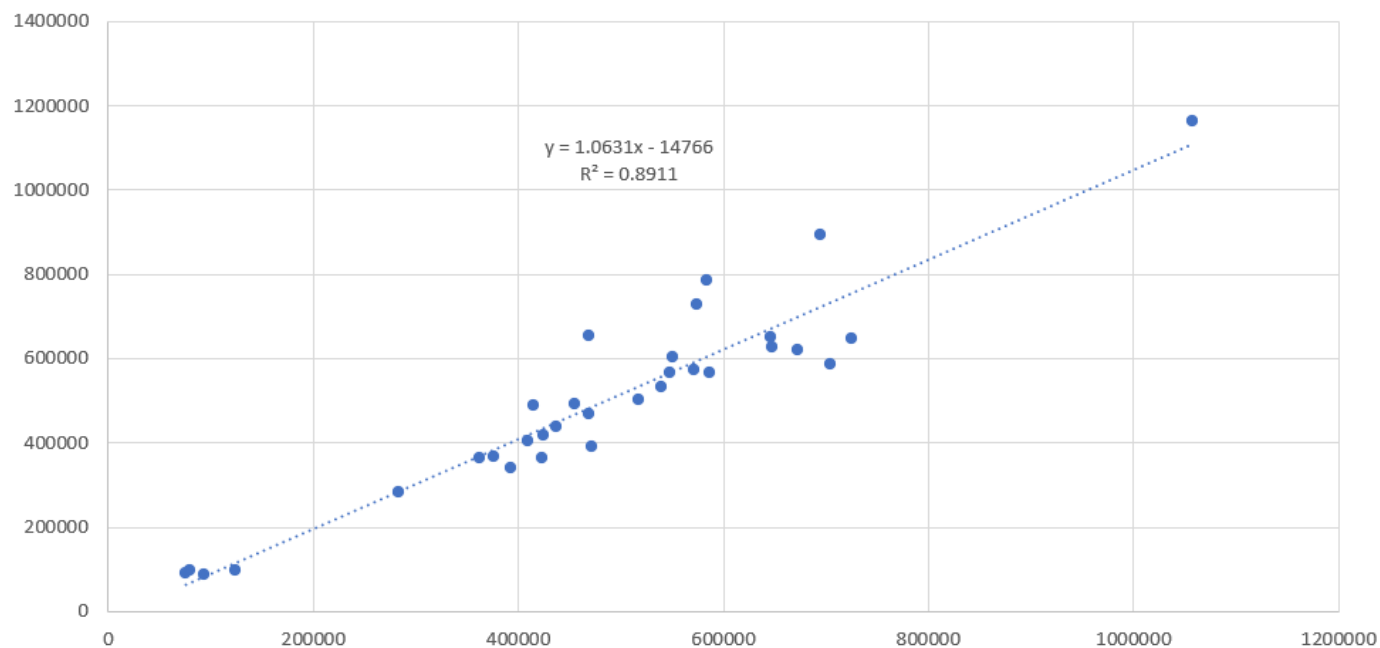
Chromosome 15 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



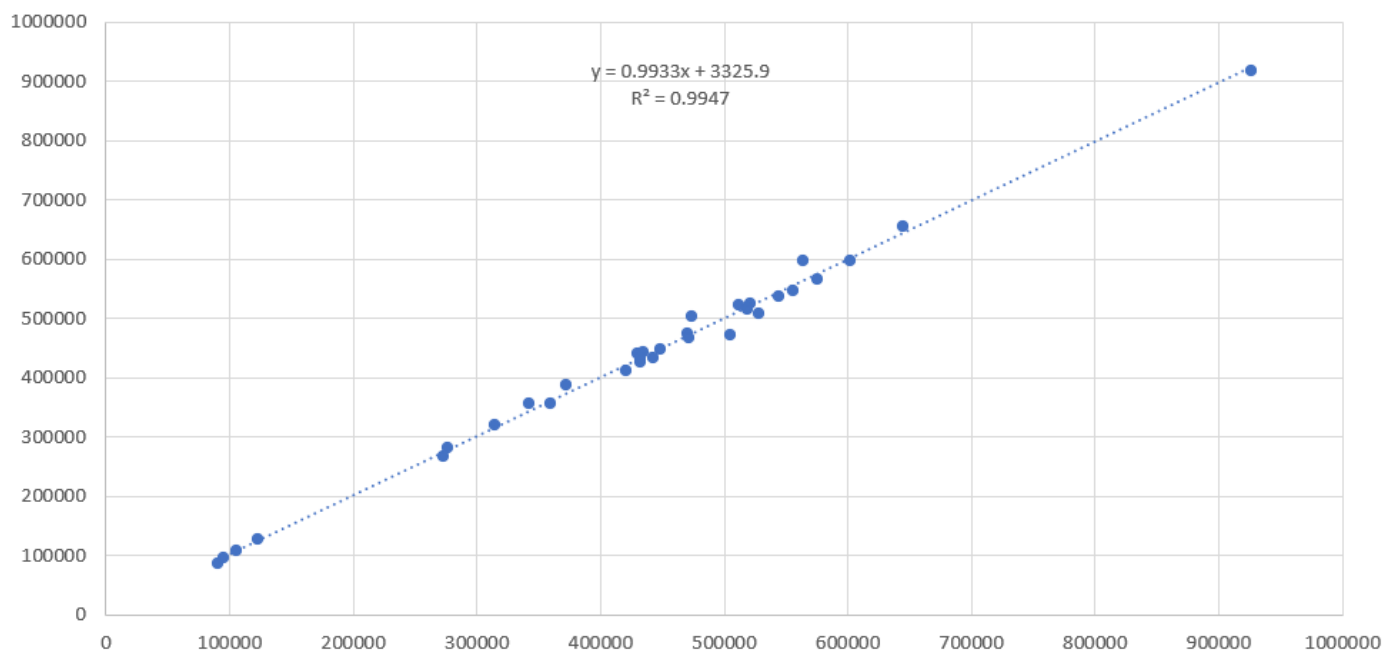
Chromosome 16 (Human)
Correlation between frequency of 32 codons and their reverse compliments



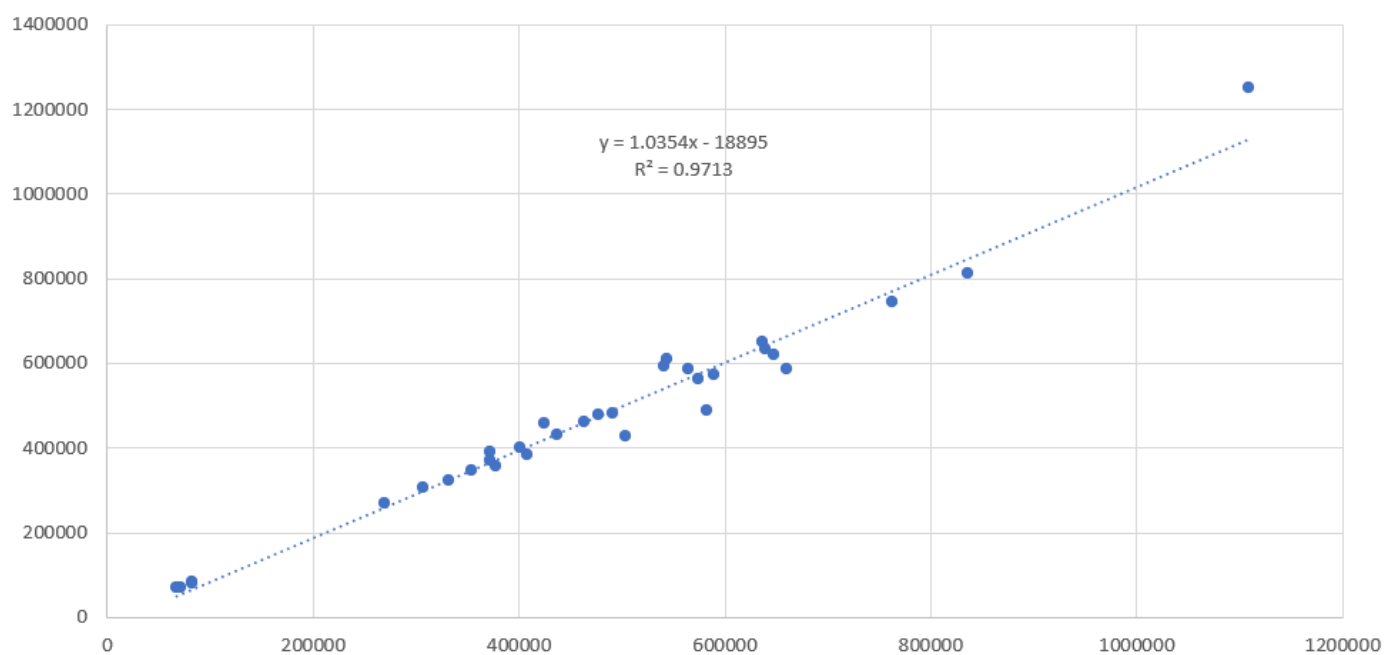
Chromosome 16 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



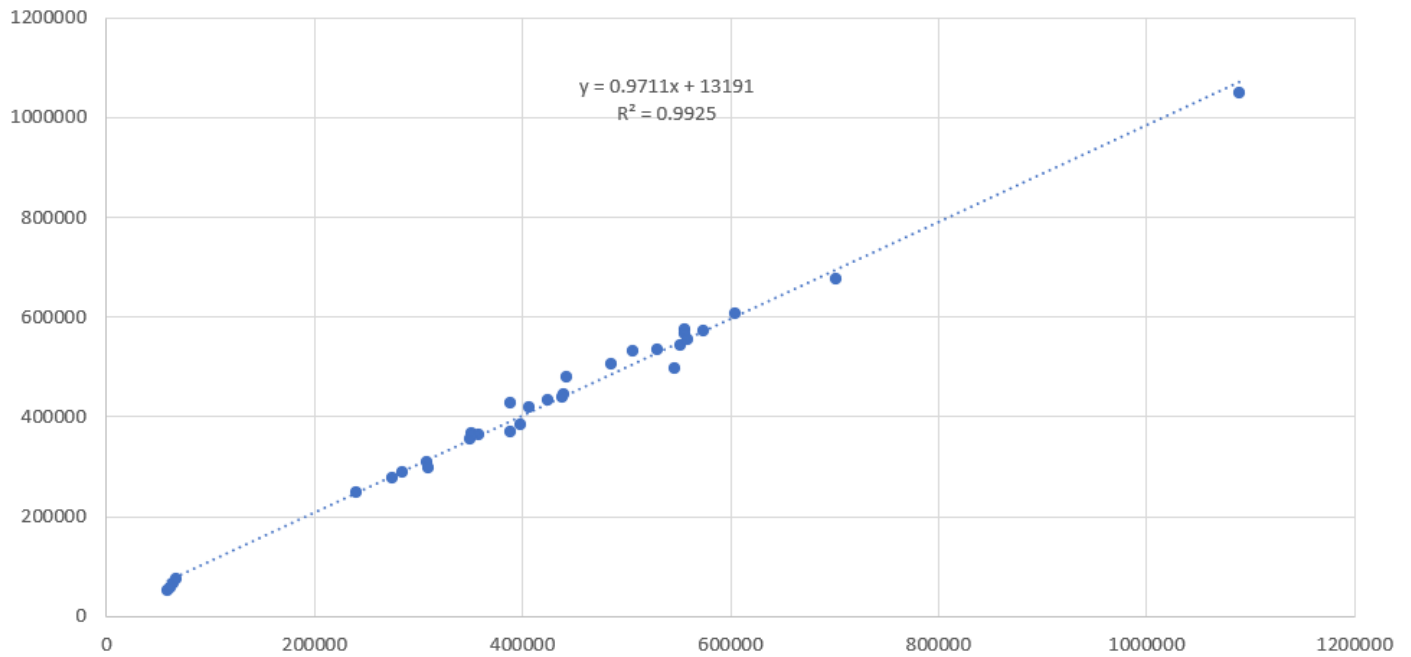
Chromosome 17 (Human)
Correlation between frequency of 32 codons and their reverse compliments



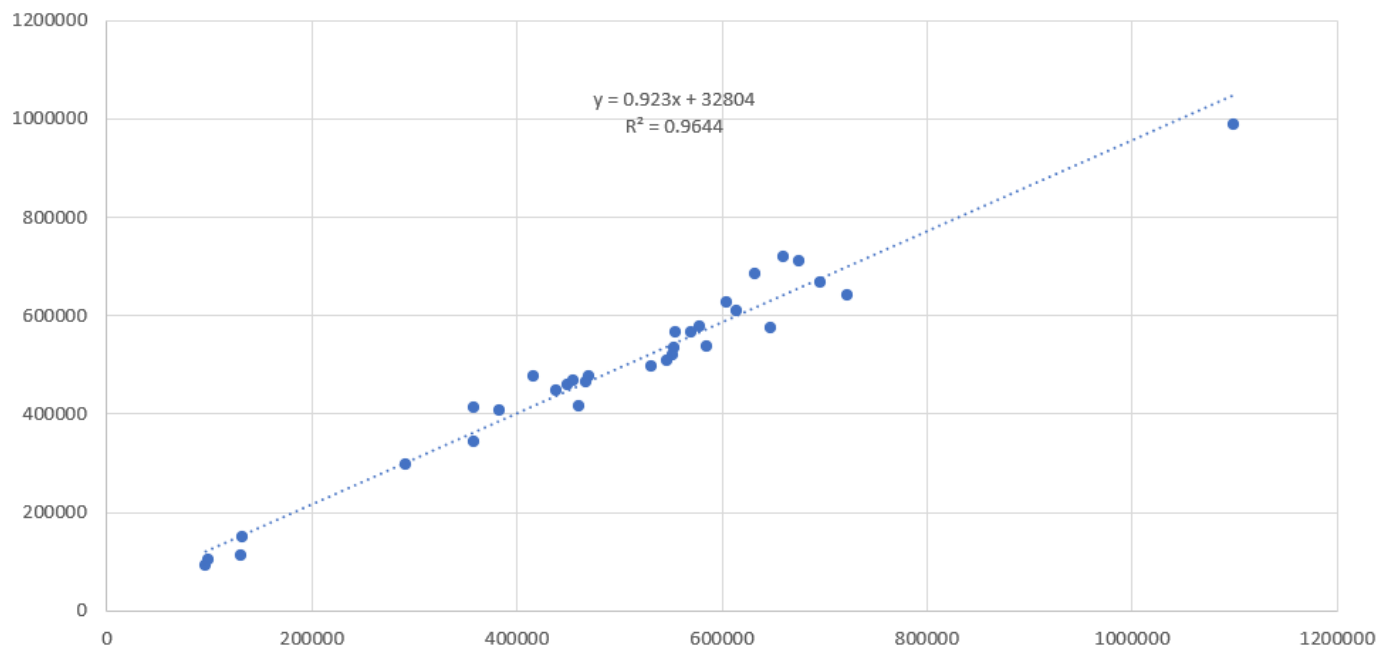
Chromosome 17 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



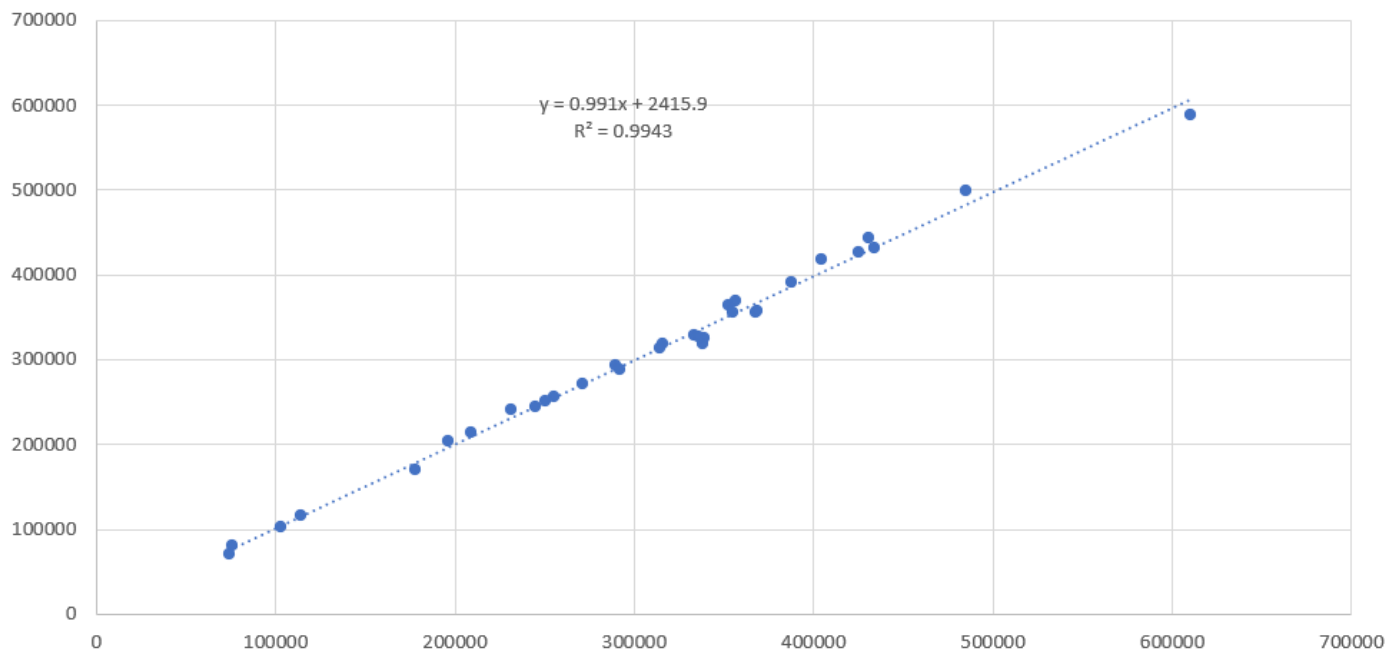
Chromosome 18 (Human)
Correlation between frequency of 32 codons and their reverse compliments



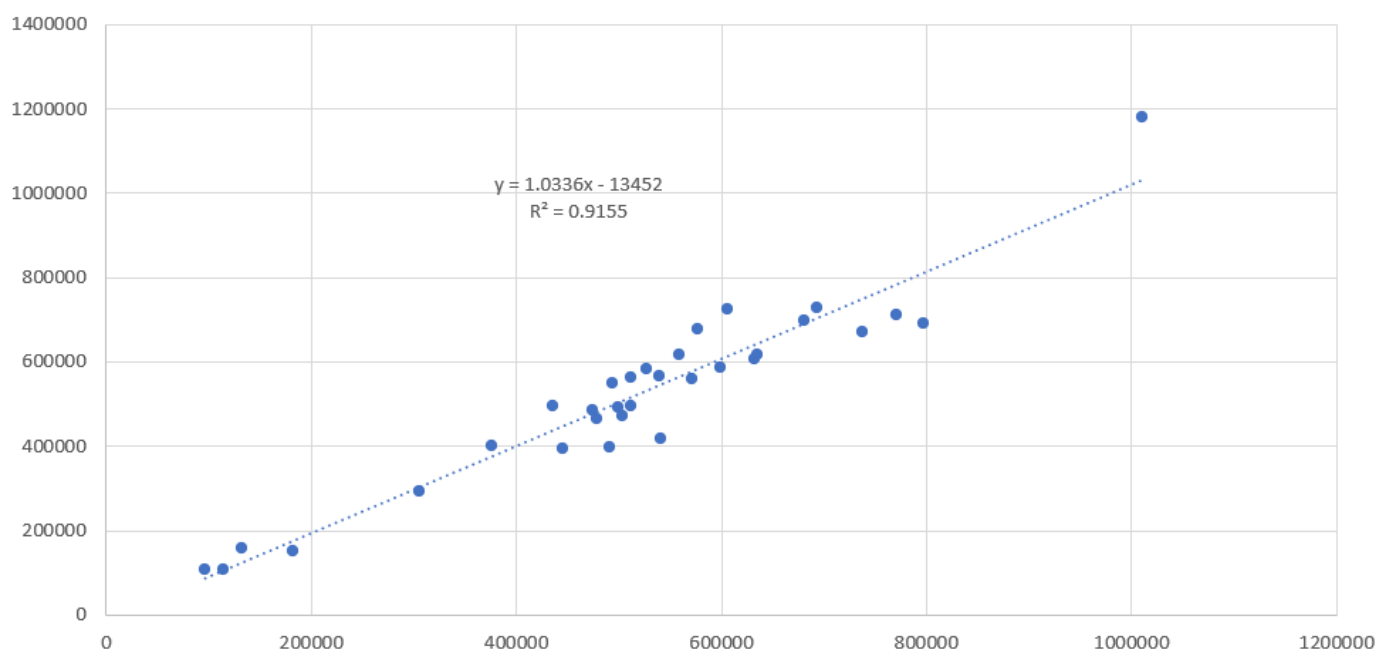
Chromosome 18 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



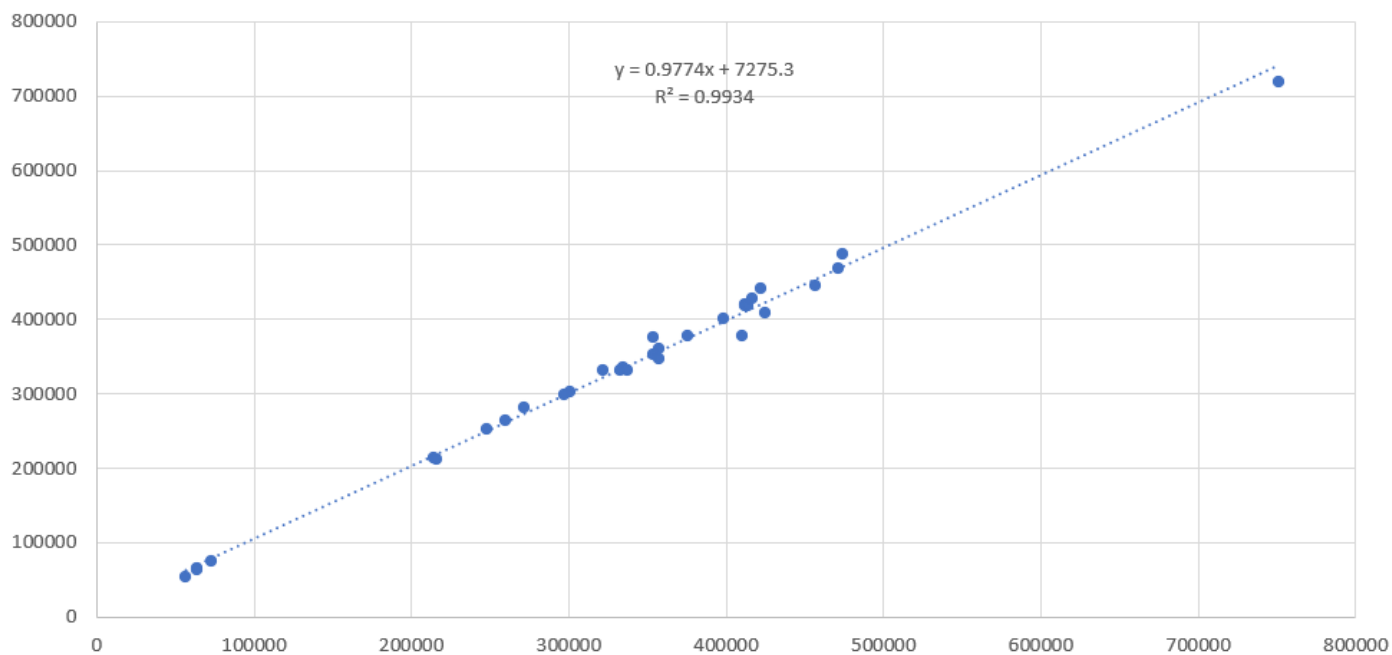
Chromosome 19 (Human)
Correlation between frequency of 32 codons and their reverse compliments



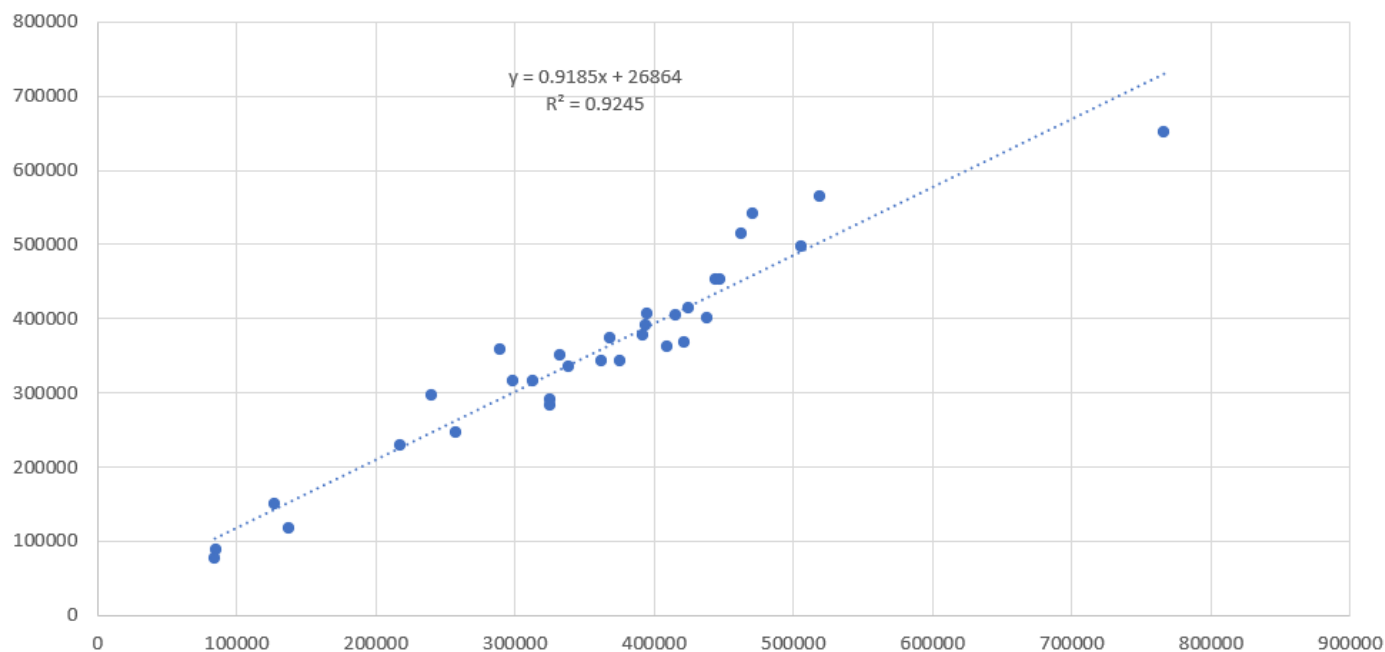
Chromosome 19 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



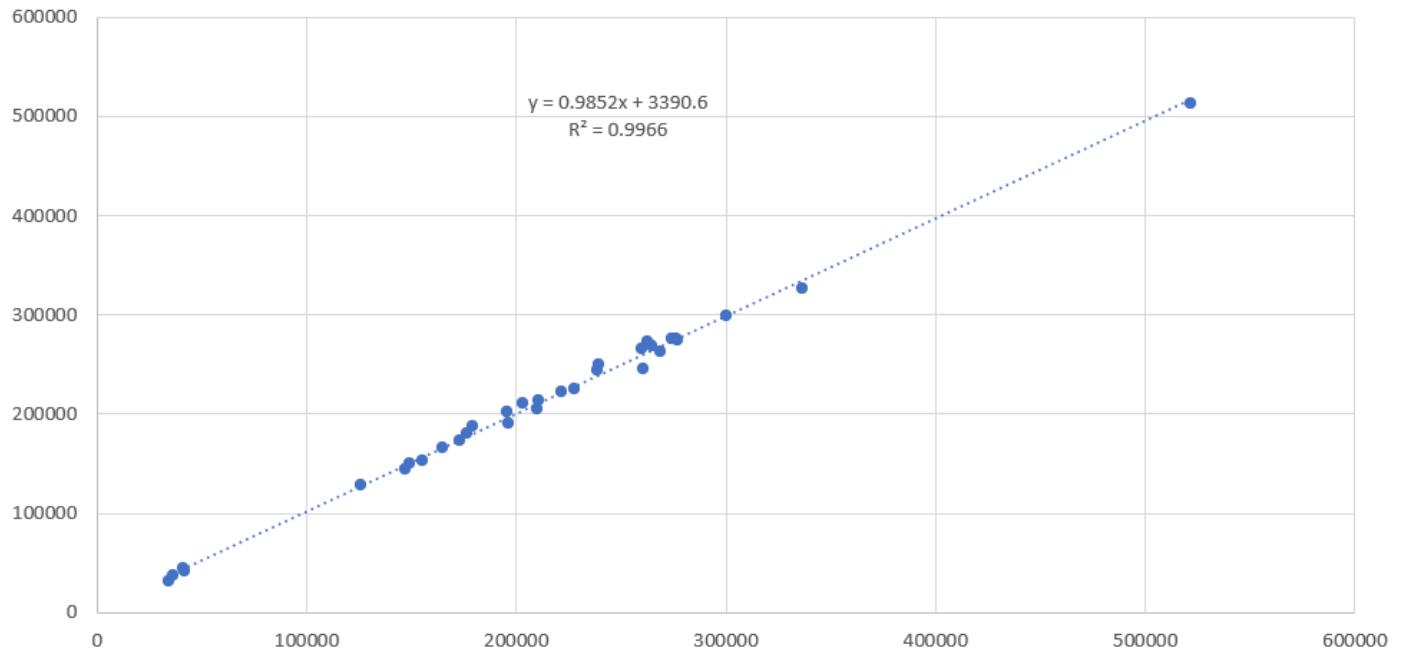
Chromosome 20 (Human)
Correlation between frequency of 32 codons and their reverse compliments



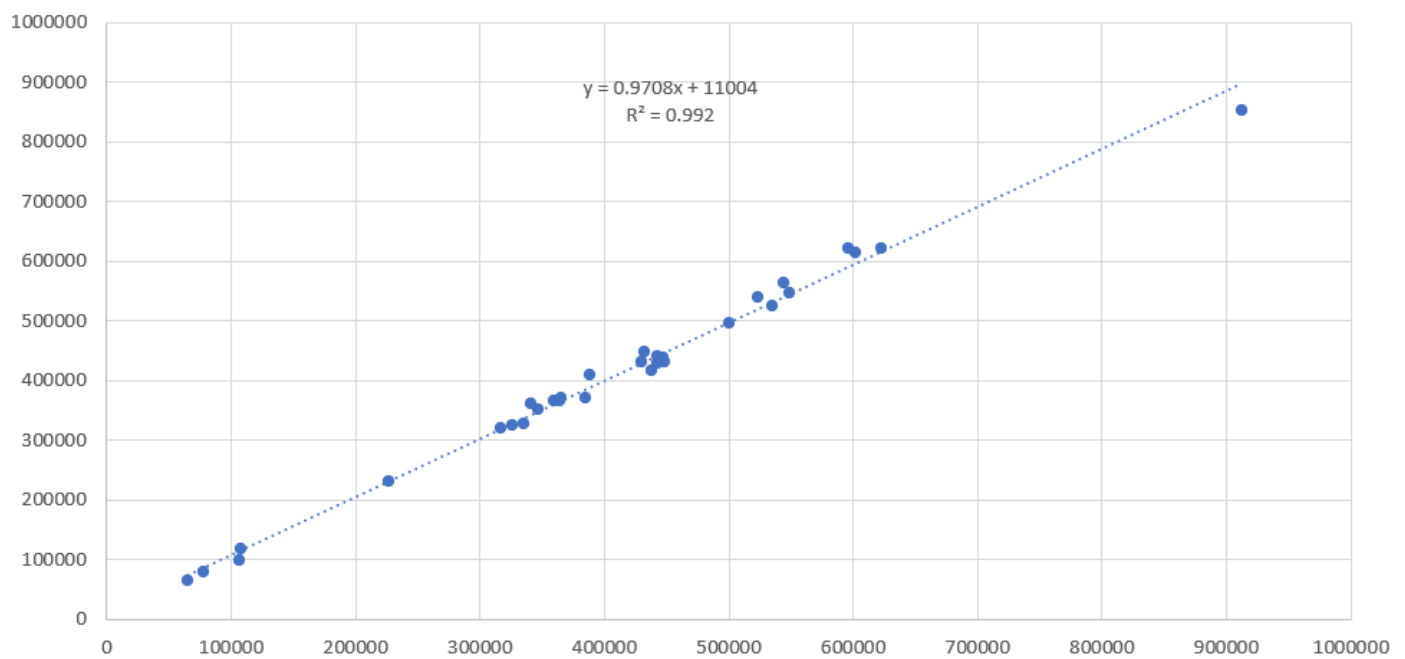
Chromosome 20 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



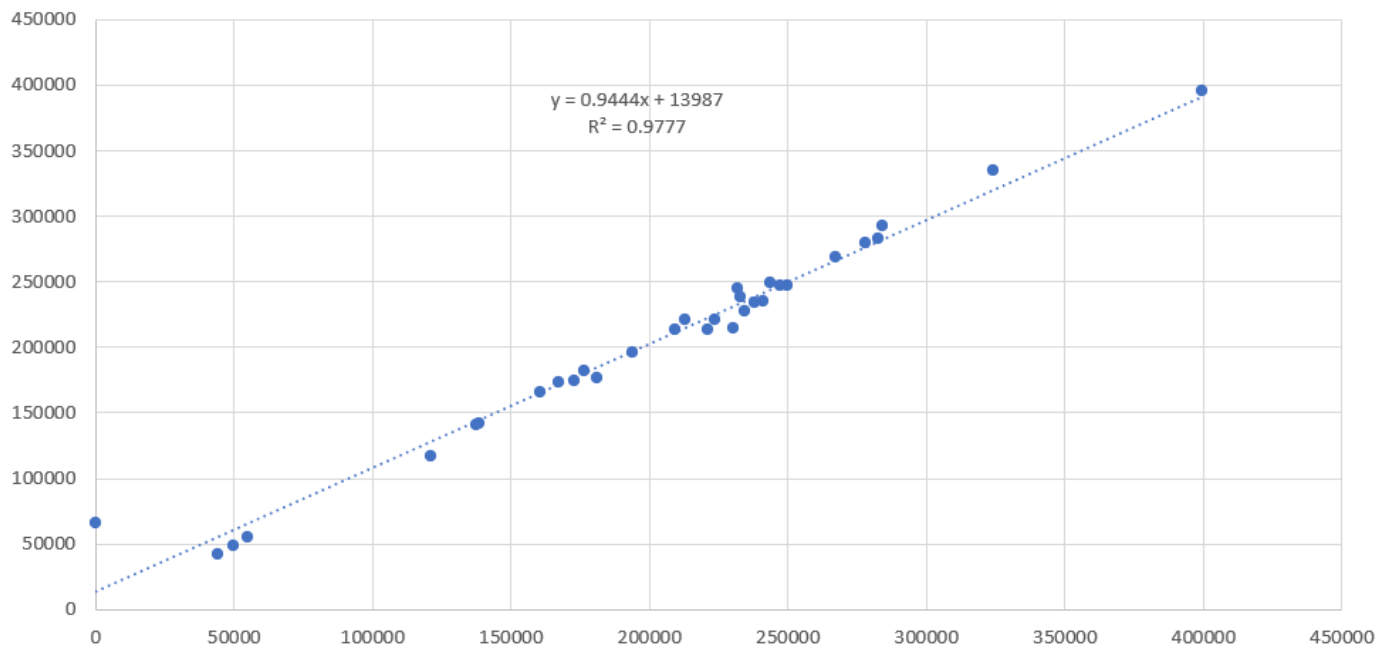
Chromosome 21 (Human)
Correlation between frequency of 32 codons and their reverse compliments



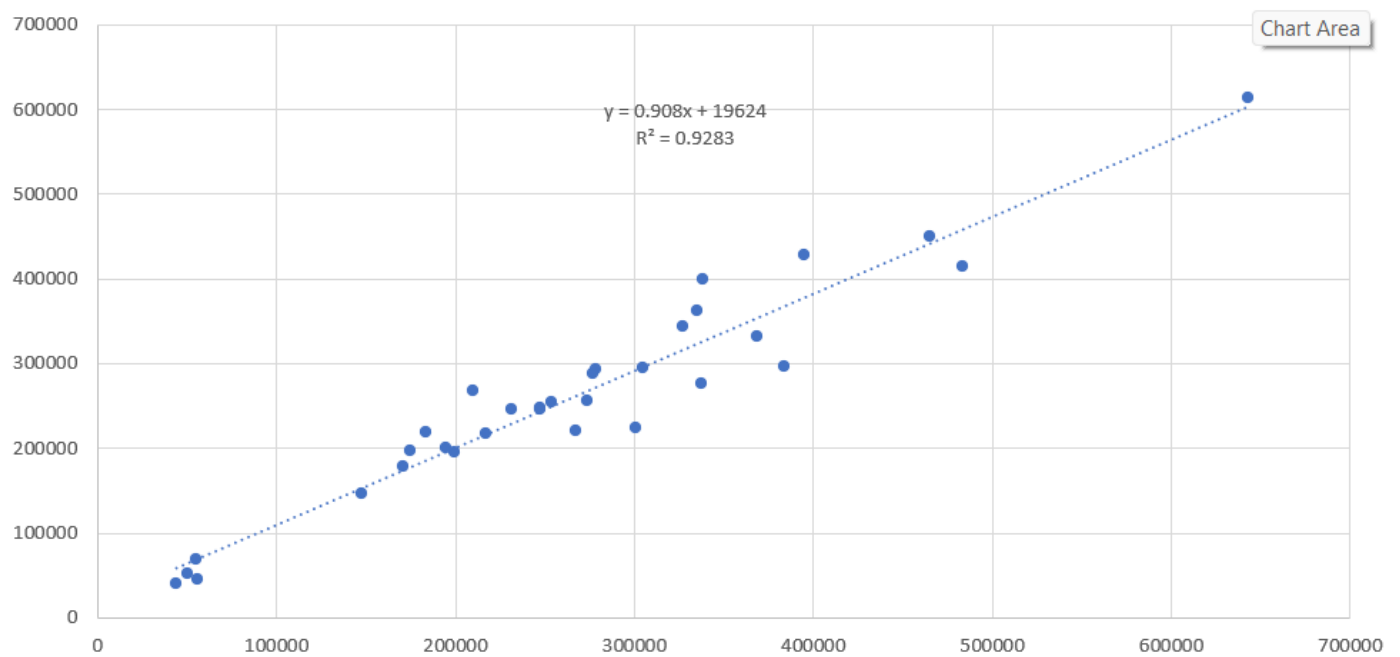
Chromosome 21 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



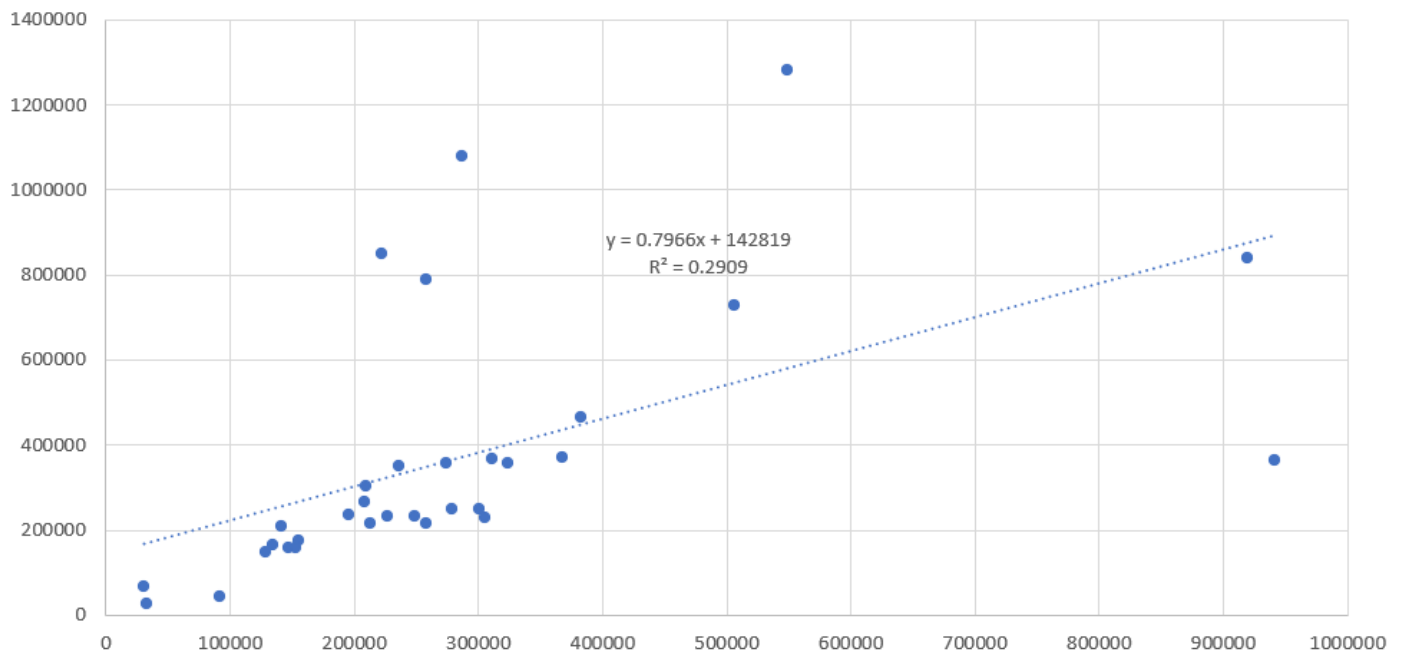
Chromosome 22 (Human)
Correlation between frequency of 32 codons and their reverse compliments



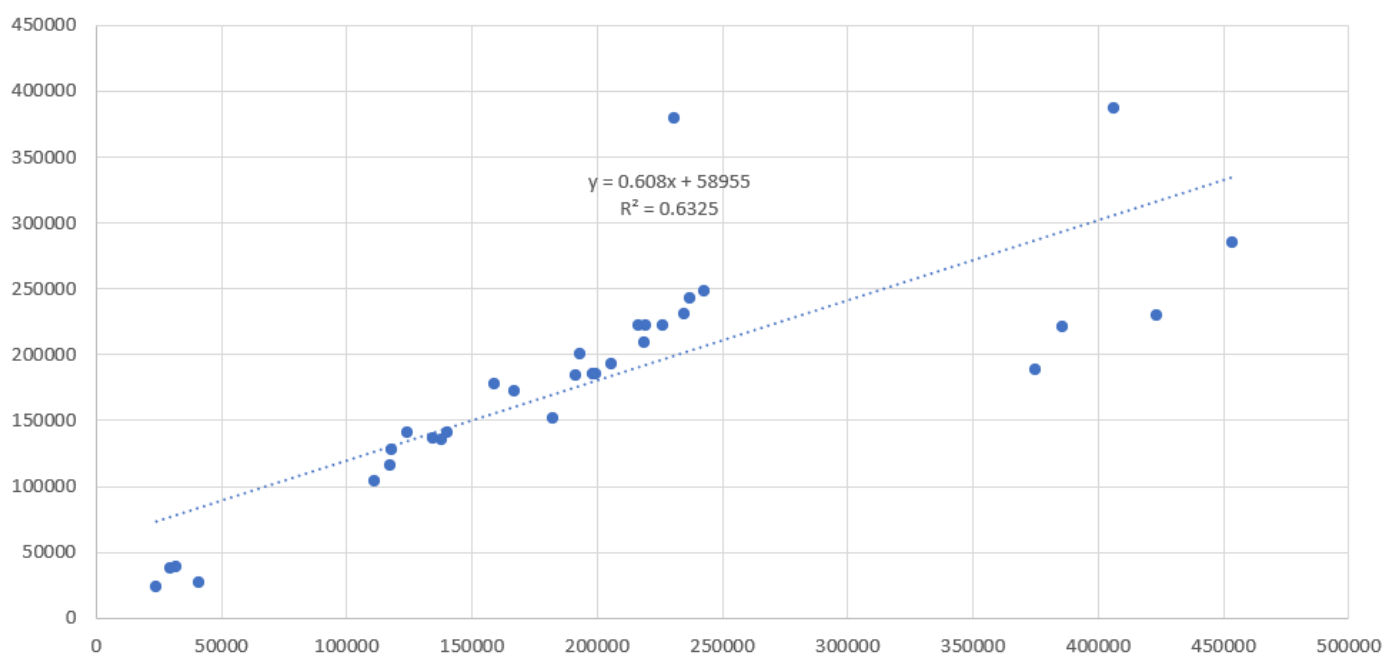
Chromosome 22 (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



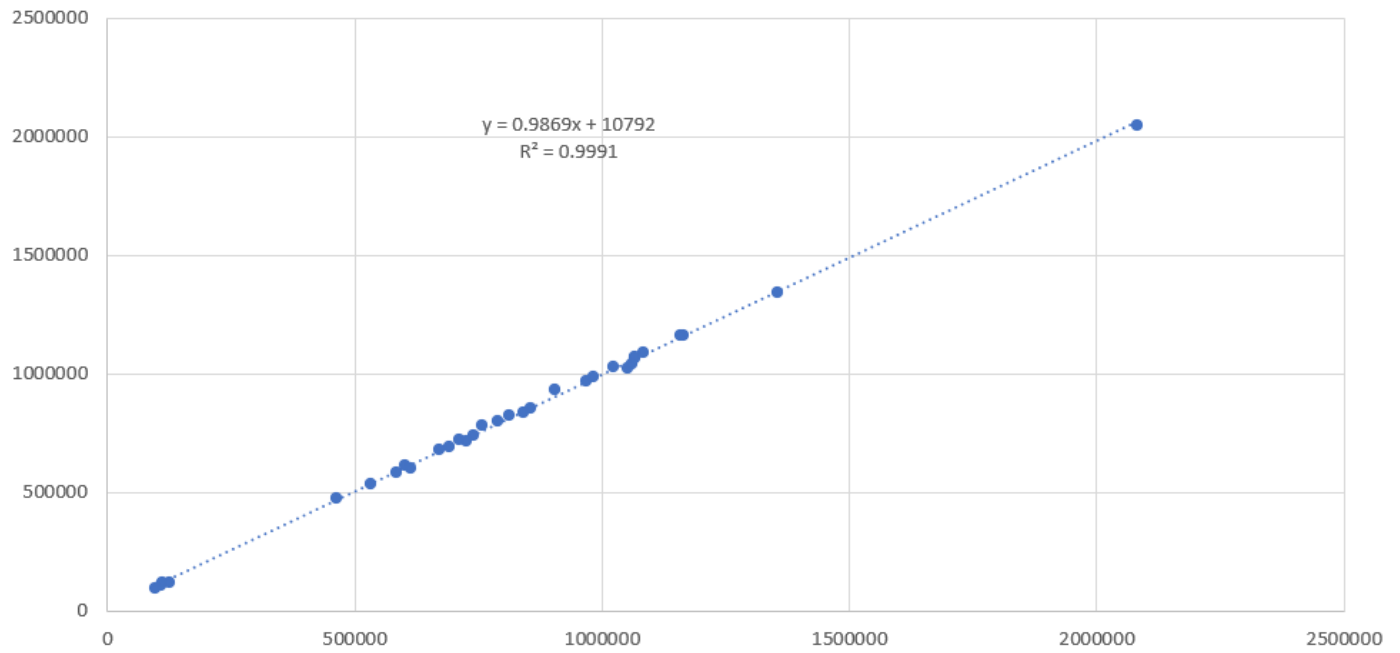
Chromosome Y (Human)
Correlation between frequency of 32 codons and their reverse compliments



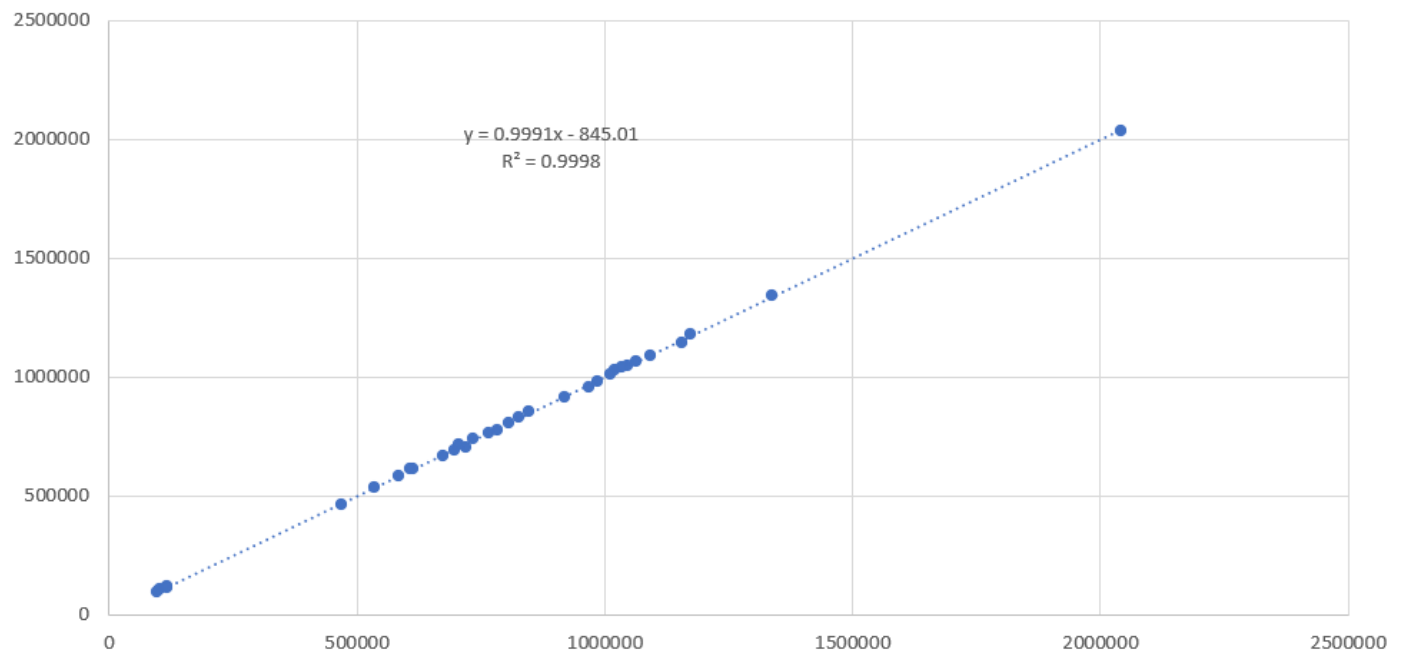
Chromosome Y (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



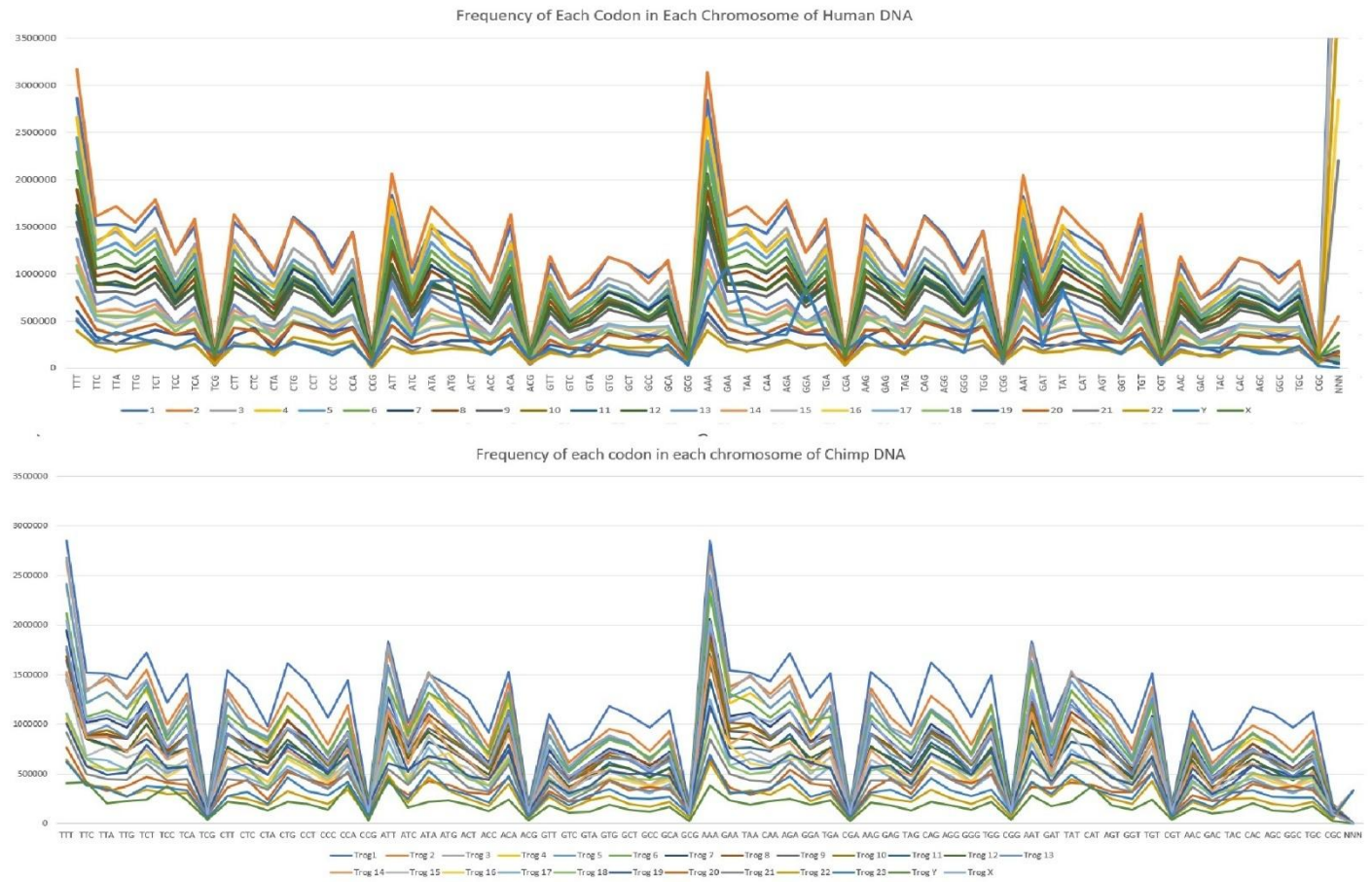
Chromosome X (Human)
Correlation between frequency of 32 codons and their reverse compliments



Chromosome X (Chimp)
Correlation between frequency of 32 codons and their reverse compliments



Human Y Chromosome Differs from Chimp Y Chromosome



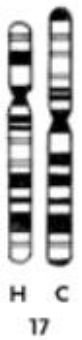
A notable divergence between chimp and human is with chromosome Y – shown as the lowest green line on the chimp chart and as the sky-blue line on the human chart.

References for Further Reading

[Chimpanzee DNA Sequences Queried Against Human Genome | Answers Research Journal](#)

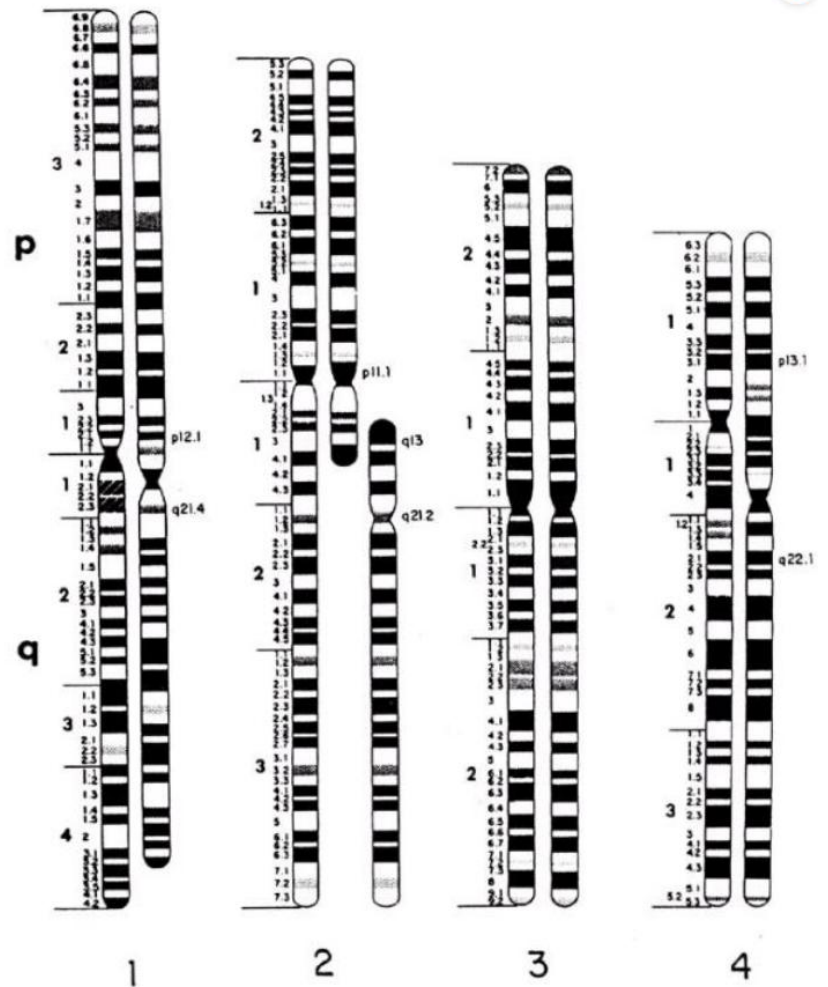
[Sandwalk: What's the Difference Between a Human and Chimpanzee?](#)

[Genetic Difference Between Humans and Chimps - Pediaa.Com](#)



Human & Chimpanzee Chromosomes

- Human on the left
- Chimp on the right
- Notice that Human Chromosome #2 appears to be a combination of Chimp Chromosomes #2 & 3



Software Used

This software was created using Visual Studio 2022. It is written in Visual Basic programming language as a windows form application.

Public Class Form1

Dim Count As Integer

Dim TotalCodons As Long

Dim TTT As Long = 0

Dim TTC As Long = 0

Dim TTA As Long = 0

Dim TTG As Long = 0

Dim TCT As Long = 0

Dim TCC As Long = 0

Dim TCA As Long = 0

Dim TCG As Long = 0

Dim TAT As Long = 0

Dim TAC As Long = 0

Dim TAA As Long = 0

Dim TAG1 As Long = 0

Dim TGT As Long = 0

Dim TGC As Long = 0

Dim TGA As Long = 0

Dim TGG As Long = 0

Dim CTT As Long = 0

Dim CTC As Long = 0

Dim CTA As Long = 0

Dim CTG As Long = 0

Dim CCT As Long = 0

Dim CCC As Long = 0

Dim CCA As Long = 0

Dim CCG As Long = 0

Dim CAT As Long = 0

Dim CAC As Long = 0

Dim CAA As Long = 0

Dim CAG As Long = 0

Dim CGT As Long = 0

Dim CGC As Long = 0

Dim CGA As Long = 0

Dim CGG As Long = 0

Dim ATT As Long = 0

Dim ATC As Long = 0

Dim ATA As Long = 0

Dim ATG As Long = 0

Dim ACT As Long = 0

Dim ACC As Long = 0

Dim ACA As Long = 0

Dim ACG As Long = 0

Dim AAT As Long = 0

Dim AAC As Long = 0

Dim AAA As Long = 0

Dim AAG As Long = 0

Dim AGT As Long = 0

Dim AGC As Long = 0

Dim AGA As Long = 0

Dim AGG As Long = 0

Dim GTT As Long = 0

Dim GTC As Long = 0

Dim GTA As Long = 0

Dim GTG As Long = 0

Dim GCT As Long = 0

Dim GCC As Long = 0

Dim GCA As Long = 0

Dim GCG As Long = 0

Dim GAT As Long = 0

Dim GAC As Long = 0

Dim GAA As Long = 0

```
Dim GAG As Long = 0
Dim GGT As Long = 0
Dim GGC As Long = 0
Dim GGA As Long = 0
Dim GGG As Long = 0
Dim NNN As Long = 0
Dim N As Integer = 0
Dim x As Integer
Dim Multiline As String = ""
```

```
Private Sub Button2_Click(sender As Object, e As EventArgs) Handles Button2.Click
```

```
    Count = 0
    N = 600
    Dim path As String = "C:\Users\craig\Downloads\Chromosomes\chromosome21cc.fasta"
    Dim sr As StreamReader = New StreamReader(path)
    Do While (sr.Peek() >= 0)
        Count += 1
        If Count Mod N <> 0 Then
            Application.DoEvents()
            Multiline &= sr.ReadLine
        Else
            Multiline = Multiline.Replace(vbCrLf, "")
            Multiline = Multiline.Replace(vbCrLf, "")
            Multiline = Multiline.Replace(vbCrLf, "")
            Multiline = Multiline.Replace(vbLf, "")
            Multiline = Multiline.Replace(" ", "")
            ProcessLines(Multiline, Chromosome)
            Multiline = ""
        End If
    Loop
```

```
End Sub
```

Sub ProcessLines(MultiLine)

Dim Bin As String = ""

If MultiLine.Length > 6 Then

For y As Integer = 0 To MultiLine.Length - 3 Step 3

Bin = MultiLine.Substring(y, 3)

Select Case Bin

Case "TTT"

TTT += 1

TotalCodons += 1

Case "TTC"

TTC += 1

TotalCodons += 1

Case "TTA"

TTA += 1

TotalCodons += 1

Case "TTG"

TTG += 1

TotalCodons += 1

Case "TCT"

TCT += 1

TotalCodons += 1

Case "TCC"

TCC += 1

TotalCodons += 1

Case "TCA"

TCA += 1

TotalCodons += 1

Case "TCG"

TCG += 1

TotalCodons += 1

Case "TAT"

TAT += 1

TotalCodons += 1

Case "TAC"

TAC += 1

TotalCodons += 1

Case "TAA"

TAA += 1

TotalCodons += 1

Case "TAG"

TAG1 += 1

TotalCodons += 1

Case "TGT"

TGT += 1

TotalCodons += 1

Case "TGC"

TGC += 1

TotalCodons += 1

Case "TGA"

TGA += 1

TotalCodons += 1

Case "TGG"

TGG += 1

TotalCodons += 1

Case "CTT"

CTT += 1

TotalCodons += 1

Case "CTC"

CTC += 1

TotalCodons += 1

Case "CTA"

CTA += 1

TotalCodons += 1

Case "CTG"

CTG += 1

TotalCodons += 1

Case "CCT"

CCT += 1

TotalCodons += 1

Case "CCC"

CCC += 1

TotalCodons += 1

Case "CCA"

CCA += 1

TotalCodons += 1

Case "CCG"

CCG += 1

TotalCodons += 1

Case "CAT"

CAT += 1

TotalCodons += 1

Case "CAC"

CAC += 1

TotalCodons += 1

Case "CAA"

CAA += 1

TotalCodons += 1

Case "CAG"

CAG += 1

TotalCodons += 1

Case "CGT"

CGT += 1

TotalCodons += 1

Case "CGC"

CGC += 1

TotalCodons += 1

Case "CGA"

CGA += 1

TotalCodons += 1

Case "CGG"

CGG += 1

TotalCodons += 1

Case "ATT"

ATT += 1

TotalCodons += 1

Case "ATC"

ATC += 1

TotalCodons += 1

Case "ATA"

ATA += 1

TotalCodons += 1

Case "ATG"

ATG += 1

TotalCodons += 1

Case "ACT"

ACT += 1

TotalCodons += 1

Case "ACC"

ACC += 1

TotalCodons += 1

Case "ACA"

ACA += 1

TotalCodons += 1

Case "ACG"

ACG += 1

TotalCodons += 1

Case "AAT"

AAT += 1

TotalCodons += 1

Case "AAC"

AAC += 1

TotalCodons += 1

Case "AAA"

AAA += 1

TotalCodons += 1

Case "AAG"

AAG += 1

TotalCodons += 1

Case "AGT"

AGT += 1

TotalCodons += 1

Case "AGC"

AGC += 1

TotalCodons += 1

Case "AGA"

AGA += 1

TotalCodons += 1

Case "AGG"

AGG += 1

TotalCodons += 1

Case "GTT"

GTT += 1

TotalCodons += 1

Case "GTC"

GTC += 1

TotalCodons += 1

Case "GTA"

GTA += 1

TotalCodons += 1

Case "GTG"

GTG += 1

TotalCodons += 1

Case "GCT"

GCT += 1

TotalCodons += 1

Case "GCC"

GCC += 1

TotalCodons += 1

Case "GCA"

GCA += 1

```
        TotalCodons += 1
    Case "GCG"
        GCG += 1
        TotalCodons += 1
    Case "GAT"
        GAT += 1
        TotalCodons += 1
    Case "GAC"
        GAC += 1
        TotalCodons += 1
    Case "GAA"
        GAA += 1
        TotalCodons += 1
    Case "GAG"
        GAG += 1
        TotalCodons += 1
    Case "GGT"
        GGT += 1
        TotalCodons += 1
    Case "GGC"
        GGC += 1
        TotalCodons += 1
    Case "GGA"
        GGA += 1
        TotalCodons += 1
    Case "GGG"
        GGG += 1
        TotalCodons += 1
    Case "NNN"
        NNN += 1
        TotalCodons += 1
End Select
```

Next

TextBox1.Text = TotalCodons * 3

End If

RichTextBox2.Text =

TTT & vbTab & TCT & vbTab & TAT & vbTab & TGT & vbCrLf &
TTC & vbTab & TCC & vbTab & TAC & vbTab & TGC & vbCrLf &
TTA & vbTab & TCA & vbTab & TAA & vbTab & TGA & vbCrLf &
TTG & vbTab & TCG & vbTab & TAG1 & vbTab & TGG & vbCrLf & vbCrLf &
CTT & vbTab & CCT & vbTab & CAT & vbTab & CGT & vbCrLf &
CTC & vbTab & CCC & vbTab & CAC & vbTab & CGC & vbCrLf &
CTA & vbTab & CCA & vbTab & CAA & vbTab & CGA & vbCrLf &
CTG & vbTab & CCG & vbTab & CAG & vbTab & CGG & vbCrLf & vbCrLf &
ATT & vbTab & ACT & vbTab & AAT & vbTab & AGT & vbCrLf &
ATC & vbTab & ACC & vbTab & AAC & vbTab & AGC & vbCrLf &
ATA & vbTab & ACA & vbTab & AAA & vbTab & AGA & vbCrLf &
ATG & vbTab & ACG & vbTab & AAG & vbTab & AGG & vbCrLf & vbCrLf &
GTT & vbTab & GCT & vbTab & GAT & vbTab & GGT & vbCrLf &
GTC & vbTab & GCC & vbTab & GAC & vbTab & GGC & vbCrLf &
GTA & vbTab & GCA & vbTab & GAA & vbTab & GGA & vbCrLf &
GTG & vbTab & GCG & vbTab & GAG & vbTab & GGG & vbCrLf &
"nnn (unknown) = " & NNN & vbCrLf & vbCrLf &
"total = " & TotalCodons * 3

RichTextBox1.Text =

"TTT" & vbTab & TTT & vbTab & "AAA" & vbTab & AAA & vbCrLf &
"TTC" & vbTab & TTC & vbTab & "GAA" & vbTab & GAA & vbCrLf &
"TTA" & vbTab & TTA & vbTab & "TAA" & vbTab & TAA & vbCrLf &
"TTG" & vbTab & TTG & vbTab & "CAA" & vbTab & CAA & vbCrLf &
"TCT" & vbTab & TCT & vbTab & "AGA" & vbTab & AGA & vbCrLf &
"TCC" & vbTab & TCC & vbTab & "GGA" & vbTab & GGA & vbCrLf &
"TCA" & vbTab & TCA & vbTab & "TGA" & vbTab & TGA & vbCrLf &
"TCG" & vbTab & TCG & vbTab & "CGA" & vbTab & CGA & vbCrLf &
"CTT" & vbTab & CTT & vbTab & "AAG" & vbTab & AAG & vbCrLf &
"CTC" & vbTab & CTC & vbTab & "GAG" & vbTab & GAG & vbCrLf &
"CTA" & vbTab & CTA & vbTab & "TAG" & vbTab & TAG1 & vbCrLf &

"CTG" & vbTab & CTG & vbTab & "CAG" & vbTab & CAG & vbCrLf &
"CCT" & vbTab & CCT & vbTab & "AGG" & vbTab & AGG & vbCrLf &
"CCC" & vbTab & CCC & vbTab & "GGG" & vbTab & GGG & vbCrLf &
"CCA" & vbTab & CCA & vbTab & "TGG" & vbTab & TGG & vbCrLf &
"CCG" & vbTab & CCG & vbTab & "CGG" & vbTab & CGG & vbCrLf &
"ATT" & vbTab & ATT & vbTab & "AAT" & vbTab & AAT & vbCrLf &
"ATC" & vbTab & ATC & vbTab & "GAT" & vbTab & GAT & vbCrLf &
"ATA" & vbTab & ATA & vbTab & "TAT" & vbTab & TAT & vbCrLf &
"ATG" & vbTab & ATG & vbTab & "CAT" & vbTab & CAT & vbCrLf &
"ACT" & vbTab & ACT & vbTab & "AGT" & vbTab & AGT & vbCrLf &
"ACC" & vbTab & ACC & vbTab & "GGT" & vbTab & GGT & vbCrLf &
"ACA" & vbTab & ACA & vbTab & "TGT" & vbTab & TGT & vbCrLf &
"ACG" & vbTab & ACG & vbTab & "CGT" & vbTab & CGT & vbCrLf &
"GTT" & vbTab & GTT & vbTab & "AAC" & vbTab & AAC & vbCrLf &
"GTC" & vbTab & GTC & vbTab & "GAC" & vbTab & GAC & vbCrLf &
"GTA" & vbTab & GTA & vbTab & "TAC" & vbTab & TAC & vbCrLf &
"GTG" & vbTab & GTG & vbTab & "CAC" & vbTab & CAC & vbCrLf &
"GCT" & vbTab & GCT & vbTab & "AGC" & vbTab & AGC & vbCrLf &
"GCC" & vbTab & GCC & vbTab & "GGC" & vbTab & GGC & vbCrLf &
"GCA" & vbTab & GCA & vbTab & "TGC" & vbTab & TGC & vbCrLf &
"GCG" & vbTab & GCG & vbTab & "CGC" & vbTab & CGC & vbCrLf & vbCrLf &
"NNN = " & NNN

[End Sub](#)

[End Class](#)