

Exploring BLAST and PSI-BLAST to Detect Distant Homologs

1) In the initial stage, we obtained data related to the kinase sequence named "Myosin Light Chain Kinase Family Member 4 (MYLK4)" from UniProt (Figure 1). UniProt ID: Q86YV6 (<https://www.uniprot.org/uniprotkb/Q86YV6/entry>)

MAST4	MAST4	MAST4	Microtubule-associated serine/threonine-protein kinase 4	AGC	MAST		O15021
CaMK2d	CaMK2d	CAMK2D	Calcium/calmodulin-dependent protein kinase type II subunit delta	CAMK	CAMK2		Q13557
BIKE	BIKE	BMP2K	BMP-2-inducible protein kinase	Other	NAK		Q9NSY1
TSSK1	TSSK1	TSSK1B	Testis-specific serine/threonine-protein kinase 1	CAMK	TSSK		Q9BXA7
SeK424	SeK424	TEY14	Inactive serine/threonine-protein kinase TEY14	Other	NIK5		Q9NMB8
SgK085	SgK085	MYLK4	Myosin light chain kinase family member 4	CAMK	MLCK		Q86YV6
ADCK2	ADCK2	ADCK2	Uncharacterized aaF domain-containing protein kinase 2	Atypical	ABC1	ABC1-C	Q7Z666
DAPK3	DAPK3	DAPK3	Death-associated protein kinase 3	CAMK	DAPK		O43293

Figure 1. We learned to Myosin Light Chain Kinase Family Member 4 (MYLK4)'s Uniprot ID.

We displayed the information of MYLK4 sequenceF (Figure2).

UniProt BLAST Align Peptide search ID mapping SPARQL UniProtKB Advanced List Search

Q86YV6 · MYLK4_HUMAN

Function

Names & Taxonomy

Subcellular Location

Disease & Variants

PTM/Processing

Expression

Interaction

Structure

Family & Domains

Sequence & Isoform

Similar Proteins

Protein¹ Myosin light chain kinase family member 4

Gene¹ MYLK4

Status¹ UniProtKB reviewed (Swiss-Prot)

Organism¹ Homo sapiens (Human)

Amino acids 388 (go to sequence)

Protein existence¹ Evidence at protein level

Annotation score¹ (4/5)

Entry Variant viewer 353 Feature viewer Genomic coordinates Publications External links History

BLAST Align Download Add Add a publication Entry feedback

Function¹

Catalytic activity¹

Rhea 17989 ATP + L-seryl-[protein] = ADP + H⁺ + O-phospho-L-seryl-[protein]

Length 388

Mass (Da) 44,508

Last updated 2006-11-28 v2

Checksum¹ EF710F8145DFC3C9

MLKVKRLEEF¹⁰ NTCYNSQLE²⁰ KHAFFQCREE³⁰ VEKVKCFLEK⁴⁰ NSGQDQSRSG⁵⁰ HNEAKEVWISN⁶⁰ ADLTERMPVK⁷⁰ SKRTSALAVD⁸⁰ IPAPPAPFDH⁹⁰ RIVTAKQGA¹⁰⁰ NSFYTVSKTE¹¹⁰ ILGGGRFQV¹²⁰ HKCEETATGL¹³⁰

KLAAKIIKTR¹⁴⁰ GHKDKKEVK¹⁵⁰ EISVMQLDH¹⁶⁰ ANLIQLYDAF¹⁷⁰ ESKNDIVLVN¹⁸⁰ EYVGGGELFD¹⁹⁰ RIIDESYNLT²⁰⁰ ELDTILPHKQ²¹⁰ ICEGIRHPHQ²²⁰ MYILHDLKP²³⁰ ENILCVNRDA²⁴⁰ KQIKIIDFGL²⁵⁰ ARRYKPREKL²⁶⁰

KVINFGTPPEFL²⁷⁰ APEVVVYDFV²⁸⁰ SFPTDMWISVG²⁹⁰ VIAYMLLSGL³⁰⁰ SPFLGNDAAE³¹⁰ TUNNILLACRW³²⁰ DLEDEEFQOI³³⁰ SEEAKEPTSK³⁴⁰ LLIKEKSWRI³⁵⁰ SASEALKHPW³⁶⁰ LSDHKLHSL³⁷⁰ NAQKKKNRGS³⁸⁰ DAQQFVTK³⁸⁸

Figure 2. Q86YV6 displayed on UniProt Database.

We displayed the MYLK4 on KinMap (Figure2).

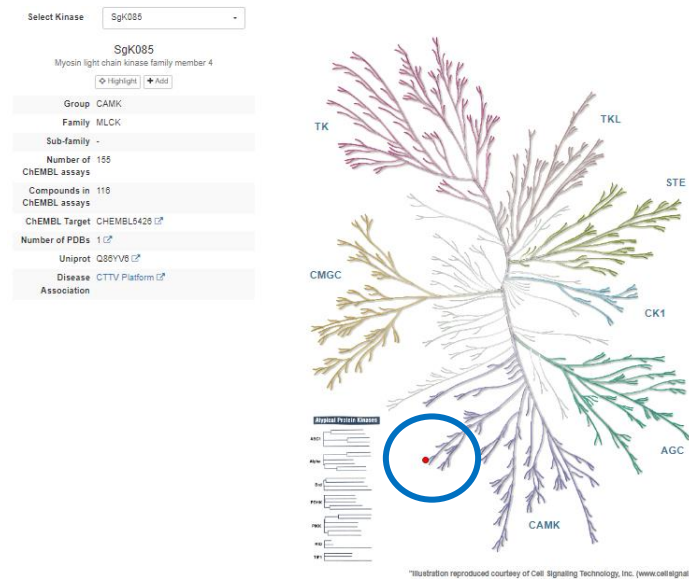


Figure 3. MYLK4 view on KinMap.

2) Using the obtained sequence information as input and selecting the relevant options, we initiated a PSI-BLAST search (Figure 4). The options that need to be selected:

Database: UniProtKB/Swiss-Prot

Organism: Homo sapiens

Max target sequences: 20

Matrix: PAM250

Parameters other than these options are left as default values.

blastn **blastp** blastx tblastn tblastx

BLASTP programs search protein databases using a protein query. more...

Enter Query Sequence

Enter accession number(s), gi(s), or FASTA sequence(s) [?](#) [Clear](#)

Query subrange [?](#)

From

To

Or, upload file Dosya Seç Dosya seçilmedi [?](#)

Job Title sp|Q86YV6|MYLK4_HUMAN Myosin light chain kinase...
Enter a descriptive title for your BLAST search [?](#)

☐ Align two or more sequences [?](#)

Choose Search Set

Databases ☒ Standard databases (nr etc.): New ☐ Experimental databases

Compare ☐ Select to compare standard and experimental database [?](#)

Standard

Database UniProtKB/Swiss-Prot(swissprot) [?](#)

Organism Homo sapiens (taxid:9606) ☐ exclude [Add organism](#)
Optional Enter organism common name, binomial, or tax id. Only 20 top taxa will be shown [?](#)

Exclude ☐ Models (XM/XP) ☐ Non-redundant RefSeq proteins (WP) ☐ Uncultured/environmental sample sequences
Optional

Program Selection

Algorithm ☐ blastp (protein-protein BLAST) ☒ PSI-BLAST (Position-Specific Iterated BLAST) ☐ PHI-BLAST (Pattern Hit Initiated BLAST) ☐ DELTA-BLAST (Domain Enhanced Lookup Time Accelerated BLAST)
Choose a BLAST algorithm [?](#)

BLAST Search database swissprot using PSI-BLAST (Position-Specific Iterated BLAST)
☒ Show results in a new window

Figure 4. We start the PSI-BLAST search as the options.

3) In the previous step, the 'max target sequence' option was set to 10 (the option for 20 was not available for the first iteration). We downloaded the output table in text format for the first iteration. From this table, we stored the UniProt IDs provided for each kinase in a table. Subsequently, using these IDs, we performed a list-style search on UniProt and reached the corresponding information for each kinase.

Subsequently, we added the 10 kinases obtained in the first stage to KinMap in list format and visualized their positions on the phylogenetic tree.

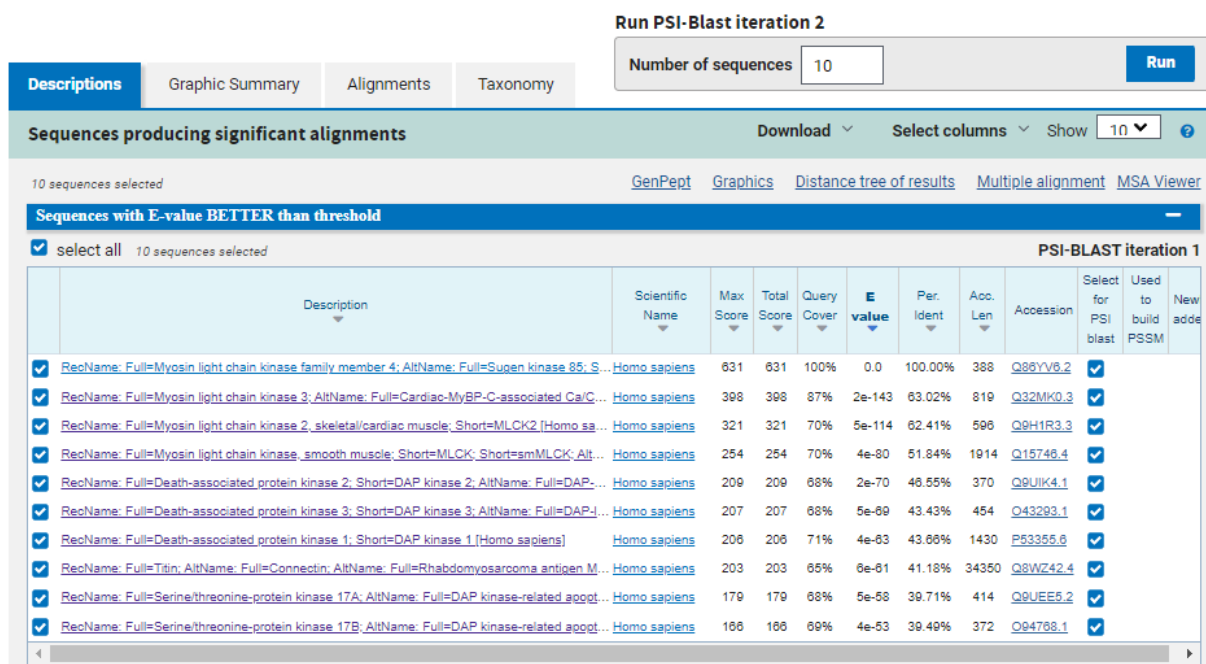
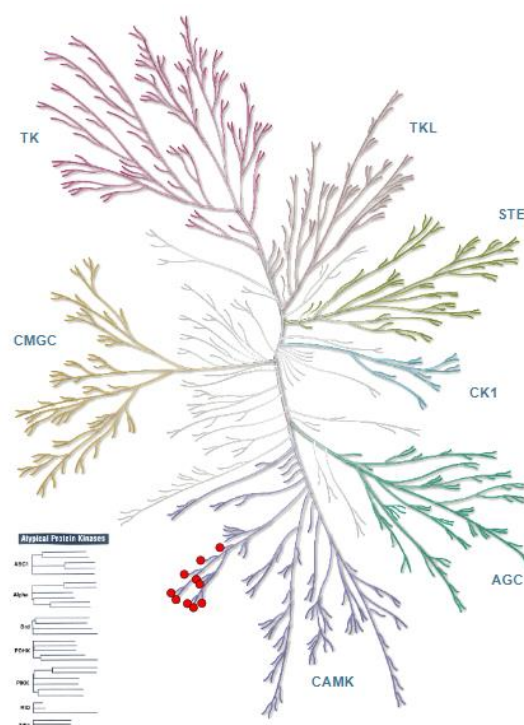


Figure 5. Result of first iteration.

Iteration 1: Max target sequence = 10

TTN	Titin
STK17B	Serine/Threonine Kinase 17B
STK17A	Serine/Threonine Kinase 17A
MYLK	Myosin Light Chain Kinase
MYLK4	Myosin Light Chain Kinase 4
MYLK3	Myosin Light Chain Kinase 3
MYLK2	Myosin Light Chain Kinase 2
DAPK3	Death-Associated Protein Kinase 3
DAPK2	Death-Associated Protein Kinase 2
DAPK1	Death-Associated Protein Kinase 1



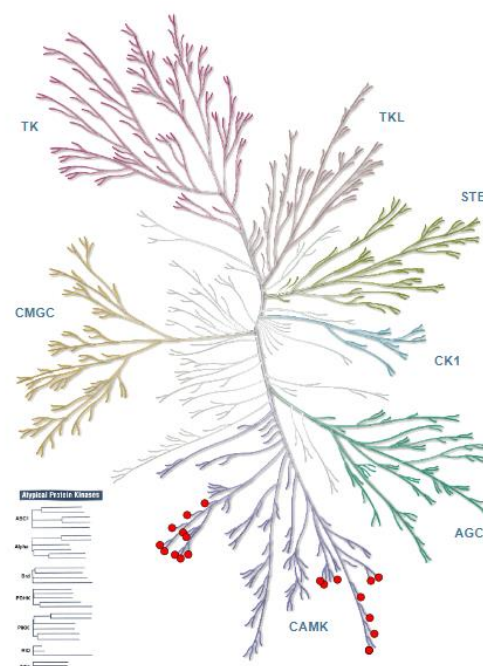
4) In this stage, we set the maximum target sequence for the second iteration to 20 and conducted a new search. We included additional hits in the result table and downloaded the UniProt IDs for the first iteration in text format, incorporating them into a table. Subsequently, by searching the UniProt IDs in list format, we reached the relevant kinases. The kinases included in the result table for Iteration 2 are highlighted in yellow (Figure 6).

Sequences with E-value BETTER than threshold											
<input checked="" type="checkbox"/> select all 20 sequences selected Skip to the first new sequence											
PSI-BLAST iteration 2											
	Description	Scientific Name	Max Score	Total Score	Query Cover	E value	Per. Ident	Acc. Len	Accession	Select for PSI blast	Used to build PSSM
<input checked="" type="checkbox"/>	RecName: Full=Myosin light chain kinase family member 4; AltName: Full=Supen kinase 85; ...	Homo sapiens	581	581	100%	0.0	100.00%	388	Q89YV8.2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Myosin light chain kinase 3; AltName: Full=Cardiac-MyBP-C-associated Ca/G...	Homo sapiens	524	524	87%	0.0	82.46%	819	Q32MK0.3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Myosin light chain kinase 2, skeletal/cardiac muscle; Short=MLCK2 [Homo sa...	Homo sapiens	413	413	78%	1e-151	59.08%	595	Q8H1R3.3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Death-associated protein kinase 1; Short=DAP kinase 1 [Homo sapiens]	Homo sapiens	411	411	72%	6e-144	42.76%	1430	P53355.6	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Death-associated protein kinase 2; Short=DAP kinase 2; AltName: Full=DAP...	Homo sapiens	383	383	73%	2e-141	43.84%	370	Q9U1K4.1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Death-associated protein kinase 3; Short=DAP kinase 3; AltName: Full=DAP...	Homo sapiens	381	381	69%	6e-140	43.01%	454	Q43293.1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Myosin light chain kinase, smooth muscle; Short=MLCK; Short=smMLCK; Alt...	Homo sapiens	403	403	80%	5e-138	47.44%	1914	Q15746.4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Serine/threonine-protein kinase 17B; AltName: Full=DAP kinase-related atp...	Homo sapiens	370	370	75%	3e-136	36.79%	372	Q64768.1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Serine/threonine-protein kinase 17A; AltName: Full=DAP kinase-related atp...	Homo sapiens	363	363	72%	7e-133	37.76%	414	Q8UEE5.2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Titin; AltName: Full=Connectin; AltName: Full=Rhabdomyosarcoma antigen...	Homo sapiens	359	359	65%	3e-116	41.02%	34350	Q8WZ42.4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Calcium/calmodulin-dependent protein kinase type 1D; AltName: Full=CaM ki...	Homo sapiens	247	247	60%	5e-86	38.41%	385	Q8LI85.1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Calcium/calmodulin-dependent protein kinase type 1; AltName: Full=CaM ki...	Homo sapiens	242	242	72%	5e-84	36.24%	370	Q14912.1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Calcium/calmodulin-dependent protein kinase type IV; Short=CaMK IV; AltNa...	Homo sapiens	240	240	68%	4e-82	35.66%	473	Q16566.1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Serine/threonine-protein kinase H1; AltName: Full=Protein serine kinase H1...	Homo sapiens	238	238	82%	4e-82	33.82%	424	P11801.4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Calcium/calmodulin-dependent protein kinase type 1B; AltName: Full=CaM ki...	Homo sapiens	227	227	68%	4e-78	35.45%	343	Q8P2M8.2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Calcium/calmodulin-dependent protein kinase type 1G; AltName: Full=CaM ki...	Homo sapiens	227	227	65%	6e-77	36.96%	476	Q89NX5.3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Calcium/calmodulin-dependent protein kinase type II subunit delta; Short=Ca...	Homo sapiens	226	226	71%	1e-76	35.34%	490	Q13557.3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Calcium/calmodulin-dependent protein kinase type II subunit alpha; Short=Ca...	Homo sapiens	225	225	73%	2e-76	34.26%	478	Q8UQM7.2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Calcium/calmodulin-dependent protein kinase type II subunit gamma; Short...	Homo sapiens	224	224	72%	2e-75	33.88%	556	Q13555.4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	RecName: Full=Serine/threonine-protein kinase H2; AltName: Full=Protein serine kinase H2...	Homo sapiens	220	220	72%	7e-75	34.71%	385	Q89QS6.1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Run PSI-BLAST Iteration 3 with max number of sequences 20 <input type="button" value="Run"/>											

Figure 6. Result of second iteration and added 10 kinase.

Iteration 2: Max target sequence = 20

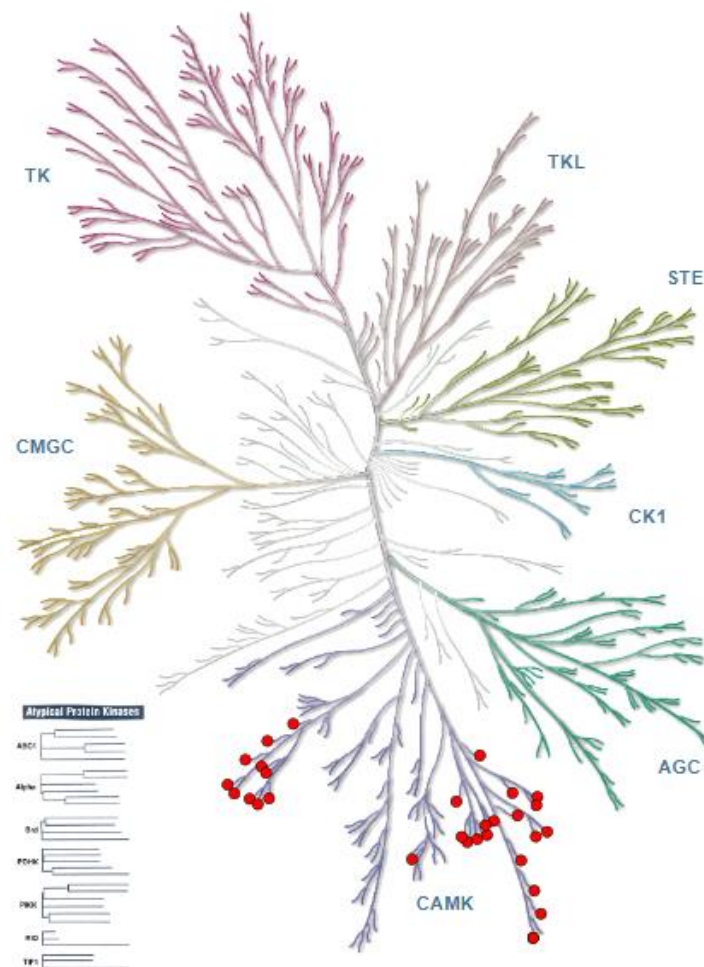
CAMK1D	Calcium/Calmodulin-Dependent Protein Kinase 1D
CAMK1D	Calcium/Calmodulin-Dependent Protein Kinase 1D
CAMK4	Calcium/Calmodulin-Dependent Protein Kinase 4
PSKH1	Protein Serine Kinase H1
PNCK	Pregnancy Upregulated Nonubiquitous CaM Kinase
CAMK1G	Calcium/Calmodulin-Dependent Protein Kinase 1G
CAMK2D	Calcium/Calmodulin-Dependent Protein Kinase 2D
CAMK2A	Calcium/Calmodulin-Dependent Protein Kinase 2A
CAMK2G	Calcium/Calmodulin-Dependent Protein Kinase 2G
PSKH2	Protein Serine Kinase H2



5) In all subsequent stages, the increment steps from the previous two iterations have been applied. The max target sequence has been increased by 10 at each step. Therefore, for the 3rd iteration, our max target sequence count is 30.

Iteration 3: Max target sequence = 30

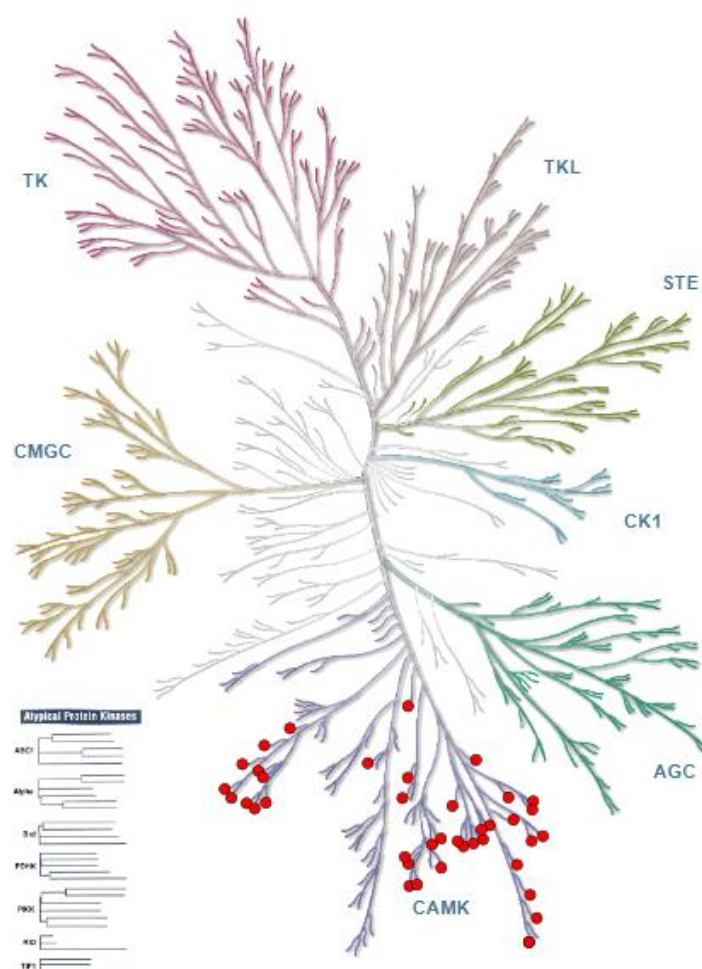
CAMK2B	Calcium/Calmodulin-Dependent Protein Kinase 2B
DCLK1	Doublecortin Like Kinase 1
DCLK2	Doublecortin Like Kinase 2
DCLK3	Doublecortin Like Kinase 3
CAMKV	Calcium/Calmodulin-Dependent Protein Kinase-Like Vesicle-Associated
PHKG1	Phosphorylase Kinase Catalytic Subunit Gamma 1
PHKG2	Phosphorylase Kinase Catalytic Subunit Gamma 2
CHEK2	Checkpoint Kinase 2
CASK	Calcium/Calmodulin-Dependent Serine Protein Kinase
RPS6KA2	Ribosomal Protein S6 Kinase A2



6) PSI-BLAST iterations were continued until kinases from at least 3 groups were included in the results table. The max target sequence was increased by 10 in each iteration. Below are the kinases included in the results table for the 4th iteration and subsequent iterations, along with their positions on the phylogenetic tree.

Iteration 4: Max target sequence = 40

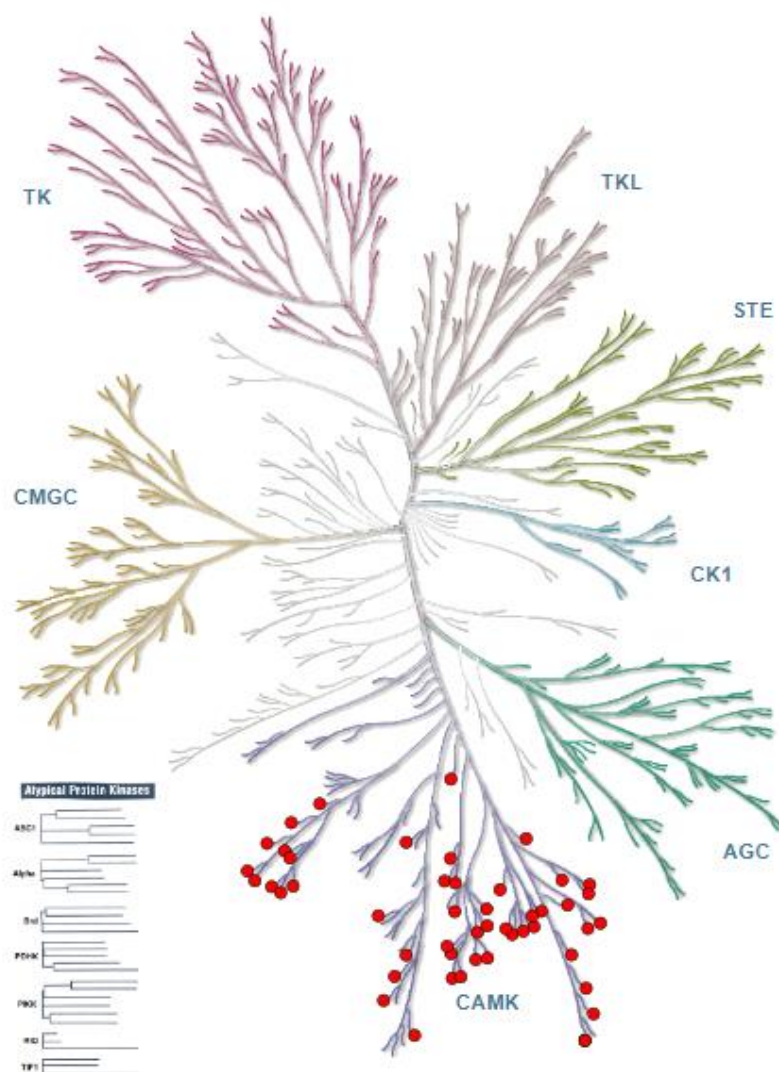
RPS6KA3	Ribosomal Protein S6 Kinase A3
RPS6KA1	Ribosomal Protein S6 Kinase A1
RPS6KA6	Ribosomal Protein S6 Kinase A6
PRKD2	Protein Kinase D2
RPS6KA5	Ribosomal Protein S6 Kinase A5
MAPKAPK3	Mitogen-Activated Protein Kinase-Activated Protein Kinase 3
PRKD1	Protein Kinase D1
STK33	Serine/Threonine Kinase 33
MAPKAPK2	Mitogen-Activated Protein Kinase-Activated Protein Kinase 2
SNRK	Sucrose Non-Fermenting Related Kinase



Iteration 5: Max target sequence = 50

PRKD3	Protein Kinase D3
RPS6KA4	Ribosomal Protein S6 Kinase A4
MAPKAPK5	Mitogen-Activated Protein Kinase-Activated Protein Kinase 5
NUAK1	NUAK Family SNF1-Like Kinase 1
SIK1	Salt-Inducible Kinase 1

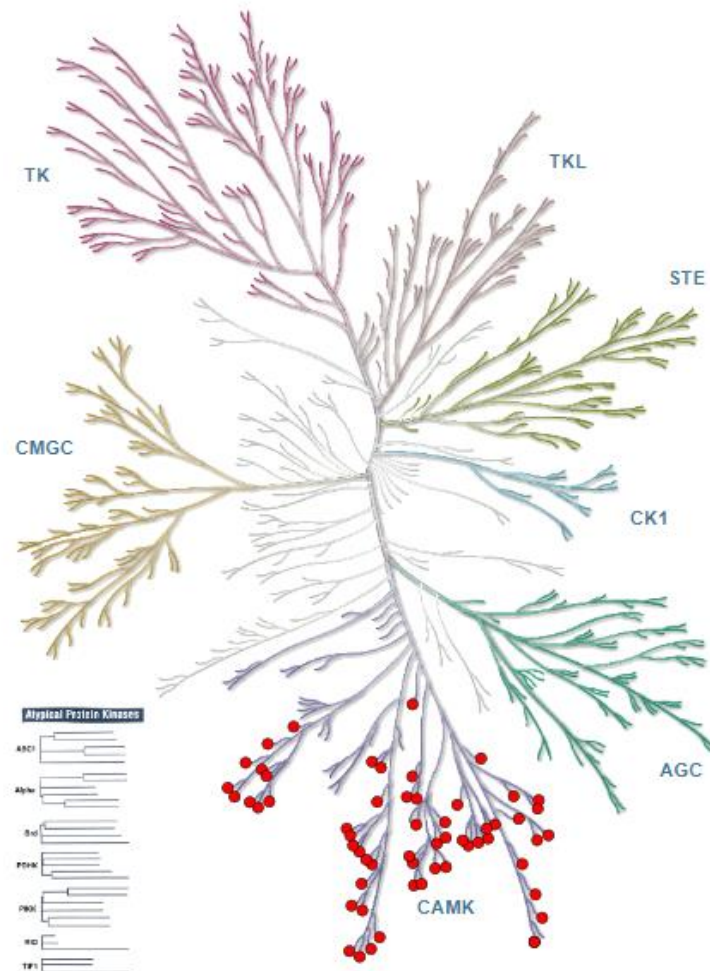
SIK1B	Salt-Inducible Kinase 1B
MKNK2	MAP Kinase-Interacting Serine/Threonine Kinase 2
SIK3	Salt-Inducible Kinase 3
MARK4	Microtubule Affinity Regulating Kinase 4
PRKAA2	Protein Kinase AMP-Activated Catalytic Subunit Alpha 2



Iteration 6: Max target sequence = 60

MARK3	Microtubule Affinity Regulating Kinase 3
MARK2	Microtubule Affinity Regulating Kinase 2
SIK2	Salt-Inducible Kinase 2
PRKAA1	Protein Kinase AMP-Activated Catalytic Subunit Alpha 1

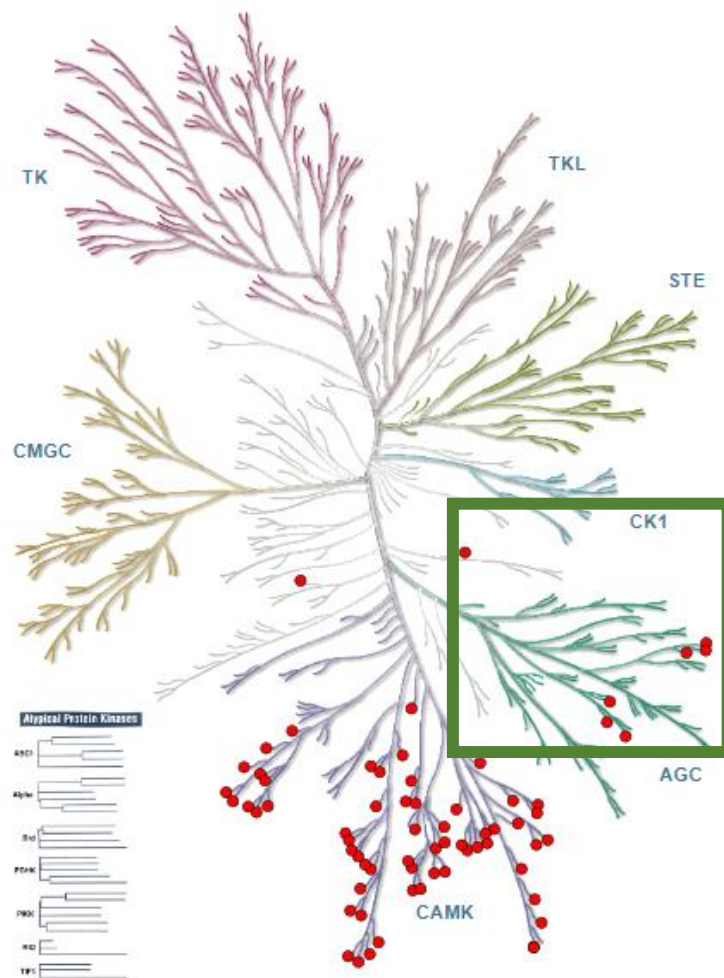
NUAK2	NUAK Family SNF1-Like Kinase 2
MARK1	Microtubule Affinity Regulating Kinase 1
BRSK1	Breast Tumor Kinase 1
MELK	Maternal Embryonic Leucine Zipper Kinase
BRSK2	Breast Tumor Kinase 2
NIM1K	Never in Mitosis Gene A-Related Kinase



Iteration 7: Max target sequence = 70

In the 7th iteration, kinases from the AGC kinase group were observed for the first time outside the CAMK kinase group. The AGC group represents the protein kinase A, G, and C subgroups.

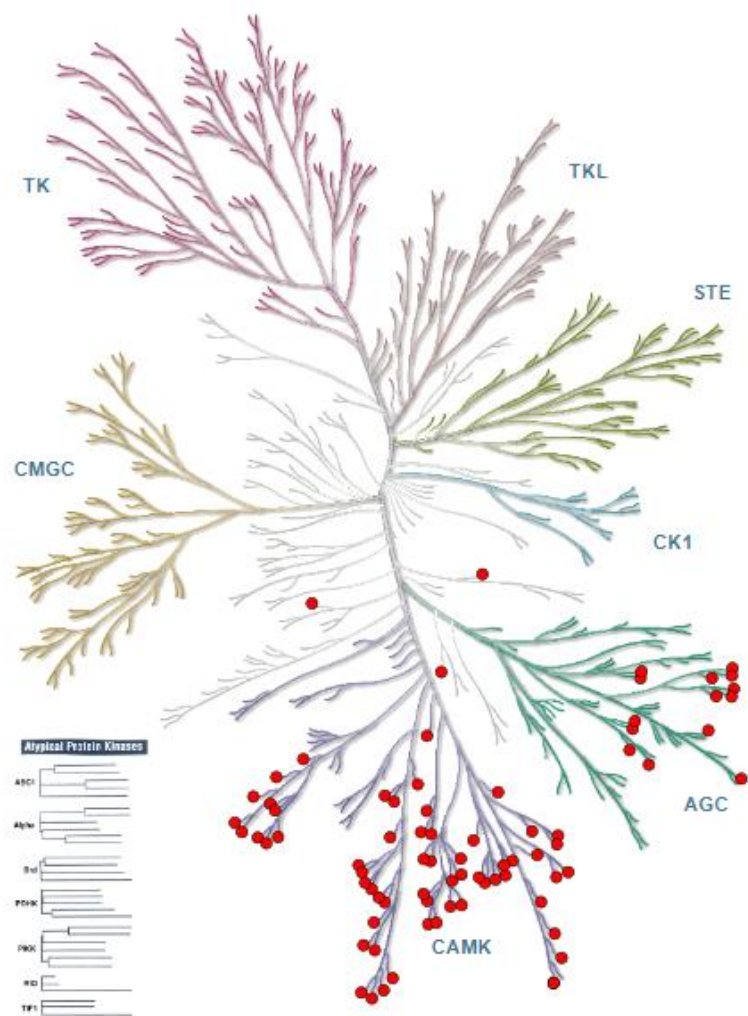
HUNK	Hormonally Upregulated Neu-associated Kinase
PRKACB	Protein Kinase CAMP-Activated Catalytic Subunit Beta
ORKACA	Ovarian Cancer Kinase A
AKT3	AKT Serine/Threonine Kinase 3
PLK4	Polo-Like Kinase 4
PRKACG	Protein Kinase CAMP-Activated Catalytic Subunit Gamma
AKT2	AKT Serine/Threonine Kinase 2
AKT1	AKT Serine/Threonine Kinase 1
PRKX	Protein Kinase X-Linked
ULK3	Unc-51 Like Autophagy Activating Kinase 3



Iteration 8: Max target sequence = 80

PRKY	Protein Kinase Y-Linked
MKNK1	MAP Kinase-Interacting Serine/Threonine Kinase 1
SGK2	Serum/Glucocorticoid Regulated Kinase 2

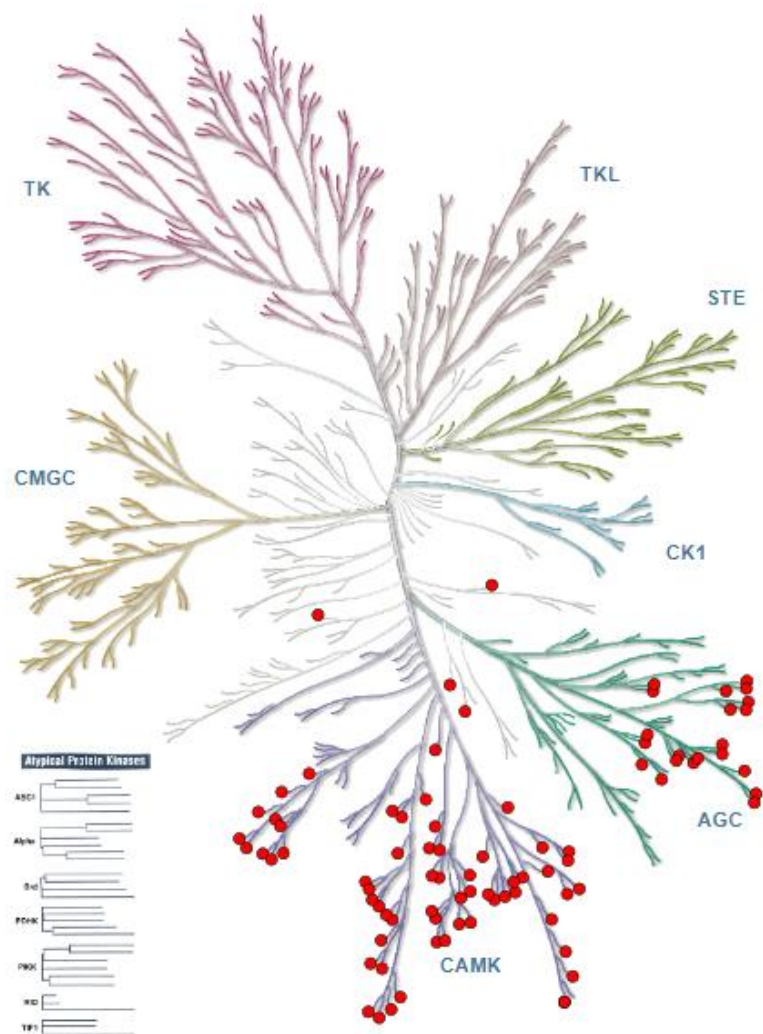
SGK1	Serum/Glucocorticoid Regulated Kinase 1
RPS6KB2	Ribosomal Protein S6 Kinase B2
RPS6KB1	Ribosomal Protein S6 Kinase B1
PRKCH	Protein Kinase C Epsilon
AURKA	Aurora Kinase A
SGK3	Serum/Glucocorticoid Regulated Kinase 3
PRKCA	Protein Kinase C Alpha



Iteration 9: Max target sequence = 90

PRKCE	Protein Kinase C Epsilon
PRKCB	Protein Kinase C Beta

PRKCG	Protein Kinase C Gamma
AURKC	Aurora Kinase C
PRKCQ	Protein Kinase C Theta
PRKCI	Protein Kinase C Iota
PRKCD	Protein Kinase C Delta
PDPK2P	3-phosphoinositide dependent protein kinase-2 pseudogene
PRKCZ	Protein Kinase C Zeta
PDKP1	3-phosphoinositide dependent protein kinase-1 pseudogene

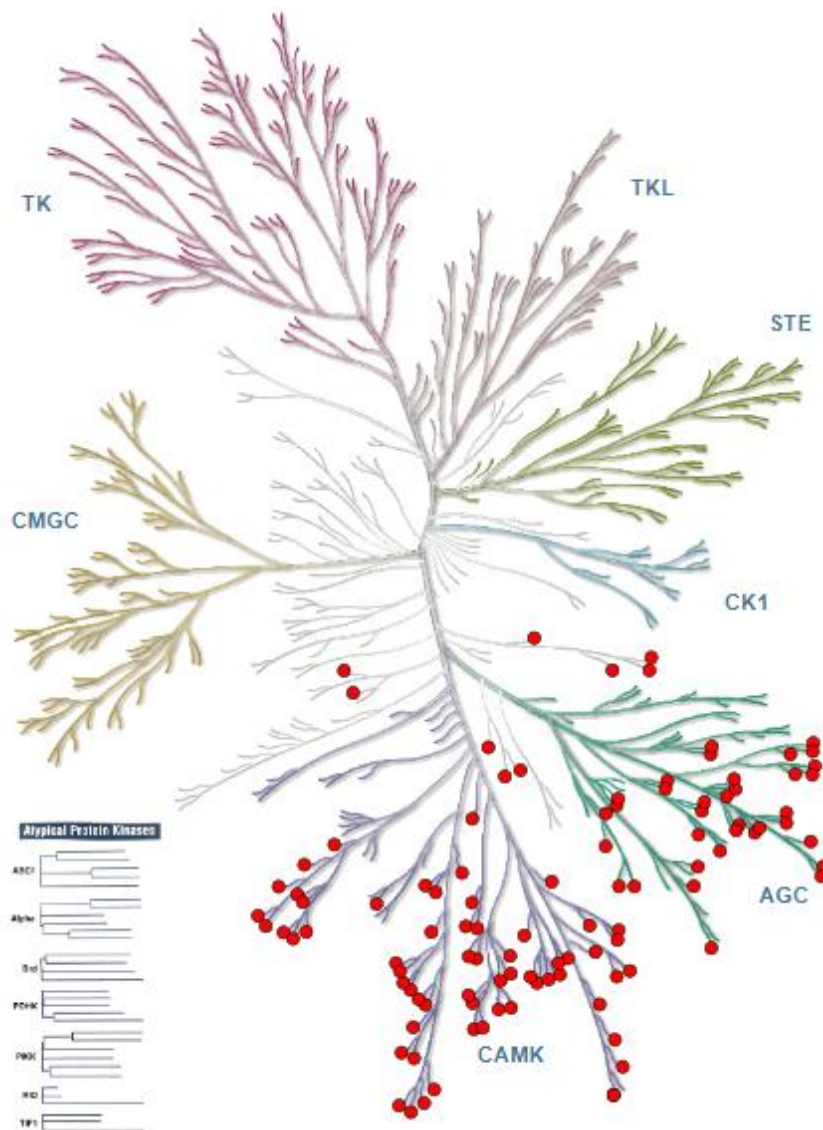


Iteration 10: Max target sequence = 100

AURKB	Aurora Kinase B
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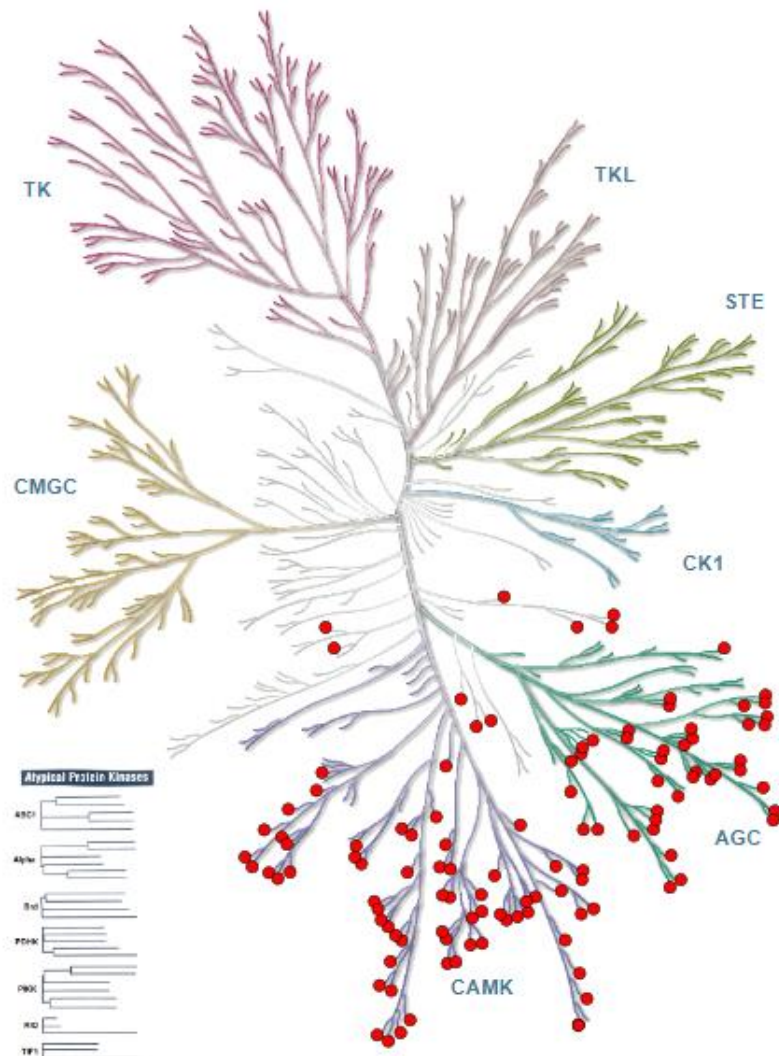
PKN2	Protein Kinase N2
PRKG2	Protein Kinase G2
PRKG1	Protein Kinase G1
PKN1	Protein Kinase N1
MAST3	Microtubule-Associated Serine/Threonine Kinase 3
MAST2	Microtubule-Associated Serine/Threonine Kinase 2
PLK1	Polo-Like Kinase 1
PLK3	Polo-Like Kinase 3
STK36	Serine/Threonine Kinase 36

MAST1	Microtubule-Associated Serine/Threonine Kinase 1
MAST4	Microtubule-Associated Serine/Threonine Kinase 4
PKN3	Protein Kinase N3
PLK2	Polo-Like Kinase 2
STK38L	Serine/Threonine Kinase 38 Like
STK38	Serine/Threonine Kinase 38
DMPK	Myotonic Dystrophy Protein Kinase
TSSK3	Testis-Specific Serine Kinase 3
ROCK1	Rho-Associated Coiled-Coil Containing Protein Kinase 1
CDC42BPA	Cell Division Cycle 42 Binding Protein Kinase Alpha



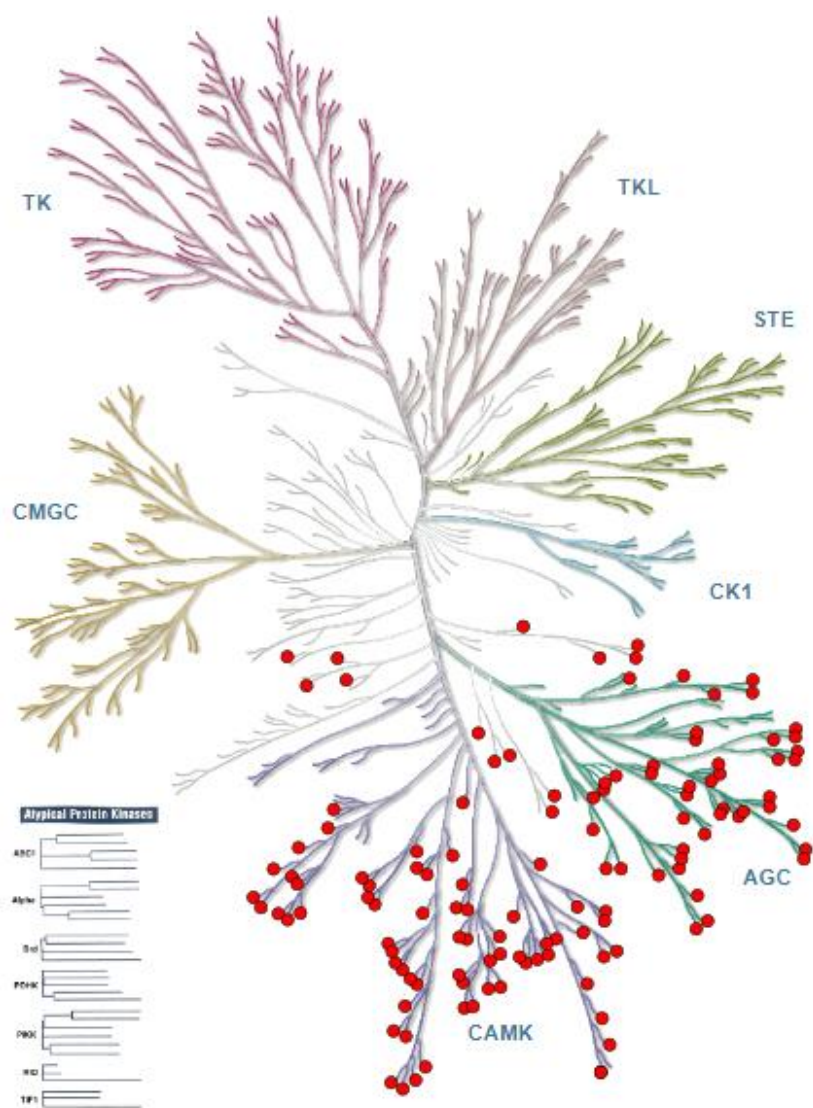
Iteration 12: Max target sequence = 120

CDC42BPB	CDC42 binding protein kinase beta
CDC42BPG	CDC42 binding protein kinase gamma
ROCK2	Rho-associated coiled-coil containing protein kinase 2
LATS2	Large tumor suppressor kinase 2
TSSK2	Testis-specific serine kinase 2
TSSK1B	Testis-specific serine kinase 1B
CIT	Citron Rho-interacting kinase
OBSCN	Obscurin, cytoskeletal calmodulin and titin-interacting RhoGEF
GRK5	G protein-coupled receptor kinase 5
CAMPKK2	Calcium/calmodulin-dependent protein kinase kinase 2



Iteration 13: Max target sequence = 130

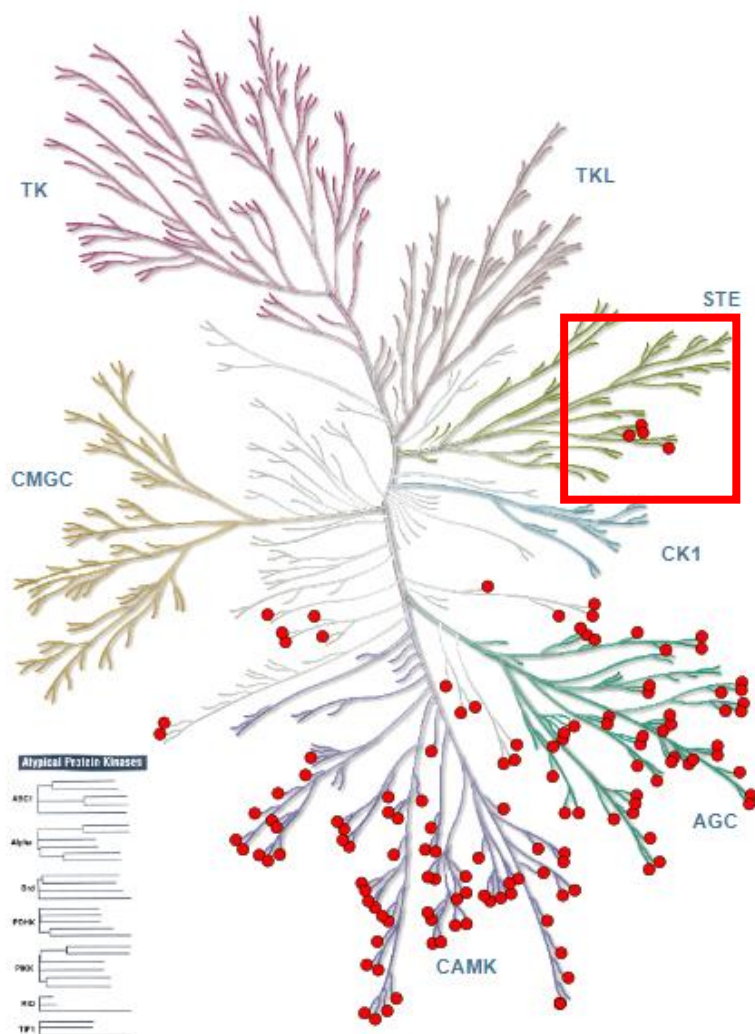
GRK6	G Protein-Coupled Receptor Kinase 6
GRK4	G Protein-Coupled Receptor Kinase 4
GRK1	G Protein-Coupled Receptor Kinase 1
TSSK4	Testis-Specific Serine Kinase 4
TSSK6	Testis-Specific Serine Kinase 6
CAMKK1	Calcium/Calmodulin-Dependent Protein Kinase Kinase 1
STK32B	Serine/Threonine Kinase 32B
ULK2	Unc-51 Like Autophagy Activating Kinase 2
STK32A	Serine/Threonine Kinase 32A
GRK3	G Protein-Coupled Receptor Kinase 3



Iteration 14: Max target sequence = 140

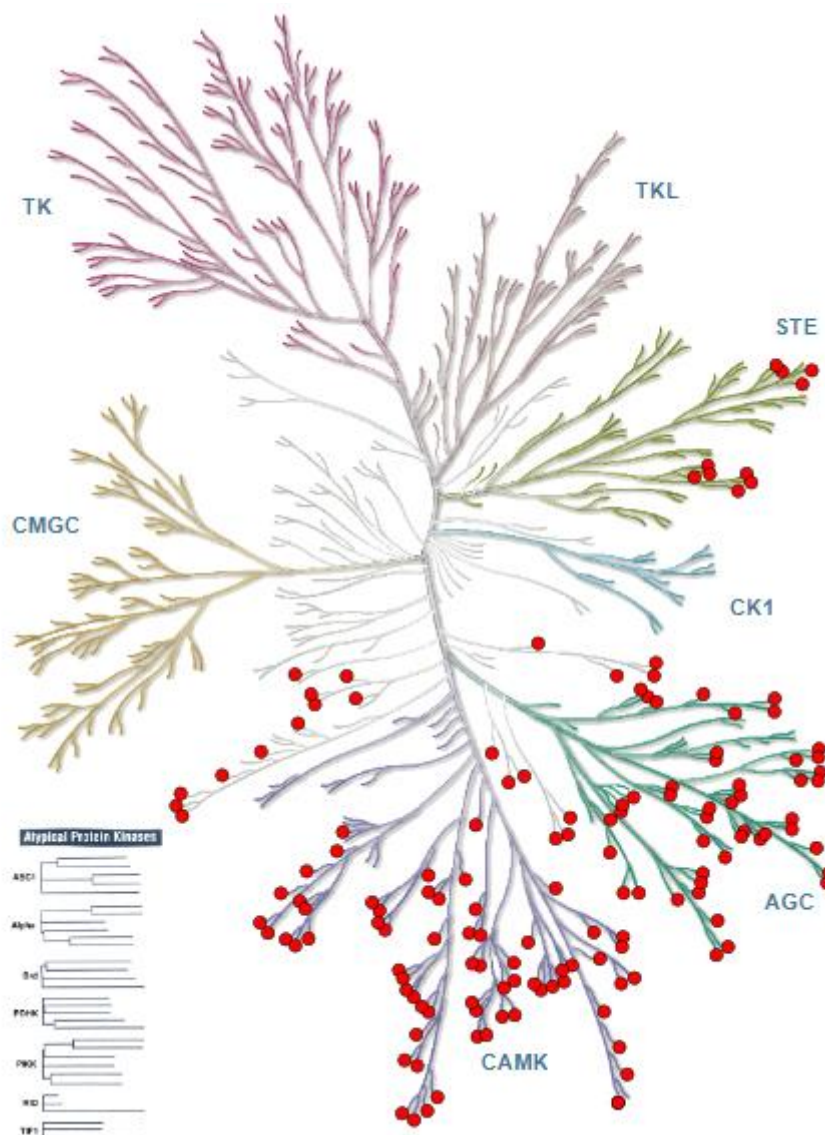
In the 14th iteration, a kinase from the STE kinase group was observed for the first time. The STE kinase group represents a specific protein kinase family called Signal Transducing and Extracellular Signal-Regulated Kinase (STE).

STK32C	Serine/Threonine Kinase 32C
GRK2	G Protein-Coupled Receptor Kinase 2
GRK7	G Protein-Coupled Receptor Kinase 7
ULK1	Unc-51 Like Autophagy Activating Kinase 1
NEK5	Never In Mitosis A-Related Kinase 5
NEK3	Never In Mitosis A-Related Kinase 3
PAK6	p21-Activated Kinase 6
PAK1	p21-Activated Kinase 1
PAK2	p21-Activated Kinase 2
NEK	Never In Mitosis A-Related Kinase
PAK3	p21-Activated Kinase 3



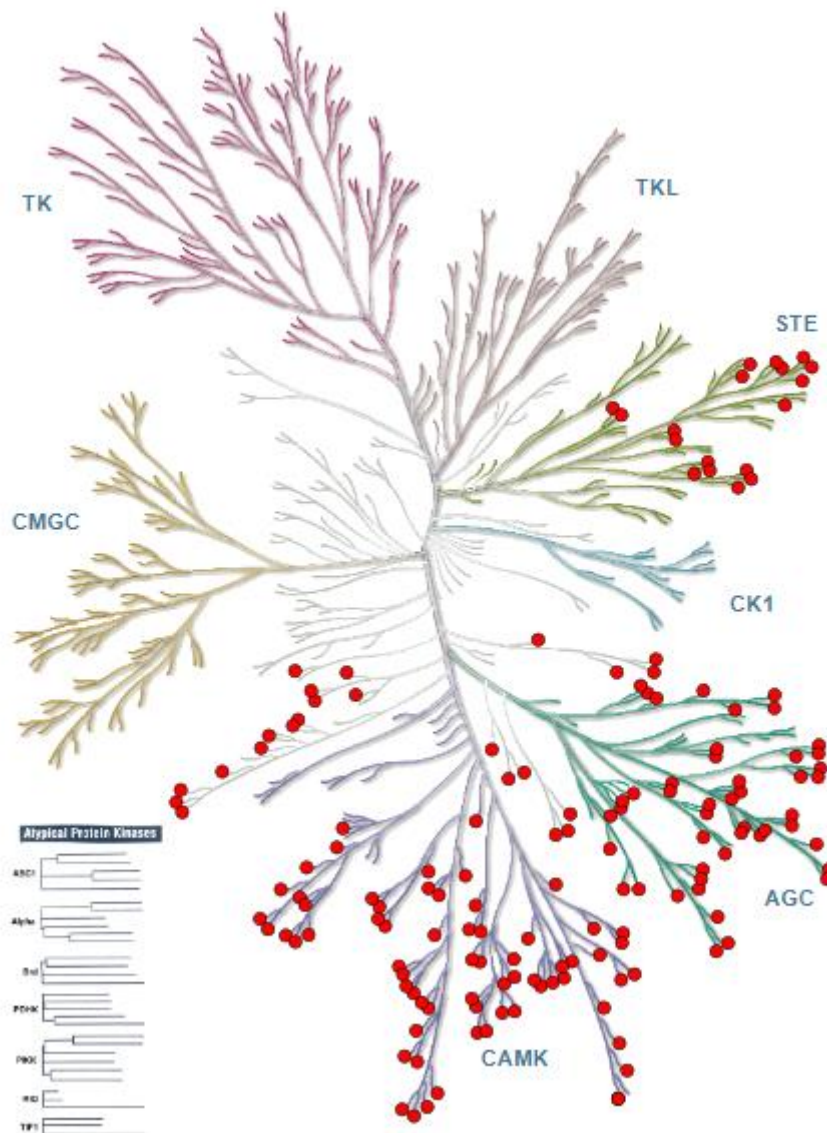
Iteration 15: Max target sequence = 150

PAK4	p21-activated kinase 4
PAK5	p21-activated kinase 5
NEK1	NIMA (never in mitosis gene a)-related kinase 1
STK3	Serine/threonine kinase 3
STK4	Serine/threonine kinase 4
NEK4	NIMA (never in mitosis gene a)-related kinase 4
STK24	Serine/threonine kinase 24
NEK2	NIMA (never in mitosis gene a)-related kinase 2
NEK6	NIMA (never in mitosis gene a)-related kinase 6
STK26	Serine/threonine kinase 26
PAK4	p21-activated kinase 4



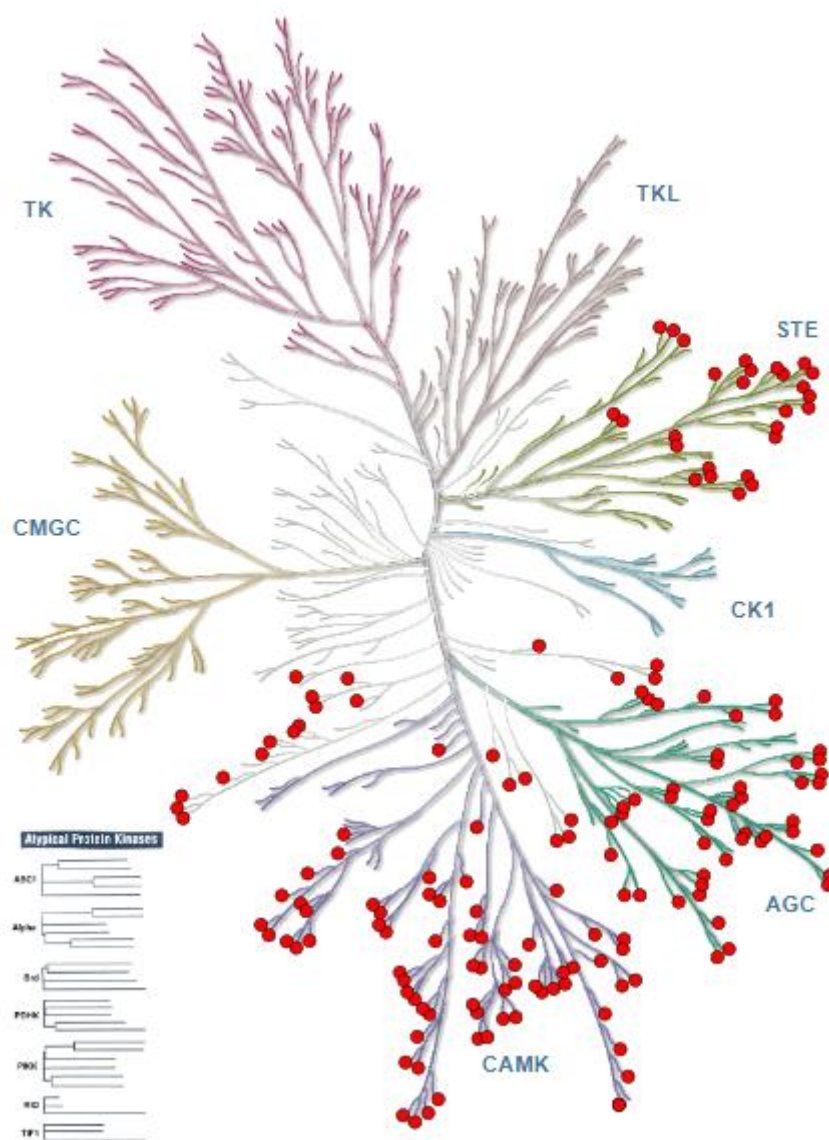
Iteration 16: Max target sequence = 160

STK25	Serine/Threonine Kinase 25
NEK7	NIMA (Never In Mitosis Gene A)-Related Kinase 7
MAP4K3	Mitogen-Activated Protein Kinase Kinase Kinase 3
OXS1	Oxidative-Stress Responsive 1 Kinase
SLK	STE20-like Kinase
NEK9	NIMA (Never In Mitosis Gene A)-Related Kinase 9
MAP4K2	Mitogen-Activated Protein Kinase Kinase Kinase 2
STK10	Serine/Threonine Kinase 10
STK39	Serine/Threonine Kinase 39
TNIK	TRAF2- and NCK-interacting Kinase



Iteration 17: Max target sequence = 170

MAP4K5	Mitogen-Activated Protein Kinase Kinase Kinase Kinase 5
MAP4K1	Mitogen-Activated Protein Kinase Kinase Kinase Kinase 1
MINK1	Misshapen/NIK-related kinase 1
MYO3B	Myosin III B
MAP3K3	Mitogen-Activated Protein Kinase Kinase Kinase 3
MAP4K4	Mitogen-Activated Protein Kinase Kinase Kinase Kinase 4
MYO3A	Myosin III A
CHEK1	Checkpoint Kinase 1
MAP3K5	Mitogen-Activated Protein Kinase Kinase Kinase 5
MAP3K2	Mitogen-Activated Protein Kinase Kinase Kinase 2



Iteration 18: Max target sequence = 180

In the 18th iteration, a kinase from the 4th distinct kinase group was observed. According to the given instructions, we are required to stop the iteration when three groups are filled, and a kinase is marked for the first time in the 4th group. In this iteration, after the CAMK, AGC, and STE kinase groups were filled, the iteration ended as a kinase was marked for the first time in the CMGC group.

The CMGC kinase group represents a protein kinase family that encompasses a wide biological spectrum, including various kinases such as Cyclin-Dependent Kinase (CDK), Mitogen-Activated Protein Kinase (MAPK), Glycogen Synthase Kinase (GSK), and Cyclin-Dependent Kinase-Like (CDKL), involved in processes ranging from cell cycle regulation to cellular signal transduction.

MAP3K6	Mitogen-Activated Protein Kinase Kinase Kinase 6
MAP3K15	Mitogen-Activated Protein Kinase Kinase Kinase 15
MAP3K19	Mitogen-Activated Protein Kinase Kinase Kinase 19
TAOK1	Thousand and one amino acid kinase 1
TAOK2	Thousand and one amino acid kinase 2
CDK2	Cyclin-Dependent Kinase 2
TAOK3	Thousand and one amino acid kinase 3
KALRN	Kalirin, RhoGEF Kinase
CDK3	Cyclin-Dependent Kinase 3
NEK10	NIMA (Never In Mitosis Gene A)-Related Kinase 10

