

## WEBLEM 11

### Introduction To Sequence Alignment

#### **BLAST:**

A sequence similarity search often provides the first information about a new DNA or protein sequence. A search allows scientists to infer the function of a sequence from similar sequences. There are many ways of performing a sequence similarity search, but probably the most popular method is the “Basic Local Alignment Search Tool” (BLAST) (1, 2). BLAST uses heuristics to produce results quickly. It also calculates an “expect value” that estimates how many matches would have occurred at a given score by chance, which can aid a user in judging how much confidence to have in an alignment.

As the name implies, BLAST performs “local” alignments. Most proteins are modular in nature, with one or more functional domains occurring within a protein. The same domains may also occur in proteins from different species. The BLAST algorithm is tuned to find these domains or shorter stretches of sequence similarity. The local alignment approach also means that an mRNA can be aligned with a piece of genomic DNA, as is frequently required in genome assembly and analysis. If instead BLAST started out by attempting to align two sequences over their entire lengths (known as a global alignment), fewer similarities would be detected, especially with respect to domains and motifs.

#### 1. BLASTN:

The BLASTN nucleotide-nucleotide search looks for more distant sequences.

#### 2. BLASTP:

BLASTP performs protein-protein sequence comparison, and its algorithm is the basis of many other types of BLAST searches such a BLASTX and TBLASTN.

#### 3. PHI-BLAST:

PHI-BLAST (Pattern-Hit Initiated BLAST) is a search program that combines matching of regular expressions with local alignments surrounding the match. The most important features of the program have been incorporated into the BLAST software framework partly for user convenience and partly so that PHI-BLAST may be combined seamlessly with PSI-Blast. Other features that do not fit into the BLAST framework will be released later as a separate and/or separate web page query option.

#### 4. PSI-BLAST:

PSI-BLAST first performs a BLASTP search to collect information that it then uses to produce a Position-Specific-Scoring-Matrix (PSSM). A PSSM for a query of length N is an N x 20 matrix. Each of the N columns corresponds to a letter in the query, and each column contains 20 rows. Each row corresponds to a specific residue and describes the probability of related sequences having that residue at that position. PSI-BLAST can then search a database of protein sequences with this PSSM.

**FASTA:**

At EMBL-EBI, we make the world's public biological data freely available to the scientific community via a range of services and tools, perform basic research and provide professional training in bioinformatics. We are part of the European Molecular Biology Laboratory (EMBL), an international, innovative and interdisciplinary research organization funded by over 20 member states, prospect and associate member states.

ASTA (pronounced FAST-AYE) is a suite of programs for searching nucleotide or protein databases with a query sequence. FASTA itself performs a local heuristic search of a protein or nucleotide database for a query of the same type. FASTX and FASTY translate a nucleotide query for searching a protein database. TFASTX and TFASTY translate a nucleotide database to be searched with a protein query. Optimal searches are available with the programs SSEARCH (local), GGSEARCH (global) and GLSEARCH (global query against local database).

**5. FASTAp;**

This tool provides sequence similarity searching against protein databases using the FASTA suite of programs. FASTA provides a heuristic search with a protein query. FASTX and FASTY translate a DNA query. Optimal searches are available with SSEARCH (local), GGSEARCH (global) and GLSEARCH (global query, local database).

**6. FASTAn:**

This tool provides sequence similarity searching against nucleotide databases using the FASTA suite of programs. FASTA provides a heuristic search with a nucleotide query. TFASTX and TFASTY translate the DNA database for searching with a protein query. Optimal searches are available with SSEARCH (local), GGSEARCH (global) and GLSEARCH (global query, local database).

**WEBLEM 11/a**(URL: <https://blast.ncbi.nlm.nih.gov/Blast.cgi>)**Aim:**

To study the Query ‘Keratin’ in BLASTn.

**Introduction:**

As the name implies, BLAST performs “local” alignments. Most proteins are modular in nature, with one or more functional domains occurring within a protein. The same domains may also occur in proteins from different species. The BLAST algorithm is tuned to find these domains or shorter stretches of sequence similarity. The local alignment approach also means that an mRNA can be aligned with a piece of genomic DNA, as is frequently required in genome assembly and analysis. If instead BLAST started out by attempting to align two sequences over their entire lengths (known as a global alignment), fewer similarities would be detected, especially with respect to domains and motifs.

- The BLASTN nucleotide-nucleotide search looks for more distant sequences.

Rhodopsin, also called visual purple, pigment-containing sensory protein that converts light into an electrical signal. Rhodopsin is found in a wide range of organisms, from vertebrates to bacteria. In many seeing animals, including humans, it is required for vision in dim light and is located in the retina of the eye specifically, within the tightly packed disks that make up the outer segment of the retina’s photoreceptive rod cells, which are specially adapted for vision under low-light conditions.

Rhodopsin was discovered in 1876 by German physiologist Franz Christian Boll, who observed that the normally reddish purple frog retina turned pale in bright light. The fading of colour was later attributed to the destruction of rhodopsin, via a process known as bleaching. Bleaching and the subsequent regeneration of rhodopsin are major steps in the visual cycle—the series of biochemical reactions that is critical for vision in low light.

**Methodology:**

1. Open the homepage of blast.
2. After that click the Blastn.
3. Enter the sequence for keratin taken by Genebank.
4. Open the result page.
5. Interpret the result.

## Observation:

The screenshot shows the BLAST homepage. At the top, the NIH logo and "U.S. National Library of Medicine National Center for Biotechnology Information" are displayed. The "BLAST®" logo is on the left, and a "Log in" button is on the right. Below the header, a "Basic Local Alignment Search Tool" section is shown with a brief description of what BLAST does. A "NEWS" box on the right says "BLAST+ 2.12.0 is here!" and provides a link to more news. The main content area includes sections for "Web BLAST" (with icons for Nucleotide BLAST, blastx, and tblastn), "BLAST Genomes" (with a search bar and links for Human, Mouse, Rat, and Microbes), and "Standalone and API BLAST" (with links for Download BLAST, Use BLAST API, and Use BLAST in the cloud).

Fig1. Homepage of BLAST

The screenshot shows the NCBI genebank interface. The top navigation bar includes "NCBI", "Resources", "How To", and "Sign in to NCBI". The main search bar is set to "Nucleotide" and has a dropdown for "Nucleotide" and an "Advanced" link. A "Search" button is on the right, along with "Help" and "COVID-19 Information" links. The COVID-19 information box contains links to CDC, NIH, SARS-CoV-2 data, Prevention and treatment information, and Español. Below this is a "FASTA" section for the sequence NM\_001287832.1. The sequence is for Haplochromis burtoni rhodopsin-like (rhodopsin), mRNA. The sequence itself is a long string of nucleotide bases. To the right of the sequence are several options: "Send to:" (with dropdowns for "Change region shown" and "Customize view"), "Analyze this sequence" (with links for Run BLAST, Pick Primers, Highlight Sequence Features, Find in this Sequence, and Show in Genome Data Viewer), "Articles about the rhodopsin gene" (with a link to "Timing and location of rhodopsin expression in newly born rodent [Brain Res Dev Brain Res. 2004]"), and "Reference sequence information" (with a link to "RefSeq protein product" and "See the reference protein sequence for Rhodopsin (NP\_001274761.1)").

Fig2. Fasta sequence taken from genebank

NIH U.S. National Library of Medicine  
National Center for Biotechnology Information

Log in

BLAST® > blastn suite

Standard Nucleotide BLAST

Enter Query Sequence

Enter accession number(s), gis(s), or FASTA sequence(s)

From  To

Or, upload file

Job Title

Enter a descriptive title for your BLAST search

Align two or more sequences

New columns added to the Description Table  
Click 'Select Columns' or 'Manage Columns'.

Choose Search Set

Database  Standard databases (nr etc.)  rRNA/ITS databases  Genomic + transcript databases  Betacoronavirus  
Nucleotide collection (nr/nt)

Organism Optional  Enter organism name or id—completions will be suggested  exclude

Exclude Optional  Models (XM/XP)  Uncultured/environmental sample sequences

Limit to Optional  Sequences from type material

Entrez Query Optional

Program Selection

Optimize for  Highly similar sequences (megablast)  More dissimilar sequences (discontiguous megablast)  Somewhat similar sequences (blastn)  
Choose a BLAST algorithm

BLAST  Search database Nucleotide collection (nr/nt) using Megablast (Optimize for highly similar sequences)  Show results in a new window

+ Algorithm parameters

Fig3. Search bar for blastn with sequence.

BLAST  Search database Nucleotide collection (nr/nt) using Megablast (Optimize for highly similar sequences)  Show results in a new window

+ Algorithm parameters

General Parameters

Max target sequences   Selected the maximum number of aligned sequences to display

Short queries  Automatically adjust parameters for short input sequences

Expect threshold

Word size

Max matches in a query range

Scoring Parameters

Match/Mismatch   Scores  Gap Costs

Filters and Masking

Filter  Low complexity regions  Species-specific repeats for: Homo sapiens (Human)

Mask  Mask for lookup table only  Mask lower case letters

BLAST  Search database Nucleotide collection (nr/nt) using Megablast (Optimize for highly similar sequences)  Show results in a new window

[Twitter](#) [Facebook](#) [YouTube](#) [LinkedIn](#) [Blog](#) [Support Center](#)

National Center for Biotechnology Information  
8600 Rockville Pike  
Bethesda MD, 20894 USA

Popular  
PubMed  
PubMed Central  
Bookshelf  
ePub

Resources  
Literature  
Health  
Genomes

Actions  
Submit  
Download  
Learn  
Print

Fig4. Algorithm parameters in blastn

U.S. National Library of Medicine  
National Center for Biotechnology Information

Log in

BLAST® » blastn suite » results for RID-RZVX5KVD016

Home Recent Results Saved Strategies Help

Save Search Search Summary ▾

Job Title NM\_001287832.1 *Haplochromis burtoni* rhodopsin-like...  
RID RZVX5KVD016 Search expires on 11-02 21:46 pm [Download All](#)  
Program BLASTN [Citation](#) ▾  
Database nt [See details](#) ▾  
Query ID Icl|Query\_1029  
Description NM\_001287832.1 *Haplochromis burtoni* rhodopsin-like (R...  
Molecule type dna  
Query Length 1506  
Other reports Distance tree of results MSA viewer [?](#)

Filter Results

Organism only top 20 will appear  exclude  
Type common name, binomial, taxid or group name  
+ Add organism

Percent Identity E value Query Coverage

Filter Reset

Descriptions Graphic Summary Alignments Taxonomy

Sequences producing significant alignments Download New Select columns Show 100 [?](#)

select all 100 sequences selected

GenBank Graphics Distance tree of results New MSA Viewer

| Description   | Scientific Name               | Max Score | Total Score | Query Cover | E value | Per. Ident | Acc. Len | Accession      |
|---|-------------------------------|-----------|-------------|-------------|---------|------------|----------|----------------|
| <input checked="" type="checkbox"/> <i>Haplochromis burtoni</i> rhodopsin-like (rhodopsin). mRNA  | <i>Haplochromis b...</i>      | 2782      | 2782        | 100%        | 0.0     | 100.0%     | 1506     | NM_001287832.1 |
| <input checked="" type="checkbox"/> <i>Tropheus duboisi</i> RH1 gene for rod opsin_complete cds   | <i>Tropheus duboisi</i>       | 2699      | 2699        | 97%         | 0.0     | 99.86%     | 7365     | AB674457.1     |
| <input checked="" type="checkbox"/> PREDICTED: <i>Maylandia zebra</i> rhodopsin (LOC101473594). mRNA  | <i>Maylandia zebra</i>        | 2682      | 2682        | 97%         | 0.0     | 99.66%     | 1502     | XM_004546085.3 |
| <input checked="" type="checkbox"/> PREDICTED: <i>Astatotilapia calliptera</i> rhodopsin (LOC113013042). mRNA   | <i>Astatotilapia calli...</i> | 2676      | 2676        | 97%         | 0.0     | 99.59%     | 1507     | XM_026153616.1 |
| <input checked="" type="checkbox"/> <i>Xenotilapia rotundifrons</i> RH1 gene for rod opsin_complete cds_specimen_voucher_personal collection Michio Ho... | <i>Xenotilapia rotu...</i>    | 2632      | 2632        | 97%         | 0.0     | 99.05%     | 4718     | AB458123.1     |
| <input checked="" type="checkbox"/> <i>Xenotilapia leptura</i> RH1 gene for rod opsin_complete cds_specimen_voucher_personal collection Michio Ho...      | <i>Xenotilapia leptu...</i>   | 2627      | 2627        | 97%         | 0.0     | 98.98%     | 4787     | AB458125.1     |
| <input checked="" type="checkbox"/> <i>Xenotilapia bathyphilus</i> RH1 gene for rod opsin_complete cds_specimen_voucher_personal collection Michi...      | <i>Xenotilapia bathy...</i>   | 2627      | 2627        | 97%         | 0.0     | 98.98%     | 4665     | AB458124.1     |
| <input checked="" type="checkbox"/> <i>Xenotilapia spiloptera</i> RH1 gene for rod opsin_complete cds_specimen_voucher_personal collection Michi...       | <i>Xenotilapia spilo...</i>   | 2623      | 2623        | 97%         | 0.0     | 98.91%     | 4751     | AB458128.1     |
| <input checked="" type="checkbox"/> <i>Haplochromis pyrrhcephalus</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-P10 sequence...            | <i>Haplochromis p...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 7378     | AB667170.1     |
| <input checked="" type="checkbox"/> <i>Haplochromis pyrrhcephalus</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-P9 sequence...             | <i>Haplochromis p...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 7378     | AB667169.1     |

Feedback

Fig5. Result page (header file) for Rhodopsin.

Descriptions Graphic Summary Alignments Taxonomy

Sequences producing significant alignments Download New Select columns Show 100 [?](#)

select all 0 sequences selected

GenBank Graphics Distance tree of results New MSA Viewer

| Description  | Scientific Name               | Max Score | Total Score | Query Cover | E value | Per. Ident | Acc. Len | Accession      |
|--|-------------------------------|-----------|-------------|-------------|---------|------------|----------|----------------|
| <input type="checkbox"/> <i>Haplochromis burtoni</i> rhodopsin-like (rhodopsin). mRNA  | <i>Haplochromis b...</i>      | 2782      | 2782        | 100%        | 0.0     | 100.0%     | 1506     | NM_001287832.1 |
| <input type="checkbox"/> <i>Tropheus duboisi</i> RH1 gene for rod opsin_complete cds   | <i>Tropheus duboisi</i>       | 2699      | 2699        | 97%         | 0.0     | 99.86%     | 7365     | AB674457.1     |
| <input type="checkbox"/> PREDICTED: <i>Maylandia zebra</i> rhodopsin (LOC101473594). mRNA  | <i>Maylandia zebra</i>        | 2682      | 2682        | 97%         | 0.0     | 99.66%     | 1502     | XM_004546085.3 |
| <input type="checkbox"/> PREDICTED: <i>Astatotilapia calliptera</i> rhodopsin (LOC113013042). mRNA   | <i>Astatotilapia calli...</i> | 2676      | 2676        | 97%         | 0.0     | 99.59%     | 1507     | XM_026153616.1 |
| <input type="checkbox"/> <i>Xenotilapia rotundifrons</i> RH1 gene for rod opsin_complete cds_specimen_voucher_personal collection Michio Ho... | <i>Xenotilapia rotu...</i>    | 2632      | 2632        | 97%         | 0.0     | 99.05%     | 4718     | AB458123.1     |
| <input type="checkbox"/> <i>Xenotilapia leptura</i> RH1 gene for rod opsin_complete cds_specimen_voucher_personal collection Michio Ho...      | <i>Xenotilapia leptu...</i>   | 2627      | 2627        | 97%         | 0.0     | 98.98%     | 4787     | AB458125.1     |
| <input type="checkbox"/> <i>Xenotilapia bathyphilus</i> RH1 gene for rod opsin_complete cds_specimen_voucher_personal collection Michi...      | <i>Xenotilapia bathy...</i>   | 2627      | 2627        | 97%         | 0.0     | 98.98%     | 4665     | AB458124.1     |
| <input type="checkbox"/> <i>Xenotilapia spiloptera</i> RH1 gene for rod opsin_complete cds_specimen_voucher_personal collection Michi...       | <i>Xenotilapia spilo...</i>   | 2623      | 2623        | 97%         | 0.0     | 98.91%     | 4751     | AB458128.1     |
| <input type="checkbox"/> <i>Haplochromis pyrrhcephalus</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-P10 sequence...            | <i>Haplochromis p...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 7378     | AB667170.1     |
| <input type="checkbox"/> <i>Haplochromis pyrrhcephalus</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-P9 sequence...             | <i>Haplochromis p...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 7378     | AB667169.1     |
| <input type="checkbox"/> <i>Haplochromis pyrrhcephalus</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-P8 sequence...             | <i>Haplochromis p...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 7378     | AB667168.1     |
| <input type="checkbox"/> <i>Haplochromis pyrrhcephalus</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-P7 sequence...             | <i>Haplochromis p...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 7378     | AB667167.1     |
| <input type="checkbox"/> <i>Haplochromis pyrrhcephalus</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-P6 sequence...             | <i>Haplochromis p...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 7379     | AB667166.1     |
| <input type="checkbox"/> <i>Haplochromis pyrrhcephalus</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-P5 sequence...             | <i>Haplochromis p...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 7378     | AB667165.1     |
| <input type="checkbox"/> <i>Haplochromis pyrrhcephalus</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-P4 sequence...             | <i>Haplochromis p...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 7377     | AB667164.1     |
| <input type="checkbox"/> <i>Haplochromis pyrrhcephalus</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-P3 sequence...             | <i>Haplochromis p...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 7378     | AB667163.1     |
| <input type="checkbox"/> <i>Haplochromis pyrrhcephalus</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-P2 sequence...             | <i>Haplochromis p...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 7379     | AB667162.1     |
| <input type="checkbox"/> <i>Haplochromis pyrrhcephalus</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-P1 sequence...             | <i>Haplochromis p...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 7378     | AB667161.1     |
| <input type="checkbox"/> <i>Haplochromis sp. 'macula'</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-01524 sequence...           | <i>Haplochromis s...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 7379     | AB667155.1     |
| <input type="checkbox"/> <i>Haplochromis sp. 'macula'</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-01522 sequence...           | <i>Haplochromis s...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 7378     | AB667154.1     |
| <input type="checkbox"/> <i>Haplochromis sp. 'macula'</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-01519 sequence...           | <i>Haplochromis s...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 7379     | AB667152.1     |
| <input type="checkbox"/> <i>Plecodus paradoxus</i> RH1 gene for rod opsin_complete cds_clone_Ppara_udp23                                       | <i>Plecodus parad...</i>      | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 4425     | AB588119.1     |
| <input type="checkbox"/> <i>Altolamprologus calvus</i> RH1 gene for rod opsin_complete cds_specimen_voucher_personal collection Michi...       | <i>Altolamprologus...</i>     | 2621      | 2621        | 97%         | 0.0     | 98.91%     | 4893     | AB458132.1     |
| <input type="checkbox"/> <i>Haplochromis sp. 'macula'</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-01531 sequence...           | <i>Haplochromis s...</i>      | 2617      | 2617        | 97%         | 0.0     | 98.84%     | 7379     | AB667157.1     |
| <input type="checkbox"/> <i>Haplochromis sp. 'macula'</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-01520 sequence...           | <i>Haplochromis s...</i>      | 2617      | 2617        | 97%         | 0.0     | 98.84%     | 7378     | AB667153.1     |
| <input type="checkbox"/> <i>Haplochromis sp. 'macula'</i> RH1 gene for rod opsin_complete cds_specimen_voucher_TIT-01518 sequence...           | <i>Haplochromis s...</i>      | 2617      | 2617        | 97%         | 0.0     | 98.84%     | 7378     | AB667151.1     |
| <input type="checkbox"/> PREDICTED: <i>Haplochromis burtoni</i> rhodopsin-like (rhodopsin). mRNA   | <i>Haplochromis b...</i>      | 2615      | 2615        | 97%         | 0.0     | 98.84%     | 1507     | NM_001287832.1 |

Fig6. Description for query Rhodopsin

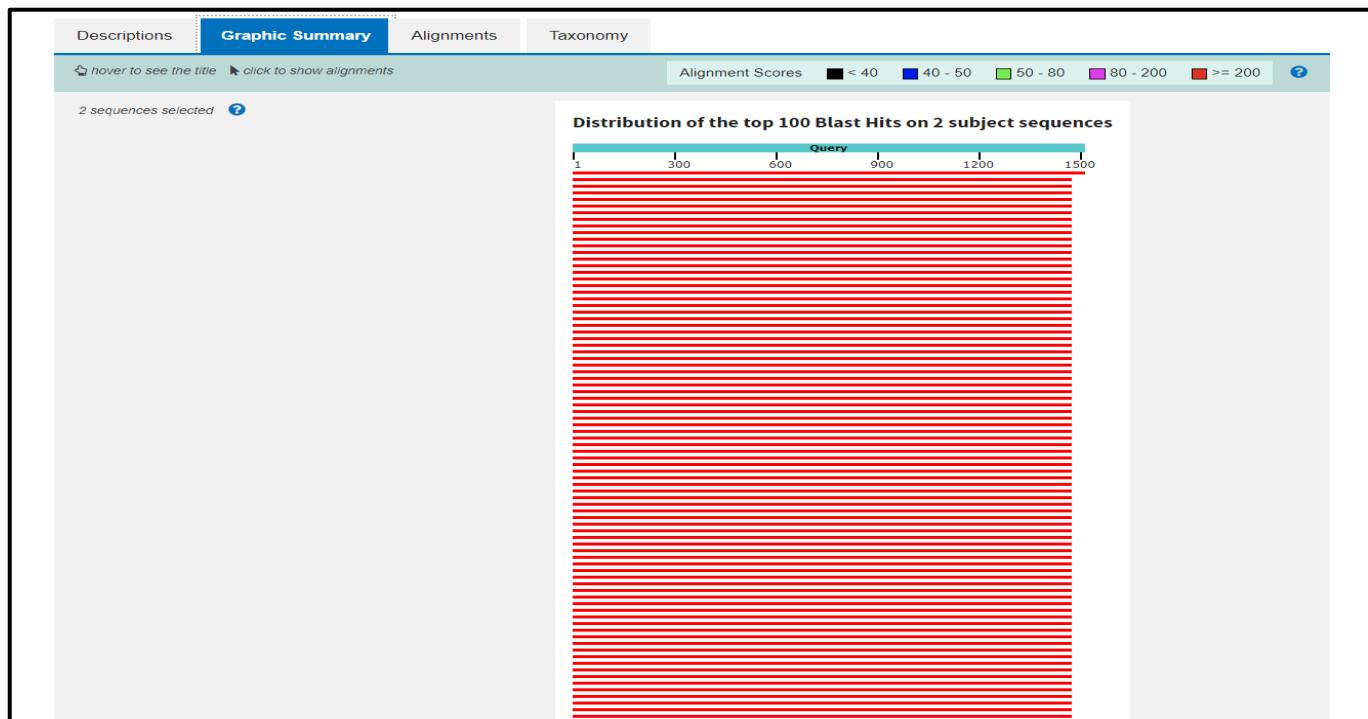


Fig7. Graphic Summary for query Rhodopsin

| Descriptions  | Graphic Summary | Alignments   | Taxonomy   |
|---|-----------------|--|--|
| Alignment view  |                 | Pairwise   | <input type="checkbox"/> CDS feature <span>Restore defaults</span> |
| <a href="#">Download</a> ▾ <span>▼ Next</span> <span>▲ Previous</span> <span>▲ First Range</span> |                 |  |  |
| Query range 1: 1 to 60  |                 |  |  |
| Query   | 1               | CCCAAACAGCCAGAAGAACCTCTGAAGGGCTATCGCAACCAAGCCGCAACCATG | 60   |
| NM_001287832.1  | 1               | .....  | 60   |
| AB674457.1  | 3768            | .....  | 3827   |
| XM_004546085.3  | 35              | C.....   | 94   |
| XM_026153616.1  | 41              | .....  | 100  |
| AB458123.1  | 3091            | .....  | 3150   |
| AB458125.1  | 3160            | .....  | 3219   |
| AB458124.1  | 3038            | .....  | 3097   |
| AB458128.1  | 3124            | .....  | 3183   |
| AB667170.1  | 3790            | .....  | 3849   |
| AB667169.1  | 3791            | .....  | 3850   |
| AB667168.1  | 3791            | .....  | 3850   |
| AB667167.1  | 3790            | .....  | 3849   |
| AB667166.1  | 3791            | .....  | 3850   |
| AB667165.1  | 3791            | .....  | 3850   |
| AB667164.1  | 3790            | .....  | 3849   |
| AB667163.1  | 3791            | .....  | 3850   |
| AB667162.1  | 3791            | .....  | 3850   |
| AB667161.1  | 3790            | .....  | 3849   |
| AB667155.1  | 3791            | .....  | 3850   |
| AB667154.1  | 3790            | .....  | 3849   |
| AB667152.1  | 3791            | .....  | 3850   |
| AB588119.1  | 2894            | .....C.....  | 2863   |
| AB458132.1  | 3267            | .....  | 3326   |
| AB667157.1  | 3791            | .....  | 3850   |
| AB667153.1  | 3790            | .....  | 3849   |
| AB667151.1  | 3790            | .....  | 3849   |
| XM_005749519.1  | 41              | .....  | 100  |
| AB667194.1  | 3790            | .....  | 3849   |
| AB667193.1  | 3790            | .....  | 3849   |
| AB667192.1  | 3790            | .....  | 3849   |
| AB667191.1  | 3790            | .....  | 3849   |
| AB667190.1  | 3790            | .....  | 3849   |
| AB667187.1  | 3790            | .....  | 3849   |
| AB667186.1  | 3790            | .....  | 3849   |
| AB667185.1  | 3791            | .....  | 3850   |
| AB667184.1  | 3791            | .....  | 3850   |
| AB667183.1  | 3790            | .....  | 3849   |
| AB667182.1  | 3791            | .....  | 3850   |
| AB667180.1  | 3791            | .....  | 3850   |
| AB667178.1  | 3791            | .....  | 3850   |
| AB667176.1  | 3791            | .....  | 3850   |
| AB667175.1  | 3791            | .....  | 3850   |
| AB667173.1  | 3790            | .....  | 3849   |
| AB667172.1  | 3790            | .....  | 3849   |
| AB667160.1  | 3790            | .....  | 3849   |
| AB667159.1  | 3791            | .....  | 3850   |
| AB667158.1  | 3790            | .....  | 3849   |
| AB667156.1  | 3791            | .....  | 3850   |
| AB458141.1  | 2794            | .....C.....  | 2853   |
| AB458140.1  | 2792            | .....C.....  | 2851   |

Fig8. Alignment for query Rhodopsin

| Descriptions   | Graphic Summary | Alignments | Taxonomy       |   |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
|--|-----------------|------------|----------------|---|------------|-------|----------------|-------------|----------------|-------------|-----|--|--|-------------|-------------|-----|--|--|-------------------------|-------------|----|--|--|---------------------|-------------|----|--|--|----------------------|-------------|----|--|--|--------------------------------|-------------|------|---|---|---------------------------------------|-------------|------|----|--|-------------------------------------|-------------|------|----|--|---------------------------------|-------------|------|----|--|---------------------------|-------------|------|---|--------------------------------------|------------------------------------|-------------|------|---|---|-------------------------------|-------------|------|---|--|--------------------------------|-------------|------|----|---|-------------------------------|-------------|------|---|--|--------------------------------------|-------------|------|---|---|------------------------------------|-------------|------|---|---|-------------------------------------|-------------|------|---|--|------------------------------------|-------------|------|---|---|---------------------------------|-------------|------|---|--|------------------------------------|-------------|------|---|---|-------------------------------------|-------------|------|---|--|------------------------------------|-------------|------|---|---|--|-------------|------|---|---|-----------------------------------|-------------|------|---|--|---------------------------------|-------------|------|---|--|----------------------------|-------------|------|---|---------------------------------------|--|-------------|------|---|---|-------------------------------|-------------|------|---|--|-----------------------------------|-------------|------|---|--|----------------------------------|-------------|------|---|---|------------------------------|-------------|------|---|---|---------------------------|-------------|------|---|--|
| Reports  | Lineage         | Organism   | Taxonomy       |   |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| 2 sequences selected <a href="#">?</a>   |                 |            |                |   |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| <table border="1"> <thead> <tr> <th>Organism</th><th>Blast Name</th><th>Score</th><th>Number of Hits</th><th>Description</th></tr> </thead> <tbody> <tr><td>Percomorphacea</td><td>bony_fishes</td><td>101</td><td></td><td></td></tr> <tr><td>. Cichlidae</td><td>bony_fishes</td><td>100</td><td></td><td></td></tr> <tr><td>. . Pseudocrenilabrinae</td><td>bony_fishes</td><td>98</td><td></td><td></td></tr> <tr><td>. . . Haplochromini</td><td>bony_fishes</td><td>62</td><td></td><td></td></tr> <tr><td>. . . . Haplochromis</td><td>bony_fishes</td><td>35</td><td></td><td></td></tr> <tr><td>. . . . . Haplochromis burtoni</td><td>bony_fishes</td><td>2782</td><td>2</td><td><a href="#">Haplochromis burtoni hits</a></td></tr> <tr><td>. . . . . Haplochromis pyrrhocephalus</td><td>bony_fishes</td><td>2621</td><td>10</td><td><a href="#">Haplochromis pyrrhocephalus hits</a></td></tr> <tr><td>. . . . . Haplochromis sp. 'macula'</td><td>bony_fishes</td><td>2621</td><td>10</td><td><a href="#">Haplochromis sp. 'macula' hits</a></td></tr> <tr><td>. . . . . Haplochromis fischeri</td><td>bony_fishes</td><td>2615</td><td>13</td><td><a href="#">Haplochromis fischeri hits</a></td></tr> <tr><td>. . . . . Maylandia zebra</td><td>bony_fishes</td><td>2682</td><td>1</td><td><a href="#">Maylandia zebra hits</a></td></tr> <tr><td>. . . . . Astatotilapia calliptera</td><td>bony_fishes</td><td>2676</td><td>1</td><td><a href="#">Astatotilapia calliptera hits</a></td></tr> <tr><td>. . . . . Pundamilia nyererei</td><td>bony_fishes</td><td>2615</td><td>1</td><td><a href="#">Pundamilia nyererei hits</a></td></tr> <tr><td>. . . . . Platyaeniodus degeni</td><td>bony_fishes</td><td>2615</td><td>11</td><td><a href="#">Platyaeniodus degeni hits</a></td></tr> <tr><td>. . . . . Aulonocara baenschi</td><td>bony_fishes</td><td>2045</td><td>1</td><td><a href="#">Aulonocara baenschi hits</a></td></tr> <tr><td>. . . . . Tramitichromis intermedius</td><td>bony_fishes</td><td>2043</td><td>1</td><td><a href="#">Tramitichromis intermedius hits</a></td></tr> <tr><td>. . . . . Melanochromis vermivorus</td><td>bony_fishes</td><td>2041</td><td>1</td><td><a href="#">Melanochromis vermivorus hits</a></td></tr> <tr><td>. . . . . Pseudotropheus sp. 'acei'</td><td>bony_fishes</td><td>2037</td><td>1</td><td><a href="#">Pseudotropheus sp. 'acei' hits</a></td></tr> <tr><td>. . . . . Labidochromis chisumulae</td><td>bony_fishes</td><td>2034</td><td>1</td><td><a href="#">Labidochromis chisumulae hits</a></td></tr> <tr><td>. . . . . 'Haplochromis' cyanus</td><td>bony_fishes</td><td>2021</td><td>1</td><td><a href="#">'Haplochromis' cyanus hits</a></td></tr> <tr><td>. . . . . Lipochromis melanopterus</td><td>bony_fishes</td><td>2015</td><td>1</td><td><a href="#">Lipochromis melanopterus hits</a></td></tr> <tr><td>. . . . . Pundamilia sp. 'red head'</td><td>bony_fishes</td><td>2015</td><td>2</td><td><a href="#">Pundamilia sp. 'red head' hits</a></td></tr> <tr><td>. . . . . Stigmatochromis modestus</td><td>bony_fishes</td><td>2004</td><td>1</td><td><a href="#">Stigmatochromis modestus hits</a></td></tr> <tr><td>. . . . . Dimidiochromis compressiceps</td><td>bony_fishes</td><td>2002</td><td>1</td><td><a href="#">Dimidiochromis compressiceps hits</a></td></tr> <tr><td>. . . . . Pundamilia sp. 'luanso'</td><td>bony_fishes</td><td>1984</td><td>1</td><td><a href="#">Pundamilia sp. 'luanso' hits</a></td></tr> <tr><td>. . . . . Copadichromis borleyi</td><td>bony_fishes</td><td>1982</td><td>1</td><td><a href="#">Copadichromis borleyi hits</a></td></tr> <tr><td>. . . . . Tropheus duboisi</td><td>bony_fishes</td><td>2699</td><td>1</td><td><a href="#">Tropheus duboisi hits</a></td></tr> <tr><td>. . . . . Xenotilapia rotundiventralis</td><td>bony_fishes</td><td>2632</td><td>1</td><td><a href="#">Xenotilapia rotundiventralis hits</a></td></tr> <tr><td>. . . . . Xenotilapia leptura</td><td>bony_fishes</td><td>2627</td><td>1</td><td><a href="#">Xenotilapia leptura hits</a></td></tr> <tr><td>. . . . . Xenotilapia bathyphilus</td><td>bony_fishes</td><td>2627</td><td>1</td><td><a href="#">Xenotilapia bathyphilus hits</a></td></tr> <tr><td>. . . . . Xenotilapia spiloptera</td><td>bony_fishes</td><td>2623</td><td>1</td><td><a href="#">Xenotilapia spiloptera hits</a></td></tr> <tr><td>. . . . . Plecodus paradoxus</td><td>bony_fishes</td><td>2621</td><td>2</td><td><a href="#">Plecodus paradoxus hits</a></td></tr> <tr><td>Alticamperoleucus calurus</td><td>bony_fishes</td><td>2621</td><td>1</td><td><a href="#">Alticamperoleucus calurus hits</a></td></tr> </tbody> </table> |                 |            |                | Organism  | Blast Name | Score | Number of Hits | Description | Percomorphacea | bony_fishes | 101 |  |  | . Cichlidae | bony_fishes | 100 |  |  | . . Pseudocrenilabrinae | bony_fishes | 98 |  |  | . . . Haplochromini | bony_fishes | 62 |  |  | . . . . Haplochromis | bony_fishes | 35 |  |  | . . . . . Haplochromis burtoni | bony_fishes | 2782 | 2 | <a href="#">Haplochromis burtoni hits</a> | . . . . . Haplochromis pyrrhocephalus | bony_fishes | 2621 | 10 | <a href="#">Haplochromis pyrrhocephalus hits</a> | . . . . . Haplochromis sp. 'macula' | bony_fishes | 2621 | 10 | <a href="#">Haplochromis sp. 'macula' hits</a> | . . . . . Haplochromis fischeri | bony_fishes | 2615 | 13 | <a href="#">Haplochromis fischeri hits</a> | . . . . . Maylandia zebra | bony_fishes | 2682 | 1 | <a href="#">Maylandia zebra hits</a> | . . . . . Astatotilapia calliptera | bony_fishes | 2676 | 1 | <a href="#">Astatotilapia calliptera hits</a> | . . . . . Pundamilia nyererei | bony_fishes | 2615 | 1 | <a href="#">Pundamilia nyererei hits</a> | . . . . . Platyaeniodus degeni | bony_fishes | 2615 | 11 | <a href="#">Platyaeniodus degeni hits</a> | . . . . . Aulonocara baenschi | bony_fishes | 2045 | 1 | <a href="#">Aulonocara baenschi hits</a> | . . . . . Tramitichromis intermedius | bony_fishes | 2043 | 1 | <a href="#">Tramitichromis intermedius hits</a> | . . . . . Melanochromis vermivorus | bony_fishes | 2041 | 1 | <a href="#">Melanochromis vermivorus hits</a> | . . . . . Pseudotropheus sp. 'acei' | bony_fishes | 2037 | 1 | <a href="#">Pseudotropheus sp. 'acei' hits</a> | . . . . . Labidochromis chisumulae | bony_fishes | 2034 | 1 | <a href="#">Labidochromis chisumulae hits</a> | . . . . . 'Haplochromis' cyanus | bony_fishes | 2021 | 1 | <a href="#">'Haplochromis' cyanus hits</a> | . . . . . Lipochromis melanopterus | bony_fishes | 2015 | 1 | <a href="#">Lipochromis melanopterus hits</a> | . . . . . Pundamilia sp. 'red head' | bony_fishes | 2015 | 2 | <a href="#">Pundamilia sp. 'red head' hits</a> | . . . . . Stigmatochromis modestus | bony_fishes | 2004 | 1 | <a href="#">Stigmatochromis modestus hits</a> | . . . . . Dimidiochromis compressiceps | bony_fishes | 2002 | 1 | <a href="#">Dimidiochromis compressiceps hits</a> | . . . . . Pundamilia sp. 'luanso' | bony_fishes | 1984 | 1 | <a href="#">Pundamilia sp. 'luanso' hits</a> | . . . . . Copadichromis borleyi | bony_fishes | 1982 | 1 | <a href="#">Copadichromis borleyi hits</a> | . . . . . Tropheus duboisi | bony_fishes | 2699 | 1 | <a href="#">Tropheus duboisi hits</a> | . . . . . Xenotilapia rotundiventralis | bony_fishes | 2632 | 1 | <a href="#">Xenotilapia rotundiventralis hits</a> | . . . . . Xenotilapia leptura | bony_fishes | 2627 | 1 | <a href="#">Xenotilapia leptura hits</a> | . . . . . Xenotilapia bathyphilus | bony_fishes | 2627 | 1 | <a href="#">Xenotilapia bathyphilus hits</a> | . . . . . Xenotilapia spiloptera | bony_fishes | 2623 | 1 | <a href="#">Xenotilapia spiloptera hits</a> | . . . . . Plecodus paradoxus | bony_fishes | 2621 | 2 | <a href="#">Plecodus paradoxus hits</a> | Alticamperoleucus calurus | bony_fishes | 2621 | 1 | <a href="#">Alticamperoleucus calurus hits</a> |
| Organism   | Blast Name      | Score      | Number of Hits | Description                                       |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| Percomorphacea   | bony_fishes     | 101        |                |   |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . Cichlidae  | bony_fishes     | 100        |                |   |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . Pseudocrenilabrinae  | bony_fishes     | 98         |                |   |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . Haplochromini  | bony_fishes     | 62         |                |   |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . Haplochromis   | bony_fishes     | 35         |                |   |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Haplochromis burtoni   | bony_fishes     | 2782       | 2              | <a href="#">Haplochromis burtoni hits</a>         |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Haplochromis pyrrhocephalus  | bony_fishes     | 2621       | 10             | <a href="#">Haplochromis pyrrhocephalus hits</a>  |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Haplochromis sp. 'macula'  | bony_fishes     | 2621       | 10             | <a href="#">Haplochromis sp. 'macula' hits</a>    |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Haplochromis fischeri  | bony_fishes     | 2615       | 13             | <a href="#">Haplochromis fischeri hits</a>        |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Maylandia zebra  | bony_fishes     | 2682       | 1              | <a href="#">Maylandia zebra hits</a>              |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Astatotilapia calliptera   | bony_fishes     | 2676       | 1              | <a href="#">Astatotilapia calliptera hits</a>     |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Pundamilia nyererei  | bony_fishes     | 2615       | 1              | <a href="#">Pundamilia nyererei hits</a>          |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Platyaeniodus degeni   | bony_fishes     | 2615       | 11             | <a href="#">Platyaeniodus degeni hits</a>         |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Aulonocara baenschi  | bony_fishes     | 2045       | 1              | <a href="#">Aulonocara baenschi hits</a>          |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Tramitichromis intermedius   | bony_fishes     | 2043       | 1              | <a href="#">Tramitichromis intermedius hits</a>   |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Melanochromis vermivorus   | bony_fishes     | 2041       | 1              | <a href="#">Melanochromis vermivorus hits</a>     |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Pseudotropheus sp. 'acei'  | bony_fishes     | 2037       | 1              | <a href="#">Pseudotropheus sp. 'acei' hits</a>    |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Labidochromis chisumulae   | bony_fishes     | 2034       | 1              | <a href="#">Labidochromis chisumulae hits</a>     |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . 'Haplochromis' cyanus  | bony_fishes     | 2021       | 1              | <a href="#">'Haplochromis' cyanus hits</a>        |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Lipochromis melanopterus   | bony_fishes     | 2015       | 1              | <a href="#">Lipochromis melanopterus hits</a>     |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Pundamilia sp. 'red head'  | bony_fishes     | 2015       | 2              | <a href="#">Pundamilia sp. 'red head' hits</a>    |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Stigmatochromis modestus   | bony_fishes     | 2004       | 1              | <a href="#">Stigmatochromis modestus hits</a>     |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Dimidiochromis compressiceps   | bony_fishes     | 2002       | 1              | <a href="#">Dimidiochromis compressiceps hits</a> |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Pundamilia sp. 'luanso'  | bony_fishes     | 1984       | 1              | <a href="#">Pundamilia sp. 'luanso' hits</a>      |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Copadichromis borleyi  | bony_fishes     | 1982       | 1              | <a href="#">Copadichromis borleyi hits</a>        |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Tropheus duboisi   | bony_fishes     | 2699       | 1              | <a href="#">Tropheus duboisi hits</a>             |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Xenotilapia rotundiventralis   | bony_fishes     | 2632       | 1              | <a href="#">Xenotilapia rotundiventralis hits</a> |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Xenotilapia leptura  | bony_fishes     | 2627       | 1              | <a href="#">Xenotilapia leptura hits</a>          |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Xenotilapia bathyphilus  | bony_fishes     | 2627       | 1              | <a href="#">Xenotilapia bathyphilus hits</a>      |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Xenotilapia spiloptera   | bony_fishes     | 2623       | 1              | <a href="#">Xenotilapia spiloptera hits</a>       |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| . . . . . Plecodus paradoxus   | bony_fishes     | 2621       | 2              | <a href="#">Plecodus paradoxus hits</a>           |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |
| Alticamperoleucus calurus  | bony_fishes     | 2621       | 1              | <a href="#">Alticamperoleucus calurus hits</a>    |            |       |                |             |                |             |     |  |  |             |             |     |  |  |                         |             |    |  |  |                     |             |    |  |  |                      |             |    |  |  |                                |             |      |   |   |                                       |             |      |    |  |                                     |             |      |    |  |                                 |             |      |    |  |                           |             |      |   |                                      |                                    |             |      |   |   |                               |             |      |   |  |                                |             |      |    |   |                               |             |      |   |  |                                      |             |      |   |   |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |                                 |             |      |   |  |                                    |             |      |   |   |                                     |             |      |   |  |                                    |             |      |   |   |  |             |      |   |   |                                   |             |      |   |  |                                 |             |      |   |  |                            |             |      |   |                                       |  |             |      |   |   |                               |             |      |   |  |                                   |             |      |   |  |                                  |             |      |   |   |                              |             |      |   |   |                           |             |      |   |  |

**Fig9. Taxonomy for query Rhodopsin**

## Results:

Here we have acquired info about the descriptions, Graphical summary, Alignment, and taxonomy related information on our query rhodopsin.

The results can be interpreted as:

Maximum score is the highest alignment score between the query sequence and the database segments.

Total score is the sum of the alignment scores of all sequences from the same db.

Percent Query coverage is the percent of the query length that is included in the aligned segments.

E-value is the measure of likeliness that sequence similarity is not random chance percent identity describes how similar the query is to the aligned sequences.

## Conclusion:

BLASTN is a great tool to get the required information on a particular FASTA sequence in detail.

## References:

1. BLAST: Basic Local Alignment Search Tool. (n.d.). Retrieved from <https://blast.ncbi.nlm.nih.gov/Blast.cgi>
2. BLAST: Basic Local Alignment Search Tool. (n.d.). Retrieved from [https://blast.ncbi.nlm.nih.gov/Blast.cgi#alnHdr\\_2](https://blast.ncbi.nlm.nih.gov/Blast.cgi#alnHdr_2)
3. Nucleotide BLAST: Search nucleotide databases using a nucleotide query. (n.d.). Retrieved from [https://blast.ncbi.nlm.nih.gov/Blast.cgi?PROGRAM=blastn&PAGE\\_TYPE=Blast-Search&LINK\\_LOC=blasthome](https://blast.ncbi.nlm.nih.gov/Blast.cgi?PROGRAM=blastn&PAGE_TYPE=Blast-Search&LINK_LOC=blasthome)
4. Haplochromis burtoni rhodopsin-like (rhodopsin), mRNA - Nucleotide - NCBI. (n.d.). Retrieved from [https://www.ncbi.nlm.nih.gov/nuccore/NM\\_001287832.1?report=fasta](https://www.ncbi.nlm.nih.gov/nuccore/NM_001287832.1?report=fasta)

## WEBLEM 11/b

(URL: <https://blast.ncbi.nlm.nih.gov/Blast.cgi>)

### Aim:

To study the Query 'Rhodopsin' in BLASTp

### Introduction:

A sequences similarity search often provides the first information about a new DNA or protein sequence. A search allows scientists to infer the function of a sequence from similar sequence. There are many ways of performing a sequences similarity search, but probably the most popular method is the "Basic Local Alignment Search Tools" (BLAST). BLAST uses heuristics to produces result quickly. It also calculates an "expect value" that estimates how many matches would have occurred at a given score by chance, which can aid a user in judging how much confidence to have in an alignment.

- BLASTP performs protein-protein sequence comparison, and its algorithm is the basis of many other types of BLAST searches such as BLASTX and TBLASTN.

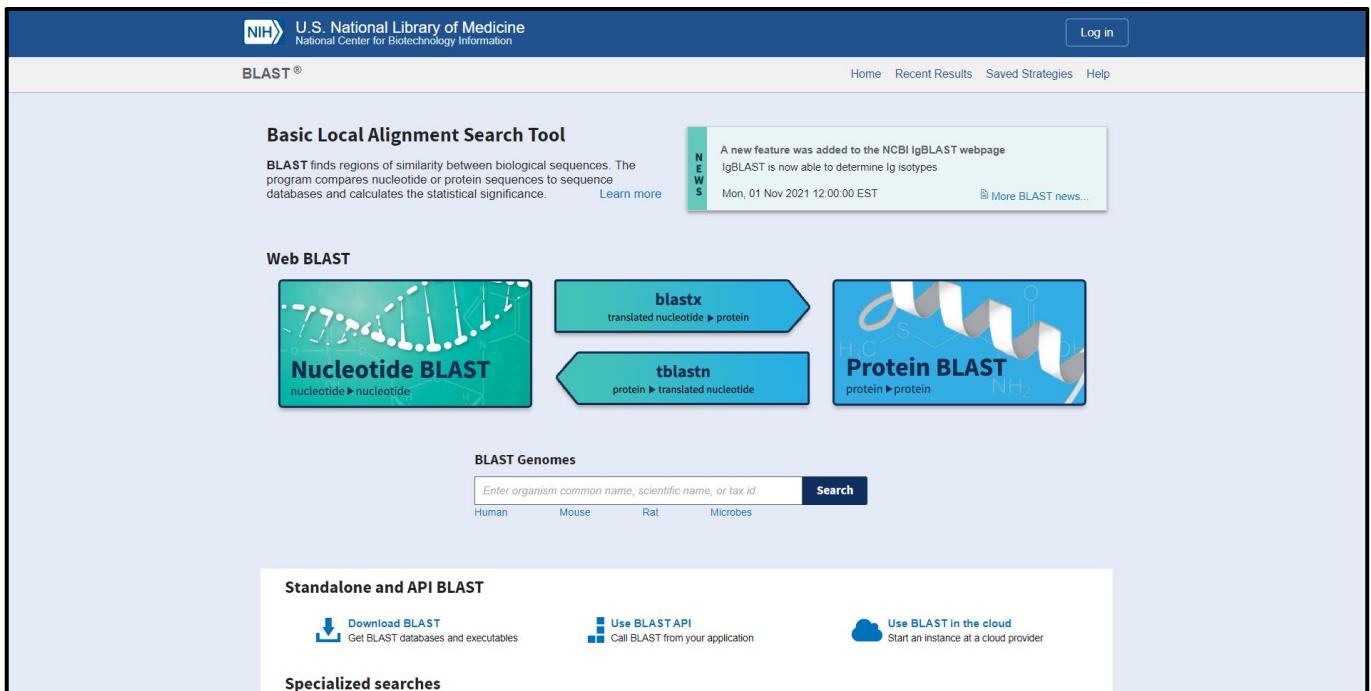
Rhodopsin, also called visual purple, pigment-containing sensory protein that converts light into an electrical signal. Rhodopsin is found in a wide range of organisms, from vertebrates to bacteria. In many seeing animals, including humans, it is required for vision in dim light and is located in the retina of the eye specifically, within the tightly packed disks that make up the outer segment of the retina's photoreceptive rod cells, which are specially adapted for vision under low-light conditions.

Rhodopsin was discovered in 1876 by German physiologist Franz Christian Boll, who observed that the normally reddish purple frog retina turned pale in bright light. The fading of colour was later attributed to the destruction of rhodopsin, via a process known as bleaching. Bleaching and the subsequent regeneration of rhodopsin are major steps in the visual cycle—the series of biochemical reactions that is critical for vision in low light.

### Methodology:

1. Open the homepage of blast.
2. After that click the Blastp.
3. Enter the sequence for rhodopsin taken from uniport
4. Open the result page.
5. Interpret the result.

## Observation:



The screenshot shows the NCBI BLAST homepage. At the top, there is a blue header with the NIH logo, the text "U.S. National Library of Medicine" and "National Center for Biotechnology Information", and a "Log in" button. Below the header, the word "BLAST®" is displayed. To the right, there are links for "Home", "Recent Results", "Saved Strategies", and "Help". A "NEWS" column on the left has a message about IgBLAST. The main content area is titled "Basic Local Alignment Search Tool" and describes BLAST as a tool for finding regions of similarity between biological sequences. It offers three main search types: "Nucleotide BLAST" (nucleotide to nucleotide), "blastx" (translated nucleotide to protein), and "tblastn" (protein to translated nucleotide). There is also a "Protein BLAST" option (protein to protein). Below these, there is a "BLAST Genomes" section with a search bar and links for "Human", "Mouse", "Rat", and "Microbes". At the bottom, there are sections for "Standalone and API BLAST" (with links to "Download BLAST", "Use BLAST API", and "Use BLAST in the cloud") and "Specialized searches".

Fig1. Home page of BLAST

```
>sp|P02699|OPSD_BOVIN Rhodopsin OS=Bos taurus OX=9913 GN=RHO PE=1 SV=1
MNGTEGPNFYVPFSNKTGVVRSPFEAPQYYLAEPWQFSMLAAYMFLLIMLGFPINFLTLY
VTQHKKLRTPLNYILLNLAVADLFMVFGGFTTLYTSLHGYFVFGPTGCNLEGFFATLG
GEIALWSLVVLAIEYYVCKPMNSNFRFGENHAIMGVAFTWVMALACAAPPVLVGWSRYIP
EGMQCSCGIDYYTPHEETNNESFVIYMFVVHFIPLIVIFFCYGQLVFTVKEAAAQQQES
ATTQKAEKEVTRMVIIMVIAFLICWLPYAGVAFYIFTHQGSDFGPIFMTIPAFFAKTSAV
YNPVIYIMMNKQFRNCMVTTLCCGKNPLGDDEASTTVSKTETSQVAPA
```

Fig2. Fasta Sequence for query rhodopsin taken from uniprot

U.S. National Library of Medicine  
National Center for Biotechnology Information

BLAST® » blastp suite

Standard Protein BLAST

blast blastx tblast tblastx

Enter Query Sequence

Enter accession number(s), g(i)s, or FASTA sequence(s)

From  To

Or, upload file

Job Title  Enter a descriptive title for your BLAST search

Align two or more sequences

New columns added to the Description Table  
Click 'Select Columns' or 'Manage Columns'.

Choose Search Set

Database: Non-redundant protein sequences (nr)

Organism: Enter organism name or id—completions will be suggested  exclude

Exclude: Enter organism common name, binomial, or tax id. Only 20 top taxa will be shown

Exclude: Models (XMP)  Non-redundant RefSeq proteins (WP)  Uncultured/environmental sample sequences

Program Selection

Algorithm: Quick BLASTP (Accelerated protein-protein BLAST)   
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 nr using Blastp (protein-protein BLAST)  Show results in a new window

+ Algorithm parameters

Fig3. Search page for blastp with sequence.

BLAST  Search database nr using Blastp (protein-protein BLAST)  Show results in a new window

+ Algorithm parameters  Restore default search parameters

General Parameters

Max target sequences: 100  Select the maximum number of aligned sequences to display

Short queries:  Automatically adjust parameters for short input sequences

Expect threshold: 0.05

Word size: 6

Max matches in a query range: 0

Scoring Parameters

Matrix: BLOSUM62

Gap Costs: Existence: 11 Extension: 1

Compositional adjustments: Conditional compositional score matrix adjustment

Filters and Masking

Filter:  Low complexity regions   
 Mask for lookup table only   
 Mask lower case letters

Mask:  Mask for lookup table only   
 Mask lower case letters

BLAST  Search database nr using Blastp (protein-protein BLAST)  Show results in a new window

[Twitter](#) [Facebook](#) [YouTube](#) [LinkedIn](#) [Blog](#) [Support Center](#)

National Center for Biotechnology Information  
8600 Rockville Pike  
Bethesda MD, 20894 USA

Popular: PubMed, PubMed Central, Bookshelf

Resources: Literature, Health, Genomes

Actions: Submit, Download, Learn

Fig4. Algorithm parameters in BLASTP

NIH U.S. National Library of Medicine  
National Center for Biotechnology Information

Log in

BLAST® » blastp suite » results for RID-RZXWTHA3013

Home Recent Results Saved Strategies Help

Edit Search Save Search Search Summary

Job Title sp|P02699|OPSD\_BOVIN Rhodopsin OS=Bos taurus...

RID RZXWTHA3013 Search expires on 11-02 22:00 pm Download All

Program BLASTP Citation

Database nr See details

Query ID Icl|Query\_91982

Description sp|P02699|OPSD\_BOVIN Rhodopsin OS=Bos taurus OX...

Molecule type amino acid

Query Length 348

Other reports Distance tree of results Multiple alignment MSA viewer

Filter Results

Organism only top 20 will appear  exclude

Type common name, binomial, taxid or group name

+ Add organism

Percent Identity E value Query Coverage

Filter Reset

Descriptions Graphic Summary Alignments Taxonomy

Sequences producing significant alignments Download New Select columns Show 100

select all 100 sequences selected

|                                     | Description   | GenPept           | Graphics  | Distance tree of results | Multiple alignment | MSA Viewer |            |          |                |
|-------------------------------------|---|-------------------|-----------|--------------------------|--------------------|------------|------------|----------|----------------|
|                                     | Description   | Scientific Name   | Max Score | Total Score              | Query Cover        | E value    | Per. Ident | Acc. Len | Accession      |
| <input checked="" type="checkbox"/> | Structure of Bovine Rhodopsin in a Trigonal Crystal Form [Bos taurus]                                     | Bos taurus        | 718       | 718                      | 100%               | 0.0        | 100.0%     | 349      | 1GZM_A         |
| <input checked="" type="checkbox"/> | rhodopsin [Bos taurus]  | Bos taurus        | 718       | 718                      | 100%               | 0.0        | 100.0%     | 348      | NP_001014890.1 |
| <input checked="" type="checkbox"/> | PREDICTED: rhodopsin [Bison bison bison]  | Bison bison bison | 716       | 716                      | 100%               | 0.0        | 99.43%     | 348      | XP_010880750.1 |
| <input checked="" type="checkbox"/> | Rhodopsin [Bos mutus]   | Bos mutus         | 716       | 716                      | 100%               | 0.0        | 99.43%     | 351      | ELR51227.1     |
| <input checked="" type="checkbox"/> | PREDICTED: rhodopsin [Bos mutus]  | Bos mutus         | 715       | 715                      | 100%               | 0.0        | 99.43%     | 348      | XP_005902896.1 |
| <input checked="" type="checkbox"/> | rhodopsin [Bos taurus]  | Bos taurus        | 712       | 712                      | 100%               | 0.0        | 99.71%     | 347      | 0811197A       |
| <input checked="" type="checkbox"/> | Crystal structure of a rhodopsin stabilizing mutant expressed in mammalian cells [Bos taurus]             | Bos taurus        | 711       | 711                      | 100%               | 0.0        | 99.43%     | 349      | 2J4Y_A         |
| <input checked="" type="checkbox"/> | Chain A: Rhodopsin [unidentified]   | unidentified      | 711       | 711                      | 100%               | 0.0        | 99.43%     | 348      | 3C9M_A         |
| <input checked="" type="checkbox"/> | Crystal Structure Of The Constitutively Active E113q N2c_D282c Rhodopsin Mutant With Bound Galectin Pe... | Bos taurus        | 709       | 709                      | 100%               | 0.0        | 99.14%     | 349      | 2X72_A         |
| <input checked="" type="checkbox"/> | rhodopsin [Bubalus bubalis]   | Bubalus bubalis   | 709       | 709                      | 100%               | 0.0        | 98.85%     | 348      | XP_006078962.1 |

Feedback

Fig5. Result page for rhodopsin

Descriptions Graphic Summary Alignments Taxonomy

Sequences producing significant alignments Download New Select columns Show 100

select all 100 sequences selected

|                                     | Description   | GenPept                        | Graphics  | Distance tree of results | Multiple alignment | MSA Viewer |            |          |                |
|-------------------------------------|---|--------------------------------|-----------|--------------------------|--------------------|------------|------------|----------|----------------|
|                                     | Description   | Scientific Name                | Max Score | Total Score              | Query Cover        | E value    | Per. Ident | Acc. Len | Accession      |
| <input checked="" type="checkbox"/> | Structure of Bovine Rhodopsin in a Trigonal Crystal Form [Bos taurus]   | Bos taurus                     | 718       | 718                      | 100%               | 0.0        | 100.0%     | 349      | 1GZM_A         |
| <input checked="" type="checkbox"/> | rhodopsin [Bos taurus]  | Bos taurus                     | 718       | 718                      | 100%               | 0.0        | 100.0%     | 348      | NP_001014890.1 |
| <input checked="" type="checkbox"/> | PREDICTED: rhodopsin [Bison bison bison]  | Bison bison bison              | 716       | 716                      | 100%               | 0.0        | 99.43%     | 348      | XP_010880750.1 |
| <input checked="" type="checkbox"/> | Rhodopsin [Bos mutus]   | Bos mutus                      | 716       | 716                      | 100%               | 0.0        | 99.43%     | 351      | ELR51227.1     |
| <input checked="" type="checkbox"/> | PREDICTED: rhodopsin [Bos mutus]  | Bos mutus                      | 715       | 715                      | 100%               | 0.0        | 99.43%     | 348      | XP_005902896.1 |
| <input checked="" type="checkbox"/> | rhodopsin [Bos taurus]  | Bos taurus                     | 712       | 712                      | 100%               | 0.0        | 99.71%     | 347      | 0811197A       |
| <input checked="" type="checkbox"/> | Crystal structure of a rhodopsin stabilizing mutant expressed in mammalian cells [Bos taurus]                 | Bos taurus                     | 711       | 711                      | 100%               | 0.0        | 99.43%     | 349      | 2J4Y_A         |
| <input checked="" type="checkbox"/> | Chain A: Rhodopsin [unidentified]   | unidentified                   | 711       | 711                      | 100%               | 0.0        | 99.43%     | 348      | 3C9M_A         |
| <input checked="" type="checkbox"/> | Crystal Structure Of The Constitutively Active E113q N2c_D282c Rhodopsin Mutant With Bound Galectin Pe...     | Bos taurus                     | 709       | 709                      | 100%               | 0.0        | 99.14%     | 349      | 2X72_A         |
| <input checked="" type="checkbox"/> | rhodopsin [Bubalus bubalis]   | Bubalus bubalis                | 709       | 709                      | 100%               | 0.0        | 98.85%     | 348      | XP_006078962.1 |
| <input checked="" type="checkbox"/> | Night blindness causing G90D rhodopsin in complex with GaCT2 peptide [Bos taurus]                             | Bos taurus                     | 708       | 708                      | 100%               | 0.0        | 99.14%     | 349      | 4BEY_A         |
| <input checked="" type="checkbox"/> | Crystal Structure of T94I rhodopsin mutant [Bos taurus]   | Bos taurus                     | 708       | 708                      | 100%               | 0.0        | 99.14%     | 349      | 5DYS_A         |
| <input checked="" type="checkbox"/> | Rhodopsin-GI protein complex [Bos taurus]   | Bos taurus                     | 708       | 708                      | 100%               | 0.0        | 99.14%     | 348      | 6QNO_R         |
| <input checked="" type="checkbox"/> | Crystal structure of the light-activated constitutively active N2C_M257Y D282C rhodopsin mutant in complex... | Bos taurus                     | 708       | 708                      | 100%               | 0.0        | 99.14%     | 349      | 44AM_A         |
| <input checked="" type="checkbox"/> | rhodopsin [Bos taurus]  | Bos taurus                     | 705       | 705                      | 98%                | 0.0        | 99.71%     | 343      | AAA30675.1     |
| <input checked="" type="checkbox"/> | rhodopsin [Ovis aries]  | Ovis aries                     | 700       | 700                      | 100%               | 0.0        | 97.41%     | 348      | XP_004016583.1 |
| <input checked="" type="checkbox"/> | rhodopsin [Oryx dammah]   | Oryx dammah                    | 697       | 697                      | 100%               | 0.0        | 96.55%     | 348      | XP_040102676.1 |
| <input checked="" type="checkbox"/> | hypothetical protein FD754_009314 [Muntiacus muntjak]   | Muntiacus muntjak              | 696       | 696                      | 100%               | 0.0        | 96.55%     | 348      | KAB0365158.1   |
| <input checked="" type="checkbox"/> | rhodopsin [Cervus canadensis]   | Cervus canadensis              | 696       | 696                      | 100%               | 0.0        | 96.26%     | 348      | XP_043296844.1 |
| <input checked="" type="checkbox"/> | rhodopsin [Odocoileus virginianus texanus]  | Odocoileus virginianus texanus | 696       | 696                      | 100%               | 0.0        | 95.98%     | 348      | XP_020728233.1 |
| <input checked="" type="checkbox"/> | PREDICTED: rhodopsin [Ceratotherium simum simum]  | Ceratotherium simum simum      | 694       | 694                      | 100%               | 0.0        | 95.69%     | 348      | XP_004442481.1 |
| <input checked="" type="checkbox"/> | rhodopsin [Ursus maritimus]   | Ursus maritimus                | 691       | 691                      | 100%               | 0.0        | 95.11%     | 348      | XP_008696069.2 |
| <input checked="" type="checkbox"/> | RechName: Full-Rhodopsin [Ovis aries]   | Ovis aries                     | 691       | 691                      | 100%               | 0.0        | 96.26%     | 348      | P02700.2       |
| <input checked="" type="checkbox"/> | rhodopsin [Acromyrmex jubatus]  | Acromyrmex jubatus             | 689       | 689                      | 100%               | 0.0        | 95.11%     | 348      | XP_014930115.1 |
| <input checked="" type="checkbox"/> | rhodopsin [Rousettus aegyptiacus]   | Rousettus aegyptiacus          | 688       | 688                      | 100%               | 0.0        | 94.83%     | 348      | XP_015977509.1 |
| <input checked="" type="checkbox"/> | hypothetical protein JFQ12_008572 [Ovis aries]  | Ovis aries                     | 688       | 688                      | 100%               | 0.0        | 92.88%     | 365      | KAG5197843.1   |
| <input checked="" type="checkbox"/> | rhodopsin [Alliropoda melanoleuca]  | Alliropoda melanoleuca         | 688       | 688                      | 100%               | 0.0        | 94.54%     | 348      | XP_002921295.1 |

Feedback

Fig6. Description for query Rhodopsin

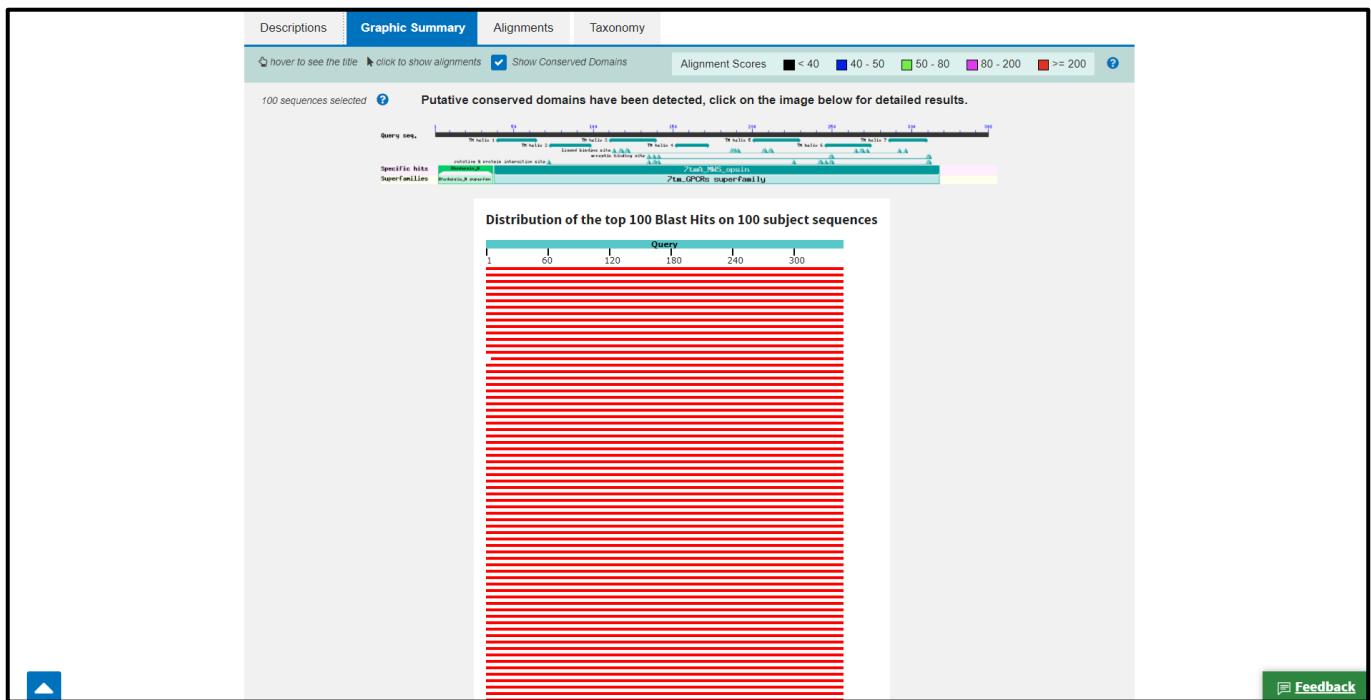


Fig7. Graphic Summary for query rhodopsin

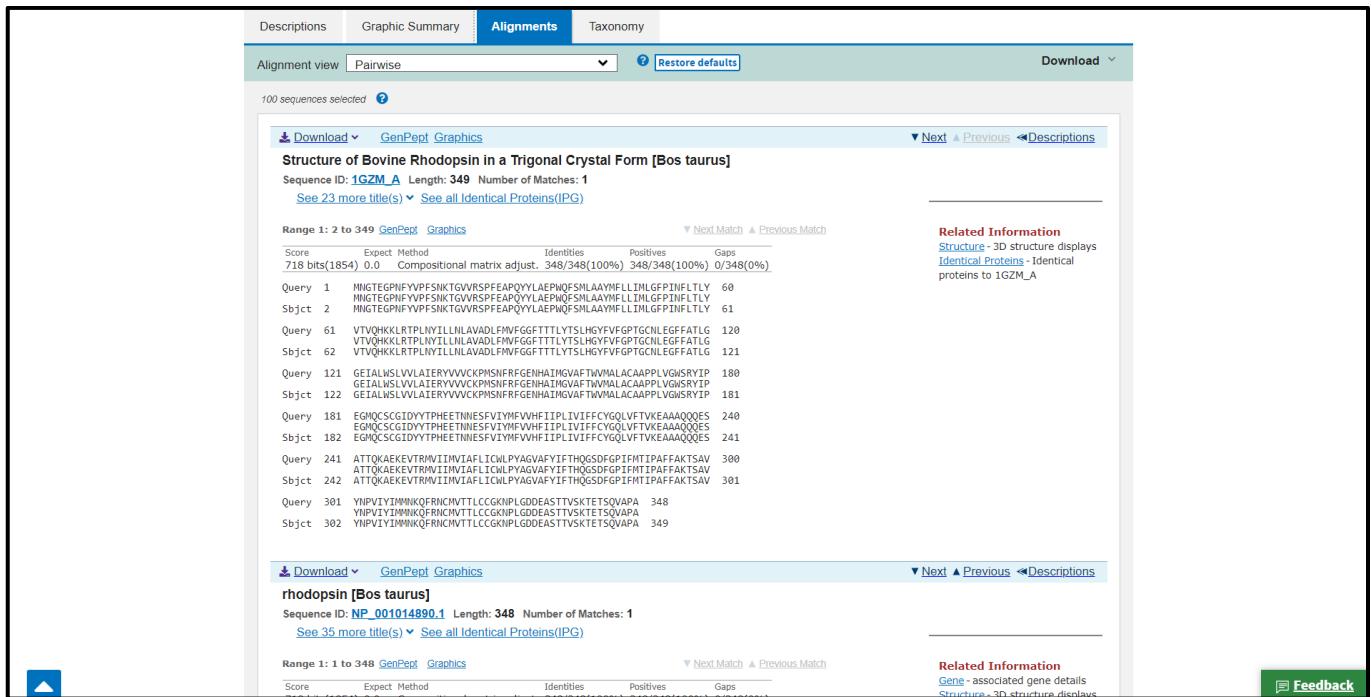


Fig8. Alignment for query rhodopsin

| Taxonomy   |                     |          |                |                                     |  |
|--|---------------------|----------|----------------|-------------------------------------|--|
| Reports  | Lineage             | Organism | Taxonomy       |                                     |  |
| 100 sequences selected  |                     |          |                |                                     |  |
| Organism   | Blast Name          | Score    | Number of Hits | Description                         |  |
| root   |                     | 200      |                |                                     |  |
| . Theria   | mammals             | 198      |                |                                     |  |
| . . Eutheria   | placental           | 190      |                |                                     |  |
| . . . Mammalia   | placental           | 188      |                |                                     |  |
| . . . . Laurasiatheria   | placental           | 126      |                |                                     |  |
| . . . . . Artiodactyla   | even-toed ungulates | 80       |                |                                     |  |
| . . . . . . Pecora   | even-toed ungulates | 64       |                |                                     |  |
| . . . . . . Bovidae  | even-toed ungulates | 58       |                |                                     |  |
| . . . . . . Bovinae  | even-toed ungulates | 53       |                |                                     |  |
| . . . . . . . Bos  | even-toed ungulates | 51       |                |                                     |  |
| . . . . . . . . Bos taurus   | even-toed ungulates | 718      | 46             | Bos taurus hits                     |  |
| . . . . . . . . Bos indicus  | even-toed ungulates | 718      | 1              | Bos indicus hits                    |  |
| . . . . . . . . Bos indicus x Bos taurus   | even-toed ungulates | 718      | 1              | Bos indicus x Bos taurus hits       |  |
| . . . . . . . . Bos mutus  | even-toed ungulates | 716      | 3              | Bos mutus hits                      |  |
| . . . . . . . . Bison bison bison  | even-toed ungulates | 716      | 1              | Bison bison bison hits              |  |
| . . . . . . . . Bubalus bubalis  | even-toed ungulates | 709      | 1              | Bubalus bubalis hits                |  |
| . . . . . . . . Ovis aries   | even-toed ungulates | 700      | 3              | Ovis aries hits                     |  |
| . . . . . . . . Capra hircus   | even-toed ungulates | 700      | 1              | Capra hircus hits                   |  |
| . . . . . . . . Oryx dammah  | even-toed ungulates | 697      | 1              | Oryx dammah hits                    |  |
| . . . . . . . . Muntiacus muntjak  | even-toed ungulates | 696      | 1              | Muntiacus muntjak hits              |  |
| . . . . . . . . Muntiacus reevesi  | even-toed ungulates | 696      | 1              | Muntiacus reevesi hits              |  |
| . . . . . . . . Cervus canadensis  | even-toed ungulates | 696      | 1              | Cervus canadensis hits              |  |
| . . . . . . . . Cervus elaphus   | even-toed ungulates | 696      | 1              | Cervus elaphus hits                 |  |
| . . . . . . . . Cervus canadensis  | even-toed ungulates | 696      | 1              | Cervus canadensis yarkandensis hits |  |
| . . . . . . . . Odocoileus virginianus texanus   | even-toed ungulates | 696      | 1              | Odocoileus virginianus texanus hits |  |
| . . . . . . . . Monodon monoceros  | whales & dolphins   | 679      | 1              | Monodon monoceros hits              |  |
| . . . . . . . . Delphinapterus leucas  | whales & dolphins   | 677      | 1              | Delphinapterus leucas hits          |  |
| . . . . . . . . Phocoena sinus   | whales & dolphins   | 677      | 1              | Phocoena sinus hits                 |  |
| . . . . . . . . Tursiops truncatus   | whales & dolphins   | 676      | 3              | Tursiops truncatus hits             |  |
| . . . . . . . . Lagenorhynchus obliquidens   | whales & dolphins   | 676      | 1              | Lagenorhynchus obliquidens hits     |  |
| . . . . . . . . Globicephala melas   | whales & dolphins   | 676      | 3              | Globicephala melas hits             |  |
| . . . . . . . . Delphinus delphis  | whales & dolphins   | 676      | 2              | Delphinus delphis hits              |  |

**Fig9. Taxonomy for query rhodopsin**

## Results:

Here we have acquired info about the descriptions, Graphical summary, Alignment, and taxonomy related information on our query rhodopsin.

The results can be interpreted as:

Maximum score is the highest alignment score between the query sequence and the database segments.

Total score is the sum of the alignment scores of all sequences from the same db.

Percent Query coverage is the percent of the query length that is included in the aligned segments.

E-value is the measure of likeliness that sequence similarity is not random chance percent identity describes how similar the query is to the aligned sequences.

## Conclusion:

BLASTN is a great tool to get the required information on a particular FASTA sequence in detail.

## References:

1. (n.d.). Retrieved from <https://www.uniprot.org/uniprot/P02699.fasta>
2. BLAST: Basic Local Alignment Search Tool. (n.d.). Retrieved from <https://blast.ncbi.nlm.nih.gov/Blast.cgi>
3. Protein BLAST: Search protein databases using a protein query. (n.d.). Retrieved from [https://blast.ncbi.nlm.nih.gov/Blast.cgi?PROGRAM=blastp&PAGE\\_TYPE=Blast-Search&LINK\\_LOC=blasthome](https://blast.ncbi.nlm.nih.gov/Blast.cgi?PROGRAM=blastp&PAGE_TYPE=Blast-Search&LINK_LOC=blasthome)
4. Rhodopsin. (n.d.). Retrieved from <https://www.britannica.com/science/rhodopsin>

## WEBLEM 11/c

(URL: <https://www.ebi.ac.uk/Tools/ssss/fasta/>)

### Aim:

To study the Query 'Rhodopsin' in FASTAn

### Introduction:

FASTA (pronounced FAST-AYE) is a suite of programs for searching nucleotide or protein databases with a query sequence. FASTA itself performs a local heuristic search of a protein or nucleotide database for a query of the same type. FASTX and FASTY translate a nucleotide query for searching a protein database. TFASTX and TFASTY translate a nucleotide database to be searched with a protein query. Optimal searches are available with the programs SSEARCH (local), GGSEARCH (global) and GLSEARCH (global query against local database).

### FASTAn:

This tool provides sequence similarity searching against nucleotide databases using the FASTA suite of programs. FASTA provides a heuristic search with a nucleotide query. TFASTX and TFASTY translate the DNA database for searching with a protein query. Optimal searches are available with SSEARCH (local), GGSEARCH (global) and GLSEARCH (global query, local database).

Rhodopsin, also called visual purple, pigment-containing sensory protein that converts light into an electrical signal. Rhodopsin is found in a wide range of organisms, from vertebrates to bacteria. In many seeing animals, including humans, it is required for vision in dim light and is located in the retina of the eye specifically, within the tightly packed disks that make up the outer segment of the retina's photoreceptive rod cells, which are specially adapted for vision under low-light conditions.

Rhodopsin was discovered in 1876 by German physiologist Franz Christian Boll, who observed that the normally reddish purple frog retina turned pale in bright light. The fading of colour was later attributed to the destruction of rhodopsin, via a process known as bleaching. Bleaching and the subsequent regeneration of rhodopsin are major steps in the visual cycle—the series of biochemical reactions that is critical for vision in low light.

### Methodology:

1. Open the homepage of FASTA.
2. After that click the FASTAn hyperlink
3. Enter the sequence for keratin taken by Genebank.
4. Open the result page.
5. Interpret the results.

## Observation:

The screenshot shows the FASTAn homepage with a teal header. The header includes the EMBL-EBI logo, a navigation bar with links for Services, Research, Training, Industry, About us, and a search bar. The main title 'FASTAn' is in the center of the header. Below the header is a sub-navigation bar with links for Protein, Nucleotide, Genomes, Proteomes, Whole Genome Shotgun, Web services, Help & Documentation, Also in this section, and Feedback. The main content area is titled 'Protein Similarity Search' and contains a brief description of the tool's purpose. Below this is a 'STEP 1 - Select your databases' section with a list of databases, including UniProt Knowledgebase, UniProtKB/Swiss-Prot, UniProtKB/Protein Isoforms, UniProtKB/UniProt, UniProtKB Reference Proteomes plus Swiss-Prot, UniProtKB COVID-19, UniProtKB Taxonomic Subsets, UniProt Clusters, Patents, Structures, and Other Protein Databases. A 'STEP 2 - Enter your input sequence' section follows, with a text input field for pasting a sequence.

Fig1. Homepage of FASTAn.

The screenshot shows a NCBI GenBank page for the Haplochromis burtoni rhodopsin-like (rhodopsin), mRNA sequence. The page has a blue header with the NCBI logo, a search bar, and a 'Sign in to NCBI' link. Below the header is a red banner with 'COVID-19 Information' and links to 'Public health information (CDC)', 'Research information (NIH)', 'SARS-CoV-2 data (NCBI)', 'Prevention and treatment information (HHS)', and 'Español'. The main content area is titled 'FASTAn' and shows the sequence details for the mRNA. The sequence is presented in a large text block, starting with the identifier 'NCBI Reference Sequence: NM\_001287832.1'. The sequence itself is a long string of nucleotide bases. To the right of the sequence are various analysis tools and links, including 'Change region shown', 'Customize view', 'Analyze this sequence' (with options for 'Run BLAST', 'Pick Primers', 'Highlight Sequence Features', 'Find in this Sequence', and 'Show in Genome Data Viewer'), 'Articles about the rhodopsin gene' (with a link to 'Timing and location of rhodopsin expression in newly born rod'), 'Reference sequence information' (with a link to 'RefSeq protein product' and 'See the reference protein sequence for Rhodopsin (NP\_001274761.1)'), 'More about the gene rhodopsin' (with a link to 'rhodopsin gene' and 'Also Known As: RH1'), and 'Related information' (with links to 'PubMed' and 'Taxonomy').

Fig2. Fasta sequence for my query rhodopsin on genbank

Protein Nucleotide Genomes Proteomes Whole Genome Shotgun Web services Help & Documentation Also in this section ▾ Feedback

▶ IMGT  
▶ Patents  
▶ Structure

STEP 2 - Enter your input sequence

Enter or paste a **DNA** sequence in any supported format:

```
[GAGGGAGCATCTTCTACTCGCCTCAAAGACCGAGGCTTCCCTGTCCTCCAGCTCTGTGTCCTGCAT
AAAAACGGCCCTCAAGCAACGGCTCCGTGATCCCCATCCAACGAAAGACTTCCTCTCCCCAGCGAAC
TACTGAAGGCTAATGTCACAGAAATAATTCCCTTTGTAATTTCACAAACGAAATTGATTCAACCTAA
GAGAGTTCAGTAAAGGTCAAGGTCAGGCCATTACAGAGTTGTTCTGTATGTCAGAAATTCACACTTAACATC
GGTGAGATTTTTTCTGAGGAGAAAAGGAAAATGCTATCTTTCACAGTTGGATCTATGATAC
TGCCCTTATTGTAATGTCAGGCTATTCAGGGCAACGTAACAAACGCACTTGCACATGAA
```

or upload a file:  No file chosen

Use a example sequence | Clear sequence | See more example inputs

STEP 3 - Set your parameters

PROGRAM

**FASTA**

*The default settings will fulfill the needs of most users.*

[More options...](#) (Click here, if you want to view or change the default settings.)

STEP 4 - Submit your job

Be notified by email (Tick this box if you want to be notified by email when the results are available)

**Submit**

If you use this service, please consider citing the following publication: [The EMBL-EBI search and sequence analysis tools APIs in 2019](#)

Please read the provided Help & Documentation and FAQs before seeking help from our support staff. If you have any feedback or encountered any issues please let us know via EMBL-EBI Support. If you plan to use these services during a course please contact us. Read our [Privacy Notice](#) if you are concerned with your privacy and how we handle personal information

**Fig3. Search bar of FASTAn with sequence.**

EMBL-EBI Services Research Training Industry About us  Help & Documentation Also in this section ▾ Feedback

Tools > Sequence Similarity Searching > FASTA

**FASTA**

Results for job **fasta-l20211101-150133-0592-55675762-p1m**

Summary Table Tool Output Visual Output Submission Details

Selection:  Select All  Invert  Clear

Apply to selection:

Annotations:  Show  Hide

Alignments:  Show  Hide

Entries:  Download in   
 fasta  format

Tools:  Launch  Clustal Omega

| Align.                              | DB-ID           | Source  | Length | Score (Bits) | Identities % | Positives % | E0       |
|-------------------------------------|-----------------|---|--------|--------------|--------------|-------------|----------|
| <input checked="" type="checkbox"/> | EM_VRT_AF315354 | Astatotilapia burtoni rhodopsin mRNA, complete cds. Cross-references and related information in: ▶ Nucleotide sequences ▶ Genomes & metagenomes ▶ Literature ▶ Protein families ▶ Samples & ontologies ▶ Protein sequences  | 1506   | 726.5        | 100.0        | 100.0       | 2.5E-204 |
| <input checked="" type="checkbox"/> | EM_VRT_AB674457 | Trophus duboisi RH1 gene for rod opsin, complete cds. Cross-references and related information in: ▶ Nucleotide sequences ▶ Literature ▶ Protein families ▶ Samples & ontologies ▶ Protein sequences  | 7365   | 706.1        | 99.9         | 99.9        | 3.4E-198 |
| <input checked="" type="checkbox"/> | EM_TSA_JL485975 | Haplochromis burtoni contig08147.Habipool mRNA sequence. Cross-references and related information in: ▶ Literature ▶ Nucleotide sequences ▶ Samples & ontologies ▶ Protein sequences  | 1479   | 700.3        | 99.9         | 99.9        | 1.9E-196 |
| <input checked="" type="checkbox"/> | EM_VRT_AB458123 | Xenotilapia rotundiventris RH1 gene for rod opsin, complete cds. specimen_voucher: personal collection Michio Horii.2m02838-1. Cross-references and related information in: ▶ Nucleotide sequences ▶ Literature ▶ Protein families ▶ Samples & ontologies ▶ Protein sequences | 4718   | 695.9        | 99.0         | 99.0        | 3.9E-195 |
| <input checked="" type="checkbox"/> | EM_VRT_AB458124 | Xenotilapia bathynphilus RH1 gene for rod opsin, complete cds. specimen_voucher: personal collection Michio Horii.2m02374. Cross-references and related information in: ▶ Nucleotide sequences ▶ Literature ▶ Protein families ▶ Samples & ontologies ▶ Protein sequences     | 4665   | 695.1        | 99.0         | 99.0        | 7.0E-195 |
|                                     | EM_VRT_AB458125 | Xenotilapia jerdoni RH1 gene for rod opsin, complete  | 4787   | 695.1        | 99.0         | 99.0        | 7.0E-195 |

**Fig4. Summary table for FASTAn with sequence**

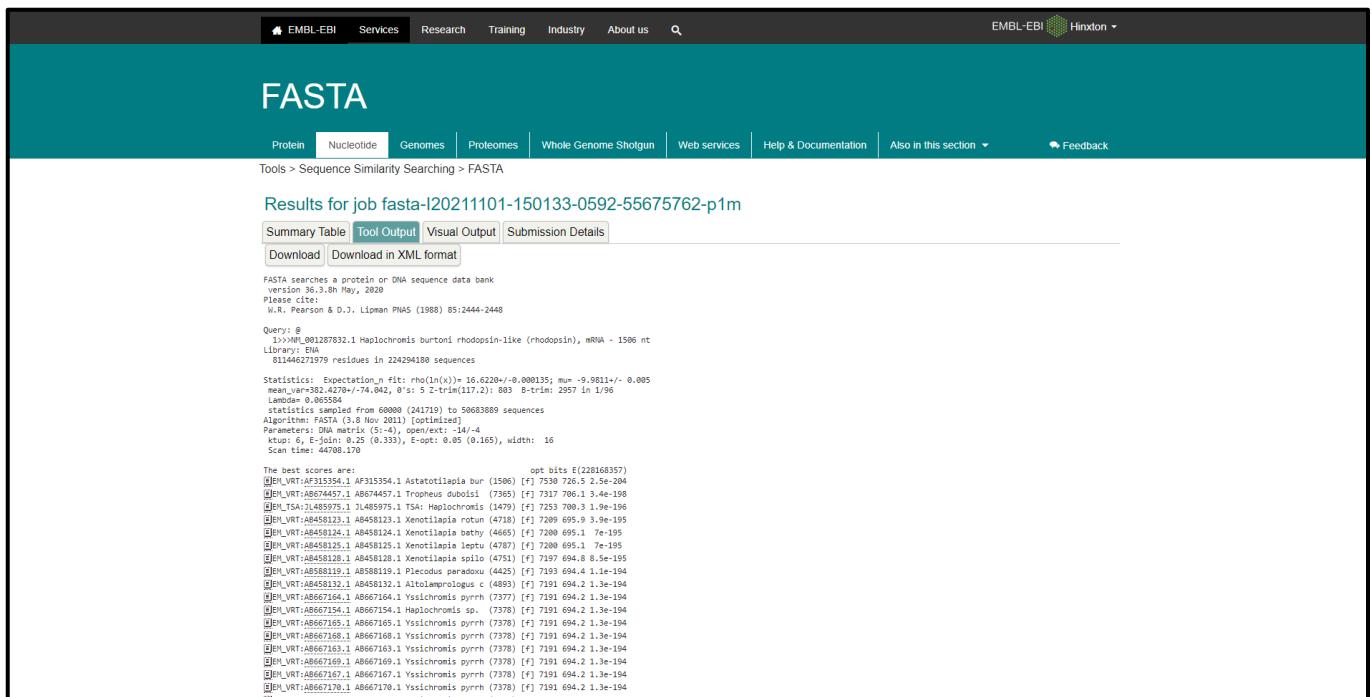


Fig5. Tool output for Rhodopsin in FASTAn

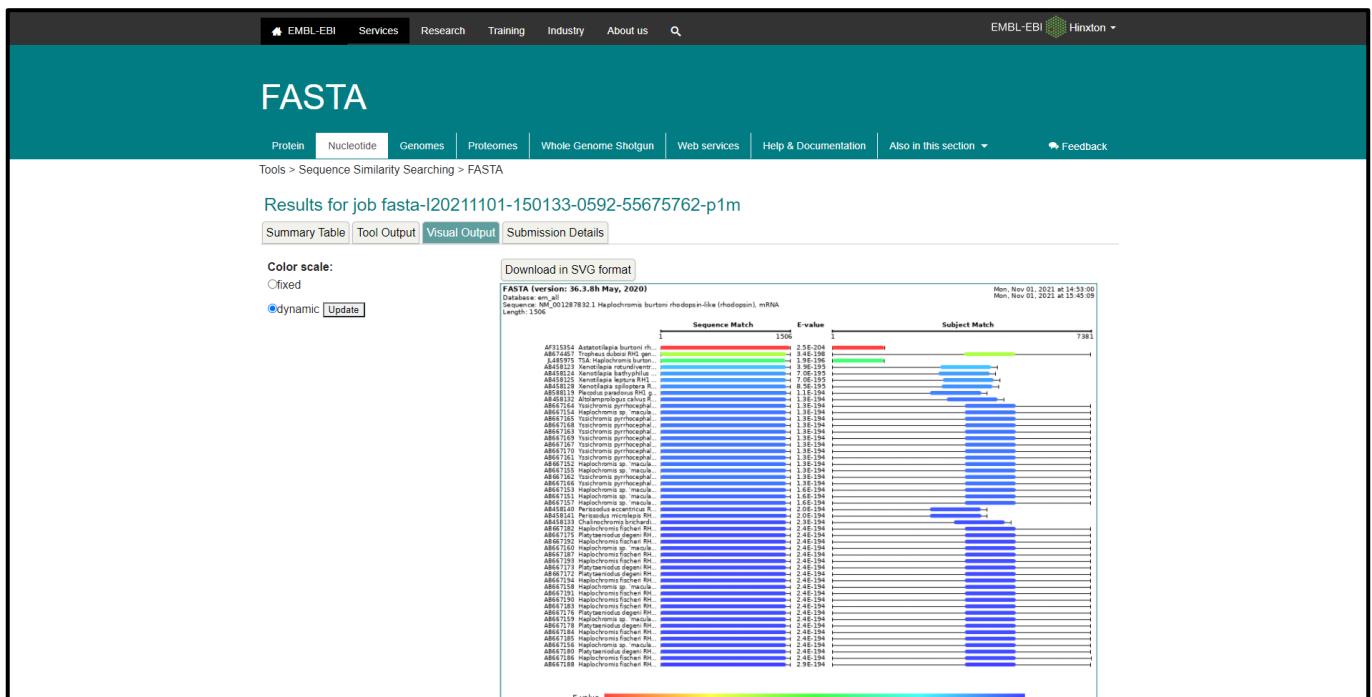


Fig6. Visual output for Rhodopsin in FASTAn

The screenshot shows the FASTA search results page. At the top, there are navigation links for Protein, Nucleotide, Genomes, Proteomes, Whole Genome Shotgun, Web services, Help & Documentation, and a dropdown for 'Also in this section'. The main content area shows the results for a job submission. The 'Submission Details' tab is selected, displaying the following information:

|                   |          |                               |   |
|-------------------|----------|-------------------------------|---|
| Program           | Database | Launched Date                 | Input Sequence  |
| FASTA             | em_all   | Mon, Nov 01, 2021 at 14:53:00 | <a href="#">fasta-I20211101-150133-0592-55675762-p1m.input</a>  |
| Version           |          | End Date                      | <a href="#">Output Result</a>                                   |
| 36.3.8h May, 2020 |          | Mon, Nov 01, 2021 at 15:45:09 | <a href="#">fasta-I20211101-150133-0592-55675762-p1m.output</a> |

Below this, the 'Command' section shows the command line used for the search:

```
cat fasta-I20211101-150133-0592-55675762-p1m.sequence | SAPPBIN/fastab36 -1 $DATA_CURRENT/fastacfg/fastab3db -L -T 32 -n -r +5/-4 -f -14 -g -4 -E "10.0 -1.0" -F 0.0 -B 50 -d 50 -m "F9B fasta-I20211101-150133-0592-55675762-p1m.m9" -m "F10 fasta-I20211101-150133-0592-55675762-p1m.m10" -z 1 \@.1- +em_all+ 6
```

The 'Input Parameters' section lists the following settings:

- Sequence type: dna
- Matrix: none
- Match/mismatch scores: +5/-4
- Gap open: 6

**Fig7. Submission details for Rhodopsin in FASTAn**

## Results:

FASTAp Result divided into 5 sections summary tables, Tool output, visual output, functional predictions, Submission details.

In summary tables it shows alignment of sequence that is length, score bits, identity percentage and positive percentage.

Tools output for keratin in FASTAp shows multiple outputs for results

In visual output the color scale can be changed between fixed and dynamic, showing E-Values

Functional Prediction's color scale can also be switched between dynamic and fixed, showing E-Values

The submission details shows use the commands and input parameters that were used before we submitted the query for running.

## Conclusion:

FASTA is another sequence alignment tool which is used to search similarities between sequences of DNA and proteins. The query sequence is broken down into sequence patterns or words known as k-tuples and the target sequences are searched for these k-tuples in order to find the similarities between the two.

**References:**

1. Rhodopsin. (n.d.). Retrieved from <https://www.britannica.com/science/rhodopsin>
2. (n.d.). Retrieved from <https://www.uniprot.org/uniprot/P02699.fasta>
3. Embl-Ebi. (n.d.). FASTA. Retrieved from <https://www.ebi.ac.uk/Tools/sss/fasta/>
4. Embl-Ebi. (n.d.). FASTA. Retrieved from <https://www.ebi.ac.uk/Tools/services/web/toolresult.ebi?jobId=fasta-I20211101-150915-0959-51807210-p2m>

DATE: 1-11-21

## WEBLEM 11/d

(URL: <https://www.ebi.ac.uk/Tools/sss/fasta/>)

### Aim:

To study the Query 'Rhodopsin' in FASTAp.

### Introduction:

FASTA (pronounced FAST-AYE) is a suite of programs for searching nucleotide or protein databases with a query sequence. FASTA itself performs a local heuristic search of a protein or nucleotide database for a query of the same type. FASTX and FASTY translate a nucleotide query for searching a protein database. TFASTX and TFASTY translate a nucleotide database to be searched with a protein query. Optimal searches are available with the programs SSEARCH (local), GGSEARCH (global) and GLSEARCH (global query against local database).

### FASTAp:

This tool provides sequence similarity searching against protein databases using the FASTA suite of programs. FASTA provides a heuristic search with a protein query. FASTX and FASTY translate a DNA query. Optimal searches are available with SSEARCH (local), GGSEARCH (global) and GLSEARCH (global query, local database).

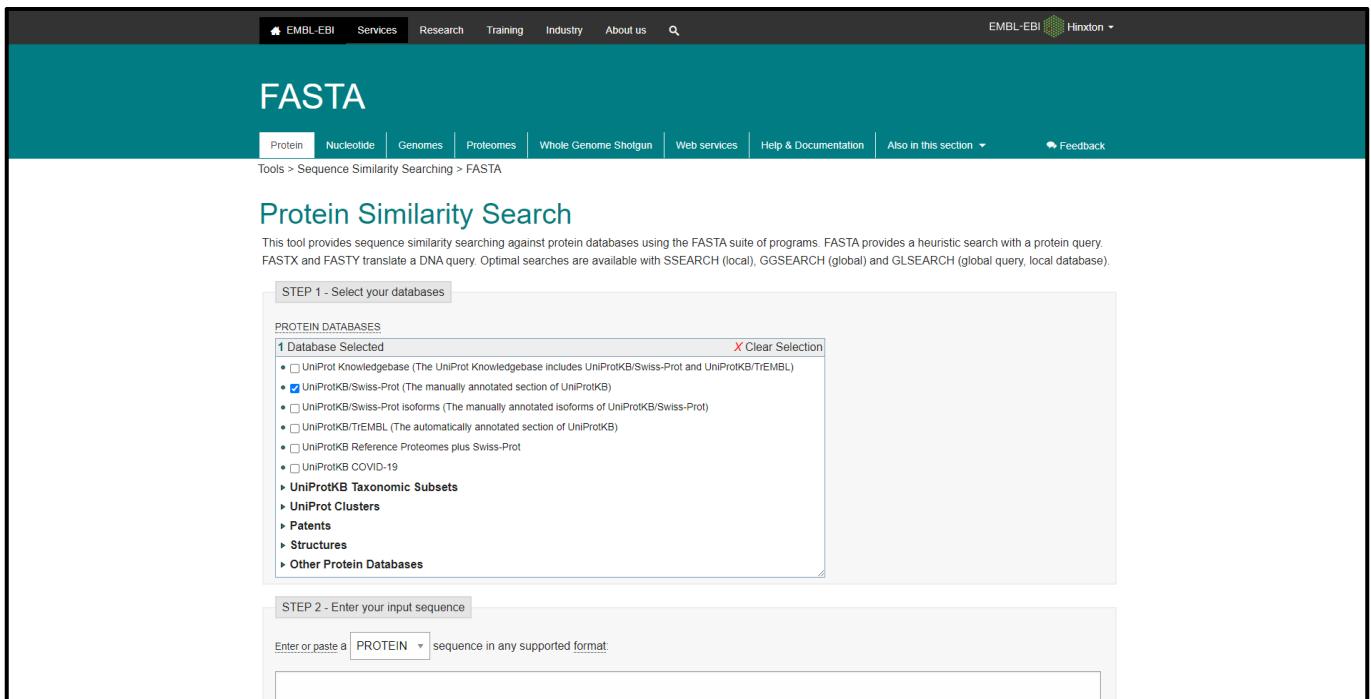
Rhodopsin, also called visual purple, pigment-containing sensory protein that converts light into an electrical signal. Rhodopsin is found in a wide range of organisms, from vertebrates to bacteria. In many seeing animals, including humans, it is required for vision in dim light and is located in the retina of the eye specifically, within the tightly packed disks that make up the outer segment of the retina's photoreceptive rod cells, which are specially adapted for vision under low-light conditions.

Rhodopsin was discovered in 1876 by German physiologist Franz Christian Boll, who observed that the normally reddish purple frog retina turned pale in bright light. The fading of colour was later attributed to the destruction of rhodopsin, via a process known as bleaching. Bleaching and the subsequent regeneration of rhodopsin are major steps in the visual cycle—the series of biochemical reactions that is critical for vision in low light.

### Methodology:

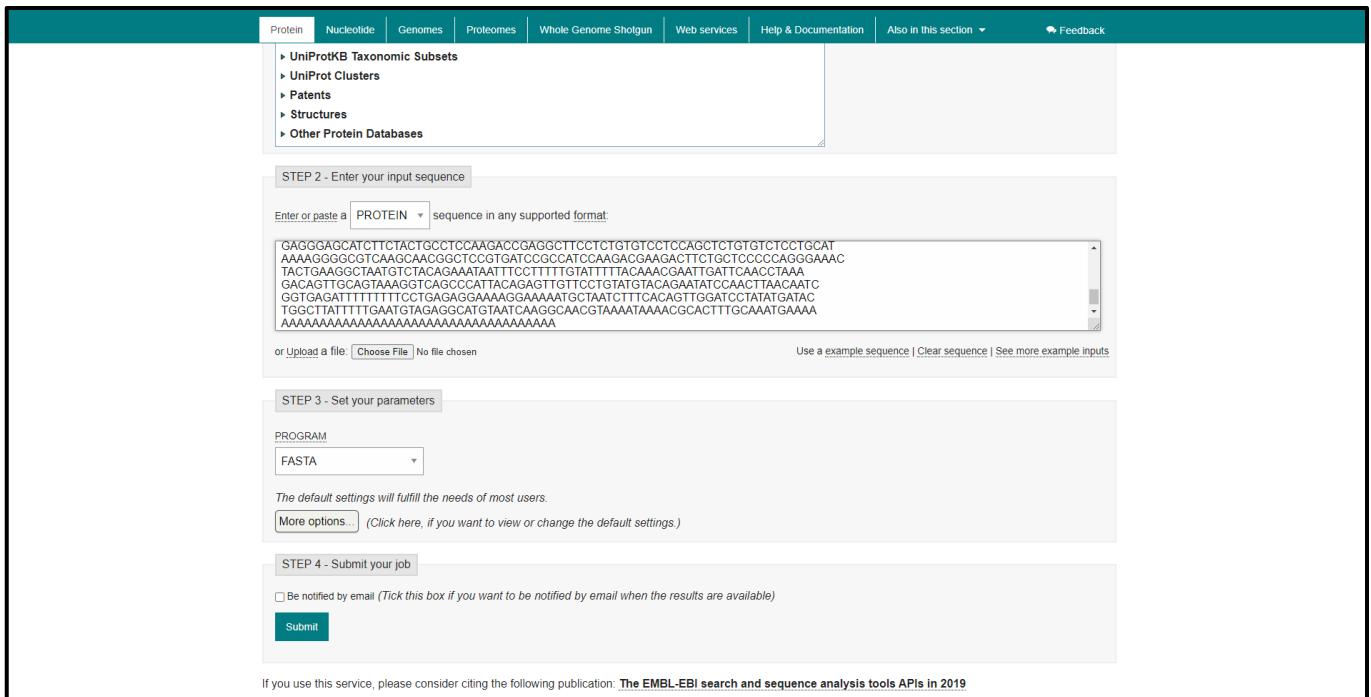
1. Open the homepage of FASTA
2. Click on the FASTAp hyperlink
3. Enter the sequence for keratin taken by uniprot
4. Open the result page.
5. Interpret the result.

## Observation:



The screenshot shows the FASTAp homepage. At the top, there is a navigation bar with links for EMBL-EBI, Services, Research, Training, Industry, About us, and a search icon. The EMBL-EBI logo and Hinxton are also present. Below the navigation bar, the title "FASTA" is displayed in a large, bold font. A sub-navigation bar below "FASTA" includes links for Protein, Nucleotide, Genomes, Proteomes, Whole Genome Shotgun, Web services, Help & Documentation, Also in this section, and Feedback. The main content area is titled "Protein Similarity Search". A sub-instruction "Tools > Sequence Similarity Searching > FASTA" is shown. The main area is divided into two sections: "STEP 1 - Select your databases" and "STEP 2 - Enter your input sequence". The "STEP 1" section shows a list of protein databases, with "UniProtKB/Swiss-Prot" selected. The "STEP 2" section contains a text input field with the placeholder "Enter or paste a PROTEIN sequence in any supported format".

Fig1. Homepage of FASTAp



The screenshot shows the FASTAp search interface. The top navigation bar and sub-navigation bar are identical to Fig1. The main content area is titled "STEP 2 - Enter your input sequence". A large text input field contains the sequence: "CAAGGGACCATCTTCTACTCCAAAGACCCAGGCTTCTCTGTGTCCTCCAGCTCTGTCCTCCAT AAAAGGGGCTCAAGCAACCGCTCCGTGATGCCCATCAAGACAAAGACTCTGTCCTCCAGGGAAAC TACTGAAGGCTAATGTCTACAGAAAATTTCCTTTGTATTTACAAACGAAATTGATTCAACTAA GACAGTTGAGTAAAGGTCAAGGCTACAGAGTTGTTCTGTATGTCAGAATATCCAACTTAAACATC GGTGAGATTTTTTCTGAGAGGAAAAGGAAAATGCTAATCTTACACAGTTGGATCCATATGATAC TGCTTATTGAAATGTAGAGGCTGTAATCAAGGCAACGTAATAAAACGCCACTTGTCAAATGAAA AAAAAAA...". Below the input field, there are buttons for "Choose File" (with "No file chosen" displayed) and "Use a example sequence | Clear sequence | See more example inputs". The "STEP 3 - Set your parameters" section includes a "PROGRAM" dropdown set to "FASTA" and a note: "The default settings will fulfill the needs of most users." A "More options..." link is also present. The "STEP 4 - Submit your job" section contains a checkbox "Be notified by email (Tick this box if you want to be notified by email when the results are available)" and a "Submit" button. At the bottom, a note says "If you use this service, please consider citing the following publication: The EMBL-EBI search and sequence analysis tools APIs in 2019".

Fig2. Search bar for FASTAp with sequence for rhodopsin taken from uniprot

```
>sp|P02699|OPSD_BOVIN Rhodopsin OS=Bos taurus OX=9913 GN=RHO PE=1 SV=1
MNGTEGPNFYVPFSNKTGVVRSPFEAPQYYLAEPWQFSMLAAYMFLLIMLGFPINFATLY
VTVQHKKLRTPLNYILLNLAVADLFMVGFFTTLYTSLHGYFVFGPTGCNLEGFFATLG
GEIALWSLVLAIERYVVVCKPMSNFRFGENHAIMGVAFTWVMALACAAPPLVGWSRYIP
EGMQCSCGIDYYTPHEETNNESFVIYMFVVHFIIPLIVIFFCYGQLVFTVKEAAAQQQES
ATTQKAKEEVTRMVIIMVIAFLICWLPYAGVAFYIFTHQGSDFGPIFMTIPIAFFAKTSAV
YNPVIYIMMKQFRNCMVTTLCCGKNPLGDEASTTVSKTETSQVAPA
```

**Fig3. Fasta sequence for my query Rhodopsin**

The screenshot shows the EMBL-EBI FASTA search results page. The top navigation bar includes links for EMBL-EBI, Services, Research, Training, Industry, About us, and a search bar. The main title is "FASTA". Below the title, there are tabs for Protein, Nucleotide, Genomes, Proteomes, Whole Genome Shotgun, and "Also in this section". A "Feedback" link is also present. The main content area displays the results for a search job. The results are titled "Results for job fasta-I20211101-150915-0959-51807210-p2m". There are five tabs at the top of the results table: "Summary Table" (selected), "Tool Output", "Visual Output", "Functional Predictions", and "Submission Details". The "Summary Table" section contains a table with the following data:

| Align. | DB:ID     | Source  | Length | Score (Bits) | Identities % | Positives % | E()     |
|--------|-----------|---|--------|--------------|--------------|-------------|---------|
| 1      | SP P05790 | Fibron heavy chain OS=Bombyx mori OX=7091 GN=FIBH PE=1 SV=4   | 5263   | 149.1        | 28.8         | 58.6        | 6.0E-33 |
| 2      | SP P13837 | G surface protein, allelic form 156 OS=Paramecium primaurelia OX=5886 GN=1560 PE=2 SV=1   | 2715   | 144.6        | 28.4         | 47.8        | 6.9E-32 |
| 3      | SP 088281 | Multiple epidermal growth factor-like domains protein 6 OS=Rattus norvegicus OX=10116 GN=Mefg6 PE=1 SV=1                                  | 1574   | 133.5        | 26.0         | 37.6        | 8.9E-29 |
| 4      | SP P17053 | G surface protein, allelic form 168 OS=Paramecium primaurelia OX=5886 GN=1680 PE=2 SV=1   | 2704   | 133.6        | 27.2         | 46.7        | 1.4E-28 |
| 5      | SP 053553 | Uncharacterized PE-PGRS family protein PE_PGRS54 OS=Mycobacterium tuberculosis (strain ATCC 25618 / H37Rv) OX=8332 GN=PE_PGRS54 PE=1 SV=1 | 1901   | 116.0        | 29.3         | 50.3        | 2.0E-23 |

On the left side of the results table, there are several filter and search options: "Selection" (with "Select All", "Invert", "Clear" buttons), "Apply to selection", "Annotations" (with "Show" and "Hide" buttons), "Alignments" (with "Show" and "Hide" buttons), "Entries" (with "Download" and "fasta" dropdown), "format" (dropdown), and "Tools" (with "Launch" and "Clustal Omega" buttons).

**Fig4. Summary table for Rhodopsin in FASTAp**

EMBL-EBI Services Research Training Industry About us

EMBL-EBI Hinxton

# FASTA

Protein Nucleotide Genomes Proteomes Whole Genome Shotgun Web services Help & Documentation Also in this section ▾

Tools > Sequence Similarity Searching > FASTA

Results for job **fasta-l20211101-150915-0959-51807210-p2m**

[Summary Table](#) [Tool Output](#) [Visual Output](#) [Functional Predictions](#) [Submission Details](#)

[Download](#) [Download in XML format](#)

FASTA searches a protein or DNA sequence data bank  
version 36.3.8b, May, 2020

Please cite:  
W.R. Pearson & D.J. Lipman PNAS (1988) 85:2444-2448

Query: @  
1>>NP\_00207932.1 *Heliochromis burtoni* rhodopsin-like (rhodopsin), mRNA - 1506 aa  
Length: 1506 Untranslated  
203850821 residue in 565254 sequences

Statistics: Expectation\_n E-fit: rho(ln(n))= 5.598e-/-0.000265; mur 21.8805e-/-0.015  
mean,var=271.4539e-/-47.371, 0.16 E-trim(114.1); 800 E-trim: 795 ln 1/65  
Lambda: 0.077844  
statistics sampled from 600000 (8000) to 61266 sequences  
Algorithm: Gapped (3.8 Nov 2011) (optimized)  
Parameters: BLS95 matrix (15:-5), open:-10/-2  
ktup: 2, E-join: 1 (0.236), E-opt: 0.2 (0.111), width: 16  
Scan time: 24.15h

The best scores are:  
opt bits E(565254)  
1>>NP\_00207932.1 *Heliochromis burtoni* rhodopsin-like (rhodopsin), mRNA - 1506 aa  
2>>P11337 *Flabellifer flabellifer* Filopin heavy chain 0s-Bombyx (2383) 1167 149.1 6e-33  
3>>P03952 *Flabellifer flabellifer* Filopin heavy chain 0s-Bombyx (2383) 1167 149.1 6e-32  
4>>P03953 *Flabellifer flabellifer* Filopin heavy chain 0s-Bombyx (2383) 1167 133.5 6e-32  
5>>P17053 *Glossy Glossy* G surface protein, allelic to (2704) 1034 133.6 5e-28  
6>>P03553 *R6.5* MYCTU Uncharacterized RE-RB85 family (1981) 888 135.0 2e-23  
7>>P09167 *NOTC3\_HUMAN* Neurogenin locus notch homol (3232) 838 111.4 5.6e-21  
8>>P07599 *NOTC1\_HUMAN* Neurogenin locus notch homol (3238) 826 111.1 2.5e-21  
9>>P03182 *NOTC3\_MOUSE* Neurogenin locus notch homol (2318) 797 106.8 4.1e-20  
10>>P11976 *PTSA1\_DICOT* Prestalk protein 0s-Glycotope (1853) 798 105.4 1.7e-20  
11>>P14200B *NOTC1\_XENTR* Neurogenin locus notch homol (2522) 789 106.8 2.6e-20  
12>>P03376 *BAR3\_White* Balbiani ring protein 3 0sCh (1780) 773 103.9 7.7e-20  
13>>P08799 *CAN\_MOUSE* Zonadhesin 0sMus musculus Ov (5376) 767 104.2 2e-19  
14>>P07207 *NOTCH3\_MOUSE* Neurogenin locus Notch prote (2703) 762 103.0 2.2e-19  
15>>P08791 *PTSA1\_MOUSE* Multiple epidermal growth fa (1691) 751 101.1 3.5e-19  
16>>P08790 *PTSA1\_MOUSE* Multiple epidermal growth fa (1692) 751 101.1 3.5e-19  
17>>P08792 *MEG11\_MOUSE* Multiple epidermal growth fa (1044) 746 100.5 5.1e-19  
18>>P08399 *PHOX5A\_MOUSE* Putative per-hexameric repeat ( 672) 733 98.6 1.2e-18  
19>>P05409B *Y68295\_DICOT* Uncharacterized transmembrane (1143) 723 97.9 3.2e-18

Fig5. Tool Output for Rhodopsin in FASTAp.



Fig6. Visual output for Rhodopsin in FASTAp

# FASTA

Protein Nucleotide Genomes Proteomes Whole Genome Shotgun Web services Help & Documentation Also in this section ▾ Feedback

Tools > Sequence Similarity Searching > FASTA

Results for job fasta-I20211101-150915-0959-51807210-p2m

Summary Table Tool Output Visual Output Functional Predictions Submission Details

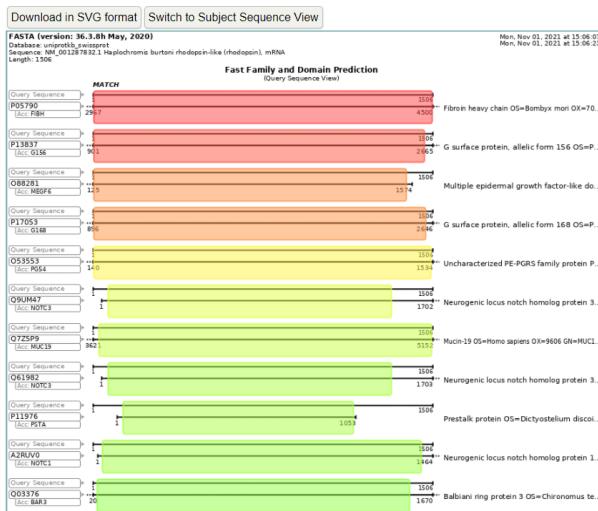
Color scale:

fixed  
 dynamic [Update](#)

Protein features:

GENE3D  
 PANTHER  
 PFAM  
 PIRSF  
 PRINTS  
 PRODOM  
 PROFILE  
 PROSITE  
 SMART  
 SSF  
 TIGERFAMS  
 Unclassified

[Update](#)



**Fig7. Functional Predictions for Rhodopsin in FASTAp**

# FASTA

Protein Nucleotide Genomes Proteomes Whole Genome Shotgun Web services Help & Documentation Also in this section ▾ Feedback

Tools > Sequence Similarity Searching > FASTA

Results for job fasta-I20211101-150915-0959-51807210-p2m

Summary Table Tool Output Visual Output Functional Predictions Submission Details

|                   |                     |                               |
|-------------------|---------------------|-------------------------------|
| Program           | Database            | Launched Date                 |
| FASTA             | uniprotkb_swissprot | Mon, Nov 01, 2021 at 15:06:07 |
| Version           |                     | End Date                      |
| 36.3.8h May, 2020 |                     | Mon, Nov 01, 2021 at 15:06:23 |

|   |
|---|
| Input Sequence                                  |
| fasta-I20211101-150915-0959-51807210-p2m.input  |
| Output Result                                   |
| fasta-I20211101-150915-0959-51807210-p2m.output |

Command

```
cat fasta-I20211101-150915-51807210-p2m.sequence | SAPPBIN/fasta:36.3.8h /fasta36 -1 $DATA_CURRENT/fastacfg.fasta3db -L -T 32 -p -s BL50 -f -10 -g -2 -E "10.0 -1.0" -F 0.0 -b 50 -d 50 -m "F9B fasta-I20211101-150915-51807210-p2m.m9" -m "F10 fasta-I20211101-150915-0959-51807210-p2m.m10" -z 1 \0:1- +uniprotkb_swissprot +2
```

## Input Parameters

Sequence type  
protein

Matrix  
BL50

Match/mismatch scores  
none

Gap open  
-10

**Fig8. Submission Details for Rhodopsin in FASTAp**

## **Results:**

FASTAp Result divided into 5 sections summary tables, Tool output, visual output, functional predictions, Submission details.

In summary tables it shows alignment of sequence that is length, score bits, identity percentage and positive percentage.

Tools output for keratin in FASTAp shows multiple outputs for results

In visual output the color scale can be changed between fixed and dynamic, showing E-Values

Functional Prediction's color scale can also be switched between dynamic and fixed, showing E-Values

The submission details shows use the commands and input parameters that were used before we submitted the query for running.

## **Conclusion:**

FASTA is another sequence alignment tool which is used to search similarities between sequences of DNA and proteins. The query sequence is broken down into sequence patterns or words known as k-tuples and the target sequences are searched for these k-tuples in order to find the similarities between the two.

## **References:**

5. Rhodopsin. (n.d.). Retrieved from <https://www.britannica.com/science/rhodopsin>
6. (n.d.). Retrieved from <https://www.uniprot.org/uniprot/P02699.fasta>
7. Embl-Ebi. (n.d.). FASTA. Retrieved from <https://www.ebi.ac.uk/Tools/sss/fasta/>
8. Embl-Ebi. (n.d.). FASTA. Retrieved from <https://www.ebi.ac.uk/Tools/services/web/toolresult.ebi?jobId=fasta-I20211101-150915-0959-51807210-p2m>

## WEBLEM 11/e

(URL: <https://blast.ncbi.nlm.nih.gov/Blast.cgi>)

### Aim:

To study the Query 'Rhodopsin' in PHI BLAST

### Introduction:

A sequence similarity search often provides the first information about a new DNA or protein sequence. A search allows scientists to infer the function of a sequence from similar sequences. There are many ways of performing a sequence similarity search, but probably the most popular method is the "Basic Local Alignment Search Tool" (BLAST) (1, 2). BLAST uses heuristics to produce results quickly. It also calculates an "expect value" that estimates how many matches would have occurred at a given score by chance, which can aid a user in judging how much confidence to have in an alignment.

PHI-BLAST (Pattern-Hit Initiated BLAST) is a search program that combines matching of regular expressions with local alignments surrounding the match. The most important features of the program have been incorporated into the BLAST software framework partly for user convenience and partly so that PHI-BLAST may be combined seamlessly with PSI-BLAST. Other features that do not fit into the BLAST framework will be released later as a separate program and/or separate Web page query options. One very restrictive way to identify protein motifs is by regular expressions that must contain each instance of the motif. The PROSITE database is a compilation of restricted regular expressions that describe protein motifs. Given a protein sequence S and a regular expression pattern P occurring in S, PHI-BLAST helps answer the question: What other protein sequences both contain an occurrence of P and are homologous to S in the vicinity of the pattern occurrences? PHI-BLAST may be preferable to just searching for pattern occurrences because it filters out those cases where the pattern occurrence is probably random and not indicative of homology. PHI-BLAST may be preferable to other flavors of BLAST because it is faster and because it allows the user to express a rigid pattern occurrence requirement.

Rhodopsin, also called visual purple, pigment-containing sensory protein that converts light into an electrical signal. Rhodopsin is found in a wide range of organisms, from vertebrates to bacteria. In many seeing animals, including humans, it is required for vision in dim light and is located in the retina of the eye specifically, within the tightly packed disks that make up the outer segment of the retina's photoreceptive rod cells, which are specially adapted for vision under low-light conditions. Rhodopsin was discovered in 1876 by German physiologist Franz Christian Boll, who observed that the normally reddish purple frog retina turned pale in bright light. The fading of colour was later attributed to the destruction of rhodopsin, via a process known as bleaching. Bleaching and the subsequent regeneration of rhodopsin are major steps in the visual cycle—the series of biochemical reactions that is critical for vision in low light.

### Methodology:

1. Open the homepage of blast.
2. After that click the BLASTp
3. Enter the sequence for rhodopsin taken by uniport.

4. Change the program selection Algorithm to PHI-BLAST
5. Enter the pattern taken by prosite
6. Open the result page
7. Interpret the result.

## Observation:

Fig1. Homepage of BLAST

```
>sp|P02699|OPSD_BOVIN Rhodopsin OS=Bos taurus OX=9913 GN=RHO PE=1 SV=1
MNGTEGPNFYVPFSNKTGVVRSPFEAPQYYLAEPWQFSMLAAYMFLLIMLGFPINFLTLY
VTQHQKKLRTPLNYILLNLAVADLFMVFGGFTTLYTSLHGYFVFGPTGCNLEGFFATLG
GEIALWSLVVLAIERYVVVCKPMSNFRFGENHAIMGVAFTWVMALACAAPPLVGWSRYIP
EGMQCSCGIDYYTPHEETNNESFVIYMFVVFIIPLIVIFFCYGQLVFTVKEAAAQQQES
ATTQKAKEEVTRMVIIMVIAFLICWLPHYAGVAFYIFTHQGSDFGPIFMTIPAFFAKTSAV
YNPVIYIMMNKQFRNCMVTTLCCGKNPLGDDEASTTVSKTETSQVAPA
```

Fig2. FASTA sequences for query Rhodopsin

NIH U.S. National Library of Medicine  
National Center for Biotechnology Information

Log in

BLAST® » blastp suite

Standard Protein BLAST

blast blastp blastx tblastn tblastx

Enter Query Sequence

Enter accession number(s), gil(s), or FASTA sequence(s)

From  To

Or, upload file

Job Title

Align two or more sequences

New columns added to the Description Table  
Click 'Select Columns' or 'Manage Columns'.

Choose Search Set

Database Non-redundant protein sequences

Organism   exclude

Exclude  Models (XMPXP)  Non-redundant RefSeq proteins (WP)  Uncultured/environmental sample sequences

Program Selection

Algorithm  Quick BLASTP (Accelerated protein-protein BLAST)  blastp (protein-protein BLAST)  PSI-BLAST (Position-Specific Iterated BLAST)  PHI-BLAST (Pattern Hit Initiated BLAST)  DELTA-BLAST (Domain Enhanced Lookup Time Accelerated BLAST)

BLAST   Show results in a new window

+ Algorithm parameters

Fig3. Search bar for PHI blast with sequence pasted

Choose a BLAST algorithm

blast   Show results in a new window

+ Algorithm parameters

General Parameters

Max target sequences

Short queries  Automatically adjust parameters for short input sequences

Expect threshold

Word size

Max matches in a query range

Scoring Parameters

Matrix

Gap Costs

Compositional adjustments

Filters and Masking

Filter  Low complexity regions

Mask  Mask for lookup table only   Mask lower case letters

BLAST   Show results in a new window

[Twitter](#) [Facebook](#) [YouTube](#) [LinkedIn](#) [GitHub](#) [Blog](#) [Support Center](#)

Fig4. Algorithm parameters for PHI blast for Rhodopsin

Algorithm parameters

General Parameters

- Max target sequences: 500 (Select the maximum number of aligned sequences to display)
- Short queries:  Automatically adjust parameters for short input sequences
- Expect threshold: 0.05
- Word size: 3
- Max matches in a query range: 0

Scoring Parameters

- Matrix: BLOSUM62
- Gap Costs: Existence: 11 Extension: 1

Filters and Masking

- Filter:  Low complexity regions
- Mask:  Mask for lookup table only
- Mask lower case letters

PSI/PHI/DELTA BLAST

- Upload PSSM: Choose File (No file chosen)
- Optional: PSI-BLAST Threshold: 0.005
- Pseudocount: 0

BLAST

Search database nr using PHI-BLAST (Pattern Hit Initiated BLAST)

Show results in a new window

Twitter Facebook YouTube LinkedIn GitHub Blog Support Center

National Center for Biotechnology Information Popular PubMed Resources Literature Actions Submit

Fig5. PSI/PHI/DELTA parameters for Rhodopsin in BLAST

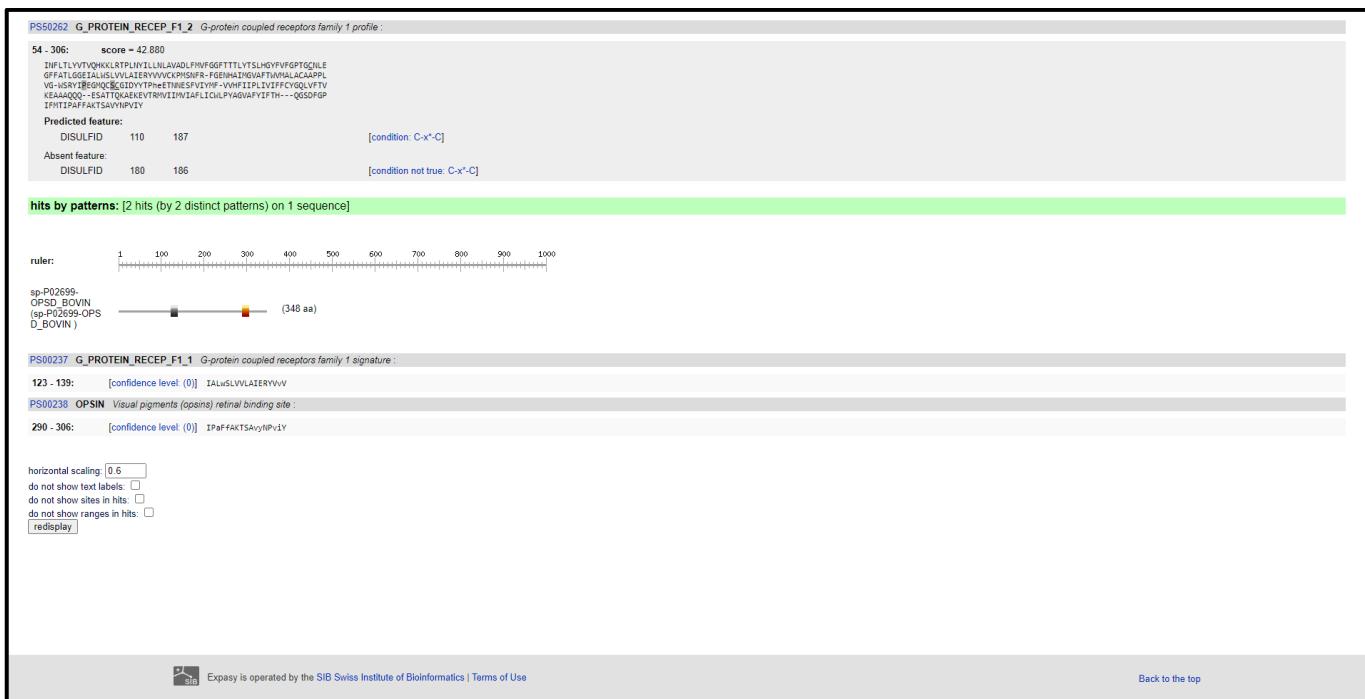


Fig6. Pattern for query in Rhodopsin in PROSITE

U.S. National Library of Medicine  
National Center for Biotechnology Information

BLAST® > blastp suite > results for RID-S02VMRMN013

Job Title: sp|P02699|OPSD\_BOVIN Rhodopsin OS=Bos taurus...  
RID: S02VMRMN013 Search expires on 11-02 23:44 pm [Download All](#)  
Program: PSI-BLAST Iteration 1 [Citation](#)  
Database: nr [See details](#)  
Query ID: Icl|Query\_7013  
Description: sp|P02699|OPSD\_BOVIN Rhodopsin OS=Bos taurus OX...  
Molecule type: amino acid  
Query Length: 348  
Other reports: [Distance tree of results](#) [Multiple alignment](#) [MSA viewer](#)

Filter Results  
Organism: only top 20 will appear  exclude  
Type common name, binomial, taxid or group name  
+ Add organism  
Percent Identity: [ ] to [ ] E value: [ ] to [ ] Query Coverage: [ ] to [ ]  
PSI-BLAST incl. threshold: 0.005 [Filter](#) [Reset](#)

Run PSI-BLAST iteration 2  
Number of sequences: 500 [Run](#)

Descriptions Graphic Summary Alignments Taxonomy

Sequences producing significant alignments  
Download [New](#) Select columns Show 500 [?](#)  
500 sequences selected GenPept Graphics Distance tree of results Multiple alignment [MSA Viewer](#)

Sequences with E-value BETTER than threshold  
Select all 500 sequences selected

|                                     | Description   | Scientific Name   | Max Score | Total Score | Query Cover | E value | Per. Ident | Acc. Len | Accession      | Select for PSI blast                | Used to build PSSM                  | Newly added |
|-------------------------------------|---|-------------------|-----------|-------------|-------------|---------|------------|----------|----------------|-------------------------------------|-------------------------------------|-------------|
| <input checked="" type="checkbox"/> | Structure of Bovine Rhodopsin in a Trigonal Crystal Form [Bos taurus]                       | Bos taurus        | 718       | 718         | 100%        | 0.0     | 100.0%     | 349      | 1GZM_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Bos taurus]  | Bos taurus        | 718       | 718         | 100%        | 0.0     | 100.0%     | 348      | NP_001014890_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | PREDICTED: rhodopsin [Bison bison bison]  | Bison bison bi... | 716       | 716         | 100%        | 0.0     | 99.43%     | 348      | XP_010860750_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Rhodopsin [Bos mutus]   | Bos mutus         | 716       | 716         | 100%        | 0.0     | 99.43%     | 351      | ELR51227.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | PREDICTED: rhodopsin [Bos mutus]  | Bos mutus         | 715       | 715         | 100%        | 0.0     | 99.43%     | 348      | XP_005902896_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Bos taurus]  | Bos taurus        | 712       | 712         | 100%        | 0.0     | 99.71%     | 347      | 0811197A       | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Crystal structure of a rhodopsin stabilizing mutant expressed in mammalian cells [Bos ta... | Bos taurus        | 711       | 711         | 100%        | 0.0     | 99.43%     | 349      | 2J4Y_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Chain A: Rhodopsin [unidentified]   | unidentified      | 711       | 711         | 100%        | 0.0     | 99.43%     | 348      | 3C9M_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Crystal Structure Of the Constitutively Active E113N N2c: D282c Rhodopsin Mutant With...    | Bos taurus        | 709       | 709         | 100%        | 0.0     | 99.14%     | 349      | 2X72_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Bubalus bubalis]   | Bubalus bubalis   | 709       | 709         | 100%        | 0.0     | 98.85%     | 348      | XP_006070962_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Night blindness causing G90D rhodopsin in complex with GaCT2 peptide [Bos taurus]           | Bos taurus        | 708       | 708         | 100%        | 0.0     | 99.14%     | 349      | 4BEY_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Crystal Structure of T94I rhodopsin mutant [Bos taurus]                                     | Bos taurus        | 708       | 708         | 100%        | 0.0     | 99.14%     | 349      | 5DYS_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Rhodopsin-G1 protein complex [Bos taurus]   | Bos taurus        | 708       | 708         | 100%        | 0.0     | 99.14%     | 348      | 6QNO_R         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Crystal structure of the light-activated constitutively active N2C: M257Y D282C rhodopsin   | Bos taurus        | 708       | 708         | 100%        | 0.0     | 99.14%     | 349      | 4A4M_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Bos taurus]  | Bos taurus        | 705       | 705         | 98%         | 0.0     | 99.71%     | 343      | AAA30675_1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Ovis aries]  | Ovis aries        | 700       | 700         | 100%        | 0.0     | 97.41%     | 348      | XP_004010583_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Oryx dammah]   | Oryx dammah       | 697       | 697         | 100%        | 0.0     | 96.55%     | 348      | XP_040102676_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | hypothetical protein FD754_009314 [Muntiacus muntjak]                                       | Muntiacus mu...   | 696       | 696         | 100%        | 0.0     | 96.55%     | 348      | KAB0365158_1   | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Cervus canadensis]   | Cervus canad...   | 696       | 696         | 100%        | 0.0     | 96.26%     | 348      | XP_043298844_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Odocoileus virginianus texanus]  | Odocoileus vi...  | 696       | 696         | 100%        | 0.0     | 95.98%     | 348      | XP_020728233_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | PREDICTED: rhodopsin [Ceratotherium simum simum]  | Ceratotheriu...   | 694       | 694         | 100%        | 0.0     | 95.69%     | 348      | XP_004442481_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Ursus maritimus]   | Ursus maritimus   | 691       | 691         | 100%        | 0.0     | 95.11%     | 348      | XP_000696069_2 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | RecName: Full=Rhodopsin [Ovis aries]  | Ovis aries        | 691       | 691         | 100%        | 0.0     | 96.26%     | 348      | EP072700_2     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |

Feedback

Fig7. Result page (header) for Rhodopsin

Descriptions Graphic Summary Alignments Taxonomy Number of sequences: 500 Run

Sequences producing significant alignments Download [New](#) Select columns Show 500 [?](#)  
500 sequences selected GenPept Graphics Distance tree of results Multiple alignment [MSA Viewer](#)

Sequences with E-value BETTER than threshold  
Select all 500 sequences selected

|                                     | Description   | Scientific Name   | Max Score | Total Score | Query Cover | E value | Per. Ident | Acc. Len | Accession      | Select for PSI blast                | Used to build PSSM                  | Newly added |
|-------------------------------------|---|-------------------|-----------|-------------|-------------|---------|------------|----------|----------------|-------------------------------------|-------------------------------------|-------------|
| <input checked="" type="checkbox"/> | Structure of Bovine Rhodopsin in a Trigonal Crystal Form [Bos taurus]                       | Bos taurus        | 718       | 718         | 100%        | 0.0     | 100.0%     | 349      | 1GZM_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Bos taurus]  | Bos taurus        | 718       | 718         | 100%        | 0.0     | 100.0%     | 348      | NP_001014890_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | PREDICTED: rhodopsin [Bison bison bison]  | Bison bison bi... | 716       | 716         | 100%        | 0.0     | 99.43%     | 348      | XP_010860750_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Rhodopsin [Bos mutus]   | Bos mutus         | 716       | 716         | 100%        | 0.0     | 99.43%     | 351      | ELR51227.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | PREDICTED: rhodopsin [Bos mutus]  | Bos mutus         | 715       | 715         | 100%        | 0.0     | 99.43%     | 348      | XP_005902896_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Bos taurus]  | Bos taurus        | 712       | 712         | 100%        | 0.0     | 99.71%     | 347      | 0811197A       | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Crystal structure of a rhodopsin stabilizing mutant expressed in mammalian cells [Bos ta... | Bos taurus        | 711       | 711         | 100%        | 0.0     | 99.43%     | 349      | 2J4Y_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Chain A: Rhodopsin [unidentified]   | unidentified      | 711       | 711         | 100%        | 0.0     | 99.43%     | 348      | 3C9M_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Crystal Structure Of the Constitutively Active E113N N2c: D282c Rhodopsin Mutant With...    | Bos taurus        | 709       | 709         | 100%        | 0.0     | 99.14%     | 349      | 2X72_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Bubalus bubalis]   | Bubalus bubalis   | 709       | 709         | 100%        | 0.0     | 98.85%     | 348      | XP_006070962_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Night blindness causing G90D rhodopsin in complex with GaCT2 peptide [Bos taurus]           | Bos taurus        | 708       | 708         | 100%        | 0.0     | 99.14%     | 349      | 4BEY_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Crystal Structure of T94I rhodopsin mutant [Bos taurus]                                     | Bos taurus        | 708       | 708         | 100%        | 0.0     | 99.14%     | 349      | 5DYS_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Rhodopsin-G1 protein complex [Bos taurus]   | Bos taurus        | 708       | 708         | 100%        | 0.0     | 99.14%     | 348      | 6QNO_R         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | Crystal structure of the light-activated constitutively active N2C: M257Y D282C rhodopsin   | Bos taurus        | 708       | 708         | 100%        | 0.0     | 99.14%     | 349      | 4A4M_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Bos taurus]  | Bos taurus        | 705       | 705         | 98%         | 0.0     | 99.71%     | 343      | AAA30675_1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Ovis aries]  | Ovis aries        | 700       | 700         | 100%        | 0.0     | 97.41%     | 348      | XP_004010583_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Oryx dammah]   | Oryx dammah       | 697       | 697         | 100%        | 0.0     | 96.55%     | 348      | XP_040102676_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | hypothetical protein FD754_009314 [Muntiacus muntjak]                                       | Muntiacus mu...   | 696       | 696         | 100%        | 0.0     | 96.55%     | 348      | KAB0365158_1   | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Cervus canadensis]   | Cervus canad...   | 696       | 696         | 100%        | 0.0     | 96.26%     | 348      | XP_043298844_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Odocoileus virginianus texanus]  | Odocoileus vi...  | 696       | 696         | 100%        | 0.0     | 95.98%     | 348      | XP_020728233_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | PREDICTED: rhodopsin [Ceratotherium simum simum]  | Ceratotheriu...   | 694       | 694         | 100%        | 0.0     | 95.69%     | 348      | XP_004442481_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | rhodopsin [Ursus maritimus]   | Ursus maritimus   | 691       | 691         | 100%        | 0.0     | 95.11%     | 348      | XP_000696069_2 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> | RecName: Full=Rhodopsin [Ovis aries]  | Ovis aries        | 691       | 691         | 100%        | 0.0     | 96.26%     | 348      | EP072700_2     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |

Feedback

Fig8. Description for query Rhodopsin

Alignments

Number of sequences: 348 Run

Alignment view: Pairwise Restore defaults Download

500 sequences selected

**Structure of Bovine Rhodopsin in a Trigonal Crystal Form [Bos taurus]**  
Sequence ID: [1GZM\\_A](#) Length: 349 Number of Matches: 1  
[See 23 more title\(s\)](#) [See all Identical Proteins\(IPG\)](#)

Range 1: 2 to 349 GenPept Graphics

Score: 718 bits(1854) 0.0 Expect: 0.0 Method: Compositional matrix adjust. Identities: 348/348(100%) Positives: 348/348(100%) Gaps: 0/348(0%)

Query 1: MNGTEPNIVYPFSNKTGVRSPFEEAPQQYLAEPHQFSNLAAYMFLLNLGCPINFILTY 60  
Sbjct 2: MNGTEPNIVYPFSNKTGVRSPFEEAPQQYLAEPHQFSNLAAYMFLLNLGCPINFILTY 61

Query 61: VTVHKKLRTPLNVLILNLAVADLPMVFGGFTTLYLHSYVYFGPTGNCLEGFATLG 120  
Sbjct 62: VTVHKKLRTPLNVLILNLAVADLPMVFGGFTTLYLHSYVYFGPTGNCLEGFATLG 121

Query 121: GEIALISLVLVLAITERVVKCPHSNFRFGENHAI1MGVAFTWMALACAAPPVLGVWSRYIP 180  
Sbjct 122: GEIALISLVLVLAITERVVKCPHSNFRFGENHAI1MGVAFTWMALACAAPPVLGVWSRYIP 181

Query 181: EGNCQCCGIDYVTPHEETNNEFVLYMFVHIEIPLIVLFFCYGQLVFTVKEAAQQQES 240  
Sbjct 182: EGNCQCCGIDYVTPHEETNNEFVLYMFVHIEIPLIVLFFCYGQLVFTVKEAAQQQES 241

Query 241: ATTGKAEKETVRMIVINMIAFLICLPLYAGVAFYIFTHQGSDFGPIMFTIPAFAKTSAV 300  
Sbjct 242: ATTGKAEKETVRMIVINMIAFLICLPLYAGVAFYIFTHQGSDFGPIMFTIPAFAKTSAV 301

Query 301: YIPVIVIYIMMKQFRNCMVTTLCCGKIPLGDEASTTTSKETSQVAPA 348  
Sbjct 302: YIPVIVIYIMMKQFRNCMVTTLCCGKIPLGDEASTTTSKETSQVAPA 349

**Rhodopsin [Bos taurus]**  
Sequence ID: [NP\\_001014890.1](#) Length: 348 Number of Matches: 1  
[See 35 more title\(s\)](#) [See all Identical Proteins\(IPG\)](#)

Range 1: 1 to 348 GenPept Graphics

Score: 240 bits(541) 0.0 Expect: 0.0 Method: Compositional matrix adjust. Identities: 348/348(100%) Positives: 348/348(100%) Gaps: 0/348(0%)

**Related Information**  
Structure - 3D structure displays  
[Identical Proteins](#) - Identical proteins to 1GZM\_A

**Feedback**

Fig9. Alignments view for query Rhodopsin

Taxonomy

Number of sequences: 348 Run

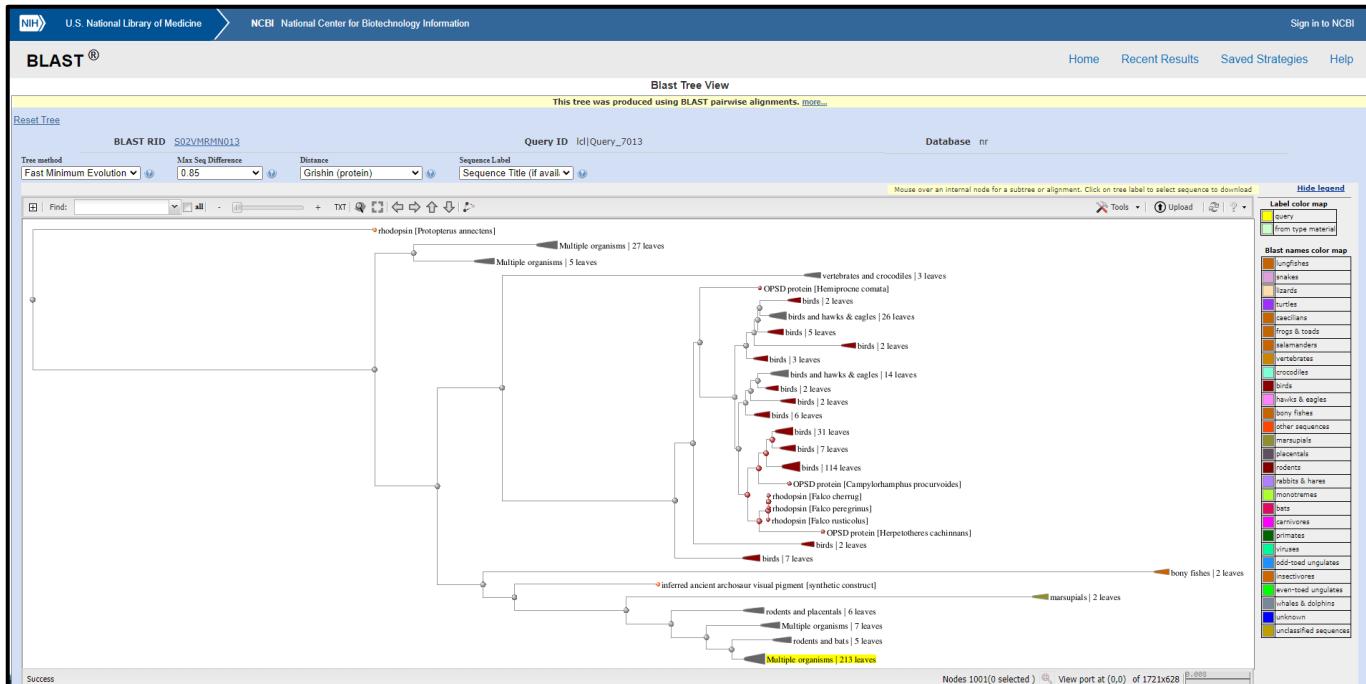
Reports Lineage Organism Taxonomy

500 sequences selected

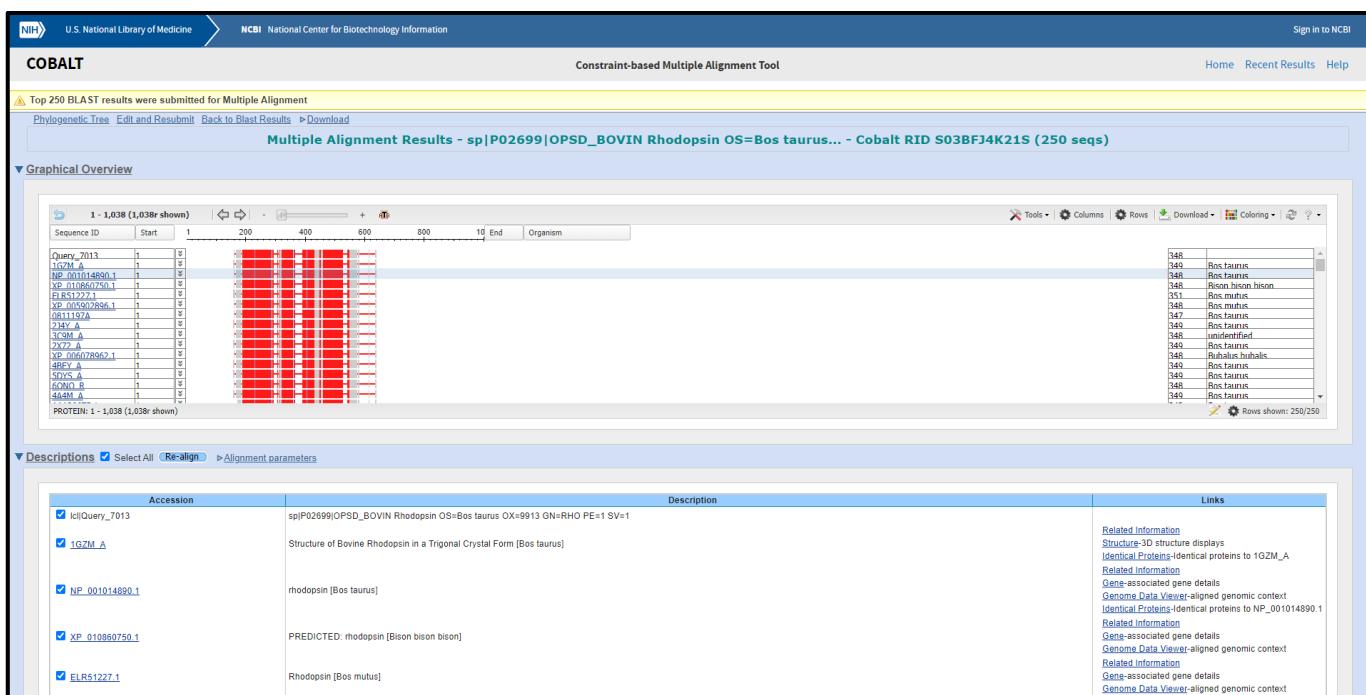
| Organism   | Blast Name          | Score | Number of Hits | Description                         |
|--|---------------------|-------|----------------|-------------------------------------|
| root   |                     |       | 845            |                                     |
| . Euteleostomi   | vertebrates         |       | 834            |                                     |
| . . Dipnotetrapodomorpha                                     | vertebrates         |       | 831            |                                     |
| . . . Tetrapoda  | vertebrates         |       | 830            |                                     |
| . . . . Amniota  | vertebrates         |       | 819            |                                     |
| . . . . . Mammalia   | mammals             |       | 399            |                                     |
| . . . . . . Theria   | mammals             |       | 395            |                                     |
| . . . . . . . Eutheria                                       | placentals          |       | 384            |                                     |
| . . . . . . . . Boreoeutheria                                | placentals          |       | 371            |                                     |
| . . . . . . . . . Laurasiatheria                             | placentals          |       | 257            |                                     |
| . . . . . . . . . . Artiodactyla                             | even-toed ungulates |       | 103            |                                     |
| . . . . . . . . . . . Peccra                                 | even-toed ungulates |       | 68             |                                     |
| . . . . . . . . . . . Bovidae                                | even-toed ungulates |       | 61             |                                     |
| . . . . . . . . . . . . Bovinae                              | even-toed ungulates |       | 56             |                                     |
| . . . . . . . . . . . . . Bos                                | even-toed ungulates |       | 54             |                                     |
| . . . . . . . . . . . . . . Bos taurus                       | even-toed ungulates | 718   | 49             | Bos taurus hits                     |
| . . . . . . . . . . . . . . . Bos indicus                    | even-toed ungulates | 718   | 1              | Bos indicus hits                    |
| . . . . . . . . . . . . . . . Bos indicus x Bos taurus       | even-toed ungulates | 718   | 1              | Bos indicus x Bos taurus hits       |
| . . . . . . . . . . . . . . . Bos mutus                      | even-toed ungulates | 716   | 3              | Bos mutus hits                      |
| . . . . . . . . . . . . . . . Bison bison bison              | even-toed ungulates | 716   | 1              | Bison bison bison hits              |
| . . . . . . . . . . . . . . . Bubalus bubalis                | even-toed ungulates | 709   | 1              | Bubalus bubalis hits                |
| . . . . . . . . . . . . . . . Ovis aries                     | even-toed ungulates | 700   | 3              | Ovis aries hits                     |
| . . . . . . . . . . . . . . . Capra hircus                   | even-toed ungulates | 700   | 1              | Capra hircus hits                   |
| . . . . . . . . . . . . . . . Oryx dammah                    | even-toed ungulates | 697   | 1              | Oryx dammah hits                    |
| . . . . . . . . . . . . . . . Muntiacus muntjak              | even-toed ungulates | 696   | 1              | Muntiacus muntjak hits              |
| . . . . . . . . . . . . . . . Muntiacus reevesi              | even-toed ungulates | 696   | 1              | Muntiacus reevesi hits              |
| . . . . . . . . . . . . . . . Cervus canadensis              | even-toed ungulates | 696   | 1              | Cervus canadensis hits              |
| . . . . . . . . . . . . . . . Cervus elaphus                 | even-toed ungulates | 696   | 1              | Cervus elaphus hits                 |
| . . . . . . . . . . . . . . . Cervus hirculus                | even-toed ungulates | 696   | 1              | Cervus hirculus hits                |
| . . . . . . . . . . . . . . . Odocoileus virginianus texanus | even-toed ungulates | 696   | 1              | Odocoileus virginianus texanus hits |
| . . . . . . . . . . . . . . . Carus elaphus hippocampus      | even-toed ungulates | 621   | 1              | Carus elaphus hippocampus hits      |
| . . . . . . . . . . . . . . . Monodon monoceros              | whales & dolphins   | 679   | 2              | Monodon monoceros hits              |

**Feedback**

Fig10. Taxonomy for Query Rhodopsin



### Fig11. Blast tree view for Rhodopsin



**Fig12: Multiple alignment view via cobalt for rhodopsin**

## Results:

In PHI-BLAST the result is divided into 4 parts. Description, Graphic summary alignment, taxonomy. We can also access other tools from within the result page like BLAST tree view and COBALT.

## Conclusion:

PHI-BLAST (Pattern-Hit Initiated BLAST) is a search program that combines matching of regular expressions with local alignments surrounding the match. The most important features of the program have been incorporated into the BLAST software framework.

## References:

1. (n.d.). Retrieved from <https://www.uniprot.org/uniprot/P02699.fasta>
2. Blast Tree View Widget. (n.d.). Retrieved from [https://blast.ncbi.nlm.nih.gov/blast/treeview/treeView.cgi?re-quest=page&blastRID=S02VMRMN013&queryID=lcl|Query\\_7013&en-trezLim=&ex=&exl=&exh=&ns=500](https://blast.ncbi.nlm.nih.gov/blast/treeview/treeView.cgi?re-quest=page&blastRID=S02VMRMN013&queryID=lcl|Query_7013&en-trezLim=&ex=&exl=&exh=&ns=500)
3. COBALT:Multiple Alignment Tool. (n.d.). Retrieved from <https://www.ncbi.nlm.nih.gov/tools/cobalt/cobalt.cgi>
4. Expasy is operated by the SIB Swiss Institute of Bioinformatics | Terms of Use. (n.d.). PROSITE. Retrieved from <https://prosite.expasy.org/cgi-bin/prosite/ScanView.cgi?scan-file=97965544372.scan.gz>
5. Protein BLAST: Search protein databases using a protein query. (n.d.). Retrieved from [https://blast.ncbi.nlm.nih.gov/Blast.cgi?PROGRAM=blastp&PAGE\\_TYPE=Blast-Search&BLAST\\_SPEC=&LINK\\_LOC=blasttab&LAST\\_PAGE=blastn](https://blast.ncbi.nlm.nih.gov/Blast.cgi?PROGRAM=blastp&PAGE_TYPE=Blast-Search&BLAST_SPEC=&LINK_LOC=blasttab&LAST_PAGE=blastn)
6. Rhodopsin. (n.d.). Retrieved from <https://www.britannica.com/science/rhodopsin>

**WEBLEM 11/f**(URL: <https://blast.ncbi.nlm.nih.gov/Blast.cgi/>)**Aim:**

To study the query Rhodopsin in PSI BLAST.

**Introduction:**

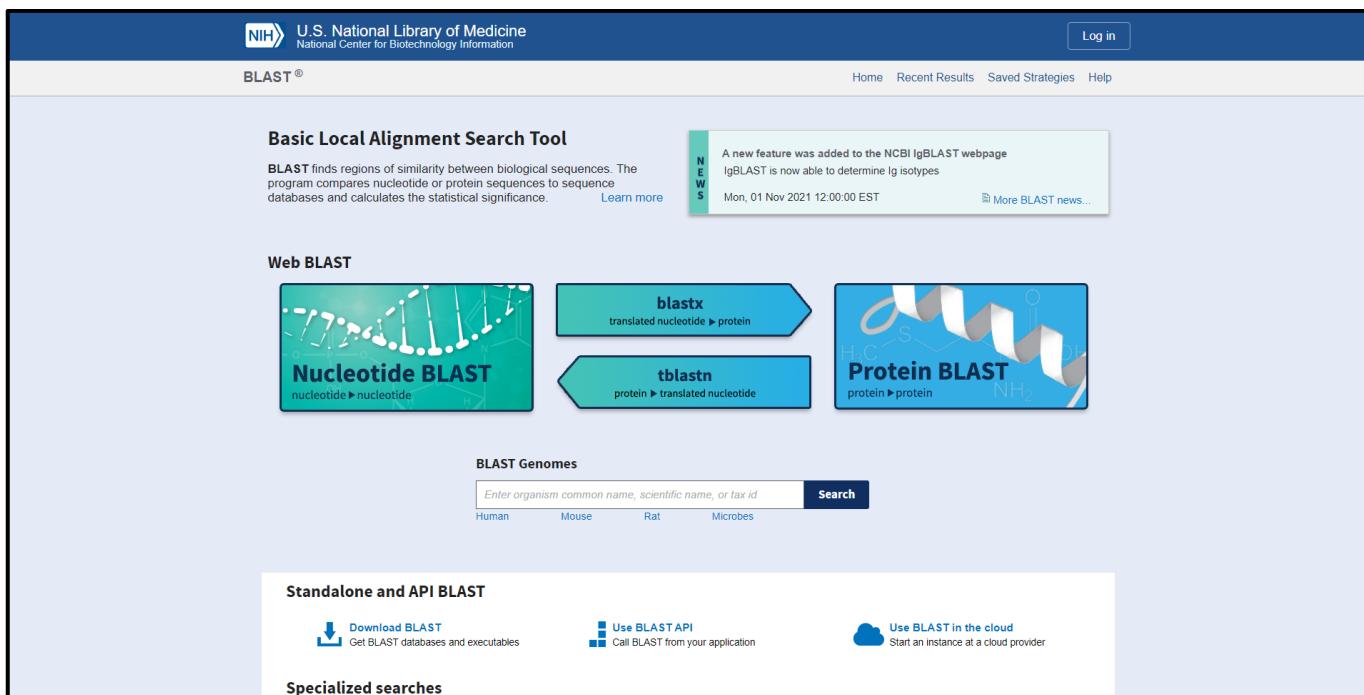
A sequence similarity search often provides the first information about a new DNA or protein sequence. A search allows scientists to infer the function of a sequence from similar sequences. There are many ways of performing a sequence similarity search, but probably the most popular method is the “Basic Local Alignment Search Tool” (BLAST) (1, 2). BLAST uses heuristics to produce results quickly. It also calculates an “expect value” that estimates how many matches would have occurred at a given score by chance, which can aid a user in judging how much confidence to have in an alignment. PSI-BLAST first performs a BLASTP search to collect information that it then uses to produce a Position-Specific-Scoring-Matrix (PSSM). A PSSM for a query of length N is an N x 20 matrix. Each of the N columns corresponds to a letter in the query, and each column contains 20 rows. Each row corresponds to a specific residue and describes the probability of related sequences having that residue at that position. PSI-BLAST can then search a database of protein sequences with this PSSM.

Rhodopsin, also called visual purple, pigment-containing sensory protein that converts light into an electrical signal. Rhodopsin is found in a wide range of organisms, from vertebrates to bacteria. In many seeing animals, including humans, it is required for vision in dim light and is located in the retina of the eye specifically, within the tightly packed disks that make up the outer segment of the retina’s photoreceptive rod cells, which are specially adapted for vision under low-light conditions. Rhodopsin was discovered in 1876 by German physiologist Franz Christian Boll, who observed that the normally reddish-purple frog retina turned pale in bright light. The fading of colour was later attributed to the destruction of rhodopsin, via a process known as bleaching. Bleaching and the subsequent regeneration of rhodopsin are major steps in the visual cycle—the series of biochemical reactions that is critical for vision in low light.

**Methodology:**

1. Open the homepage of BLAST.
2. After that click the BLASTp hyperlink
3. Enter the sequence for Rhodopsin taken from uniprot
4. Change the program selection algorithm to PSI-BLAST
5. Change the PSI-BLAST threshold value (0.0001)
6. Open the result page.
7. Interpret the results.

## Observations:



U.S. National Library of Medicine  
National Center for Biotechnology Information

Log in

BLAST®

Home Recent Results Saved Strategies Help

**Basic Local Alignment Search Tool**

BLAST finds regions of similarity between biological sequences. The program compares nucleotide or protein sequences to sequence databases and calculates the statistical significance. [Learn more](#)

**NEWS**

A new feature was added to the NCBI IgBLAST webpage  
IgBLAST is now able to determine Ig isotypes

Mon, 01 Nov 2021 12:00:00 EST [More BLAST news...](#)

**Web BLAST**

**Nucleotide BLAST** nucleotide ▶ nucleotide

**blastx** translated nucleotide ▶ protein

**tblastn** protein ▶ translated nucleotide

**Protein BLAST** protein ▶ protein

**BLAST Genomes**

Enter organism common name, scientific name, or tax id  **Search**

Human Mouse Rat Microbes

**Standalone and API BLAST**

**Download BLAST** Get BLAST databases and executables

**Use BLAST API** Call BLAST from your application

**Use BLAST in the cloud** Start an instance at a cloud provider

**Specialized searches**

Fig1. Homepage of BLAST

```
>sp|P02699|OPSD_BOVIN Rhodopsin OS=Bos taurus OX=9913 GN=RHO PE=1 SV=1
MNGTEGPNFYVPFSNKTGVVRSPFEAPQYYLAEPWQFSMLAAYMFLIMLGFPINFLTLY
VTQHQKKLRTPLNYILLNLAVADLFMVFGGFTTLYTSLHGYFVFGPTGCNLEGFFATLG
GEIALWSLVLAIERYVVVCKPMNSFRFGENHAIMGVAFTWVMALACAAPPLVGWSRYIP
EGMQCSCGIDYYTPHEETNNESFVIYMFVVFIIPLIVIFFCYGQLVFTVKEAAAQQQES
ATTQKAKEKEVTRMVIIMVIAFLICWLPHYAGVAFYIFTHQGSDFGPIFMTIPAFFAKTSAV
YNPVIYIMMINKQFRNCMVTTLCCGKNPLGDEASTTVSKTETSQVAPA
```

Fig2. FASTA sequence for Rhodopsin

U.S. National Library of Medicine  
National Center for Biotechnology Information

BLAST® » blastp suite

Standard Protein BLAST

blast blastx tblastn tblastx

Enter Query Sequence

Enter accession number(s), gil(s), or FASTA sequence(s)

From  To

Or, upload file

Job Title

Align two or more sequences

New columns added to the Description Table  
Click 'Select Columns' or 'Manage Columns'.

Choose Search Set

Database: Non-redundant protein sequences (nr)

Organism: Enter organism name or id - completions will be suggested   exclude

Exclude: Enter organism common name, binomial, or tax id. Only 20 top taxa will be shown.

Exclude: Models (XMP)  Non-redundant RefSeq proteins (WP)  Uncultured/environmental sample sequences

Program Selection

Algorithm:  Quick BLASTP (Accelerated protein-protein BLAST)  
 blastp (protein-protein BLAST)  
 PSI-BLAST (Position-Specific Iterated BLAST)  
 PHI-BLAST (Pattern Hit Initiated BLAST)  
 DELTA-BLAST (Domain Enhanced Lookup Time Accelerated BLAST)

BLAST   Show results in a new window

+ Algorithm parameters

Fig3. Search bar for PSI blast with sequence for rhodopsin taken from uniprot

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

Algorithm parameters

General Parameters

Max target sequences: 500  Select the maximum number of aligned sequences to display

Short queries:  Automatically adjust parameters for short input sequences

Expect threshold: 0.05

Word size: 3

Max matches in a query range: 0

Scoring Parameters

Matrix: BLOSUM62

Gap Costs: Existence: 11 Extension: 1

Compositional adjustments: Conditional compositional score matrix adjustment

Filters and Masking

Filter:  Low complexity regions   
 Mask for lookup table only   
 Mask lower case letters

PSI/PHI/DELTA BLAST

Upload PSSM:

PSI-BLAST Threshold: 0.005

Pseudocount: 0

BLAST   Show results in a new window

Support Center

Fig4. Algorithm parameters (General, Scoring, Filters, Masking)

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

Algorithm parameters

General Parameters

Max target sequences: 500  Select the maximum number of aligned sequences to display

Short queries:  Automatically adjust parameters for short input sequences

Expect threshold: 0.05

Word size: 3

Max matches in a query range: 0

Scoring Parameters

Matrix: BLOSUM62

Gap Costs: Existence: 11 Extension: 1

Compositional adjustments: Conditional compositional score matrix adjustment

Filters and Masking

Filter:  Low complexity regions

Mask:  Mask for lookup table only   Mask lower case letters

PSI/PHI/DELTA BLAST

Upload PSSM Optional: Choose File  No file chosen

PSI-BLAST Threshold: 0.005

Pseudocount: 0

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

Restore default search parameters

[Twitter](#) [Facebook](#) [YouTube](#) [LinkedIn](#) [Blog](#) [Support Center](#)

Fig5. Algorithm parameters for PSI/PHI/DELTA BLAST

NIH U.S. National Library of Medicine National Center for Biotechnology Information Log in

BLAST® » blastp suite » results for RID-S04D359T013

Home Recent Results Saved Strategies Help

Edit Search Save Search Search Summary  How to read this report?  BLAST Help Videos  Back to Traditional Results Page

Job Title: sp|P02699|OPSD\_BOVIN Rhodopsin OS=Bos taurus... RID: S04D359T013 Search expires on 11-03-00 11 am

Program: PSI-BLAST Iteration 1 [Citation](#)

Database: nr [See details](#)

Query ID: IclQuery\_27215

Description: sp|P02699|OPSD\_BOVIN Rhodopsin OS=Bos taurus OX...

Molecule type: amino acid

Query Length: 348

Other reports: [Distance tree of results](#) [Multiple alignment](#) [MSA viewer](#)

Filter Results

Organism: only top 20 will appear  exclude

Percent Identity:  to  E value:  to  Query Coverage:  to

PSI-BLAST incl. threshold: 0.0001

Run PSI-Blast iteration 2

Number of sequences: 500

Sequences producing significant alignments

500 sequences selected [GenPept](#) [Graphics](#) [Distance tree of results](#) [Multiple alignment](#) [MSA Viewer](#)

Sequences with E-value BETTER than threshold  select all 500 sequences selected

PSI-BLAST iteration 1

| Description   | Scientific Name  | Max Score | Total Score | Query Cover | E value | Per. Ident | Acc. Len | Accession      | Select for PSI blast                | Used to PSSM                        | Newly added |
|---|------------------|-----------|-------------|-------------|---------|------------|----------|----------------|-------------------------------------|-------------------------------------|-------------|
| <input checked="" type="checkbox"/> Structure of Bovine Rhodopsin in a Trigonal Crystal Form [Bos taurus] | Bos taurus       | 718       | 718         | 100%        | 0.0     | 100.00%    | 349      | 1GZM_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> rhodopsin [Bos taurus]  | Bos taurus       | 718       | 718         | 100%        | 0.0     | 100.00%    | 348      | NP_001014890.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> PREDICTED_rhodopsin [Bison bison bison]                               | Bison bison b... | 716       | 716         | 100%        | 0.0     | 99.43%     | 348      | XP_010866750.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> Rhodopsin [Bos taurus]  | Bos taurus       | 716       | 716         | 100%        | 0.0     | 99.43%     | 371      | ELP541922.1    | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |

Feedback

Fig6. Result page (header) for rhodopsin in PSI-BLAST

Descriptions Graphic Summary Alignments Taxonomy Number of sequences 500 Run

Sequences producing significant alignments Download New Select columns Show 500 ?

500 sequences selected GenPept Graphics Distance tree of results Multiple alignment New MSA Viewer

Sequences with E-value BETTER than threshold

select all 500 sequences selected

PSI-BLAST iteration 1

| Description   | Scientific Name   | Max Score | Total Score | Query Cover | E value | Per. Ident | Acc Len | Accession      | Selected for PSI blast              | Used to build Newly added PSSM      |
|---|-------------------|-----------|-------------|-------------|---------|------------|---------|----------------|-------------------------------------|-------------------------------------|
| Structure of Bovine Rhodopsin in a Trigonal Crystal Form [Bos taurus]                       | Bos taurus        | 718       | 718         | 100%        | 0.0     | 100.0%     | 349     | 1GZM_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| rhodopsin [Bos taurus]  | Bos taurus        | 718       | 718         | 100%        | 0.0     | 100.0%     | 348     | NP_001014890_1 | <input checked="" type="checkbox"/> |                                     |
| PREDICTED_rhodopsin [Bison bison bison]   | Bison bison bl... | 716       | 716         | 100%        | 0.0     | 99.43%     | 348     | XP_010866750_1 | <input checked="" type="checkbox"/> |                                     |
| Rhodopsin [Bos mutus]   | Bos mutus         | 716       | 716         | 100%        | 0.0     | 99.43%     | 351     | ELR51227_1     | <input checked="" type="checkbox"/> |                                     |
| PREDICTED_rhodopsin [Bos mutus]   | Bos mutus         | 715       | 715         | 100%        | 0.0     | 99.43%     | 348     | XP_005902896_1 | <input checked="" type="checkbox"/> |                                     |
| rhodopsin [Bos taurus]  | Bos taurus        | 712       | 712         | 100%        | 0.0     | 99.71%     | 347     | XP_011197A     | <input checked="" type="checkbox"/> |                                     |
| Crystal structure of a rhodopsin stabilizing mutant expressed in mammalian cells [Bos ta... | Bos taurus        | 711       | 711         | 100%        | 0.0     | 99.43%     | 349     | 2J4Y_A         | <input checked="" type="checkbox"/> |                                     |
| Chain A_Rhodopsin [unidentified]  | unidentified      | 711       | 711         | 100%        | 0.0     | 99.43%     | 348     | 3C9M_A         | <input checked="" type="checkbox"/> |                                     |
| Crystal Structure Of The Constitutively Active E113q N2c_D282c Rhodopsin Mutant With...     | Bos taurus        | 709       | 709         | 100%        | 0.0     | 99.14%     | 349     | 2X7Z_A         | <input checked="" type="checkbox"/> |                                     |
| rhodopsin [Bubalus bubalis]   | Bubalus bubalis   | 709       | 709         | 100%        | 0.0     | 98.85%     | 348     | XP_006078962_1 | <input checked="" type="checkbox"/> |                                     |
| Night blindness causing G90D rhodopsin in complex with GaC2 peptide [Bos taurus]            | Bos taurus        | 708       | 708         | 100%        | 0.0     | 99.14%     | 349     | 4BEY_A         | <input checked="" type="checkbox"/> |                                     |
| Crystal Structure of T94I rhodopsin mutant [Bos taurus]                                     | Bos taurus        | 708       | 708         | 100%        | 0.0     | 99.14%     | 349     | 5DYS_A         | <input checked="" type="checkbox"/> |                                     |
| Rhodopsin-Gi protein complex [Bos taurus]   | Bos taurus        | 708       | 708         | 100%        | 0.0     | 99.14%     | 348     | 6QNO_A         | <input checked="" type="checkbox"/> |                                     |
| Crystal structure of the light-activated constitutively active N2c_M257Y D282C rhodopsin    | Bos taurus        | 708       | 708         | 100%        | 0.0     | 99.14%     | 349     | 4A4M_A         | <input checked="" type="checkbox"/> |                                     |
| rhodopsin [Bos taurus]  | Bos taurus        | 705       | 705         | 98%         | 0.0     | 99.71%     | 343     | AAA30675_1     | <input checked="" type="checkbox"/> |                                     |
| rhodopsin [Ovis aries]  | Ovis aries        | 700       | 700         | 100%        | 0.0     | 97.41%     | 348     | XP_004018583_1 | <input checked="" type="checkbox"/> |                                     |
| rhodopsin [Oryx dammah]   | Oryx dammah       | 697       | 697         | 100%        | 0.0     | 96.55%     | 348     | XP_040102676_1 | <input checked="" type="checkbox"/> |                                     |
| hypothetical protein FD754_009314 [Muntiacus muntjak]                                       | Muntiacus mu...   | 696       | 696         | 100%        | 0.0     | 96.55%     | 348     | KAB0365158_1   | <input checked="" type="checkbox"/> |                                     |
| rhodopsin [Cervus canadensis]   | Cervus canad...   | 696       | 696         | 100%        | 0.0     | 96.26%     | 348     | XP_043298944_1 | <input checked="" type="checkbox"/> |                                     |
| rhodopsin [Odocoileus virginianus texanus]  | Odocoileus vi...  | 696       | 696         | 100%        | 0.0     | 95.98%     | 348     | XP_020728233_1 | <input checked="" type="checkbox"/> |                                     |
| PREDICTED_rhodopsin [Ceratotherium simum simum]   | Ceratotheriu...   | 694       | 694         | 100%        | 0.0     | 95.69%     | 348     | XP_004442481_1 | <input checked="" type="checkbox"/> |                                     |
| rhodopsin [Ursus maritimus]   | Ursus maritimus   | 691       | 691         | 100%        | 0.0     | 95.11%     | 348     | XP_008659609_2 | <input checked="" type="checkbox"/> |                                     |
| RecName_Full_Rhodopsin [Ovis aries]   | Ovis aries        | 691       | 691         | 100%        | 0.0     | 96.26%     | 348     | P02700_2       | <input checked="" type="checkbox"/> |                                     |

Feedback

Fig7. Description for query Rhodopsin in PSI-BLAST

Descriptions Graphic Summary Alignments Taxonomy Number of sequences 500 Run

Alignment view Pairwise Download ?

500 sequences selected

Download GenPept Graphics

Structure of Bovine Rhodopsin in a Trigonal Crystal Form [Bos taurus]

Sequence ID: 1GZM\_A Length: 349 Number of Matches: 1

See 23 more title(s) ▾ See all Identical Proteins(IPG)

Range 1: 2 to 349 GenPept Graphics ▾ Next Match ▾ Previous Match

| Score          | Expect  | Method                       | Identities    | Positives     | Gaps      |
|----------------|---|------------------------------|---------------|---------------|-----------|
| 718 bits(1854) | 0.0   | Compositional matrix adjust. | 348/348(100%) | 348/348(100%) | 0/348(0%) |
| Query 1        | MNGTEGPNEYVPFSNKTGVRSPFEEAPQQYLAEPWQFSMLAAYMFLLLIMLGFPINF       | 60                           |               |               |           |
| Sbjct 2        | MNGTEGPNEYVPFSNKTGVRSPFEEAPQQYLAEPWQFSMLAAYMFLLLIMLGFPINF       | 61                           |               |               |           |
| Query 61       | VTVHKHLRPLNLVLLNLAVALDLMVFGFTTLYLISLHGVYVFGPTCNELEGFA           | 120                          |               |               |           |
| Sbjct 121      | VTVHKHLRPLNLVLLNLAVALDLMVFGFTTLYLISLHGVYVFGPTCNELEGFA           | 121                          |               |               |           |
| Query 121      | GEIALISLVLVLAITERVVVCKPMSHFRFGENHAI1MGVAFTNWMLACAAAPPVLGVNSRYIP | 180                          |               |               |           |
| Sbjct 122      | GEIALISLVLVLAITERVVVCKPMSHFRFGENHAI1MGVAFTNWMLACAAAPPVLGVNSRYIP | 181                          |               |               |           |
| Query 181      | EGMOCSSGIDYVTPHEETNIESV1VYMFVVFHIIPL1V1FFCYGQLVFTVKEAAQOQES     | 240                          |               |               |           |
| Sbjct 182      | EGMOCSSGIDYVTPHEETNIESV1VYMFVVFHIIPL1V1FFCYGQLVFTVKEAAQOQES     | 241                          |               |               |           |
| Query 241      | ATTQAKEEVTRMIVNIAFLICMLPVAGYAVFYIFTHQGSDGFPINFTIPAAFFAKTS       | 300                          |               |               |           |
| Sbjct 242      | ATTQAKEEVTRMIVNIAFLICMLPVAGYAVFYIFTHQGSDGFPINFTIPAAFFAKTS       | 301                          |               |               |           |
| Query 301      | YIPVYIIMMKQFRCNCWTTLCCGKPLGDEA5TTSKTTETSQVAPA                   | 348                          |               |               |           |
| Sbjct 302      | YIPVYIIMMKQFRCNCWTTLCCGKPLGDEA5TTSKTTETSQVAPA                   | 349                          |               |               |           |

Download GenPept Graphics ▾ Next ▾ Previous ▾ Descriptions

rhodopsin [Bos taurus]

Sequence ID: NP\_001014890\_1 Length: 348 Number of Matches: 1

See 35 more title(s) ▾ See all Identical Proteins(IPG)

Range 1: 1 to 348 GenPept Graphics ▾ Next Match ▾ Previous Match

| Score          | Expect  | Method                       | Identities    | Positives     | Gaps      |
|----------------|---|------------------------------|---------------|---------------|-----------|
| 718 bits(1854) | 0.0   | Compositional matrix adjust. | 348/348(100%) | 348/348(100%) | 0/348(0%) |
| Query 1        | MNGTEGPNEYVPFSNKTGVRSPFEEAPQQYLAEPWQFSMLAAYMFLLLIMLGFPINF   | 60                           |               |               |           |
| Sbjct 1        | MNGTEGPNEYVPFSNKTGVRSPFEEAPQQYLAEPWQFSMLAAYMFLLLIMLGFPINF   | 61                           |               |               |           |
| Query 1        | EGMOCSSGIDYVTPHEETNIESV1VYMFVVFHIIPL1V1FFCYGQLVFTVKEAAQOQES | 240                          |               |               |           |
| Sbjct 1        | EGMOCSSGIDYVTPHEETNIESV1VYMFVVFHIIPL1V1FFCYGQLVFTVKEAAQOQES | 241                          |               |               |           |
| Query 1        | ATTQAKEEVTRMIVNIAFLICMLPVAGYAVFYIFTHQGSDGFPINFTIPAAFFAKTS   | 300                          |               |               |           |
| Sbjct 1        | ATTQAKEEVTRMIVNIAFLICMLPVAGYAVFYIFTHQGSDGFPINFTIPAAFFAKTS   | 301                          |               |               |           |
| Query 1        | YIPVYIIMMKQFRCNCWTTLCCGKPLGDEA5TTSKTTETSQVAPA               | 348                          |               |               |           |
| Sbjct 1        | YIPVYIIMMKQFRCNCWTTLCCGKPLGDEA5TTSKTTETSQVAPA               | 349                          |               |               |           |

Related Information

Gene - associated gene details

Structure - 3D structure displays

Feedback

Fig8. Alignments for query Rhodopsin in PSI-BLAST

| Descriptions   |                     | Graphic Summary |                | Alignments                          |  | Taxonomy |  | Number of sequences 500 |  | Run |  |  |  |  |  |  |  |
|--|---------------------|-----------------|----------------|-------------------------------------|--|----------|--|-------------------------|--|-----|--|--|--|--|--|--|--|
| Reports  |                     | Lineage         |                | Organism                            |  | Taxonomy |  |                         |  |     |  |  |  |  |  |  |  |
| 500 sequences selected ?                                     |                     |                 |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| Organism   | Blast Name          | Score           | Number of Hits | Description                         |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| root   | vertebrates         | 845             |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . Euteleostomi   | vertebrates         | 834             |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . Digenetrapodomorpha                                      | vertebrates         | 831             |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . Tetrapoda  | vertebrates         | 830             |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . Amniota  | vertebrates         | 819             |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . Mammalia   | mammals             | 399             |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . Theria   | mammals             | 395             |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . Eutheria                                       | placentals          | 384             |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . Boreoeutheria                                | placentals          | 371             |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . Laurasiatheria                             | placentals          | 257             |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . Artiodactyla                             | even-toed ungulates | 103             |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . Pecora                                 | even-toed ungulates | 68              |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . Bovidae                                | even-toed ungulates | 61              |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . Bovinae                              | even-toed ungulates | 56              |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . Bos                                | even-toed ungulates | 54              |                |                                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . Bos taurus                       | even-toed ungulates | 718             | 49             | Bos taurus hits                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Bos indicus                    | even-toed ungulates | 718             | 1              | Bos indicus hits                    |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Bos indicus x Bos taurus       | even-toed ungulates | 718             | 1              | Bos indicus x Bos taurus hits       |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Bos mutus                      | even-toed ungulates | 716             | 3              | Bos mutus hits                      |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Bison bison bison              | even-toed ungulates | 716             | 1              | Bison bison bison hits              |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Bubalus bubalis                | even-toed ungulates | 709             | 1              | Bubalus bubalis hits                |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Ovis aries                     | even-toed ungulates | 700             | 3              | Ovis aries hits                     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Capra hircus                   | even-toed ungulates | 700             | 1              | Capra hircus hits                   |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Oryx dammah                    | even-toed ungulates | 697             | 1              | Oryx dammah hits                    |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Muntiacus muntjak              | even-toed ungulates | 696             | 1              | Muntiacus muntjak hits              |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Muntiacus reevesi              | even-toed ungulates | 696             | 1              | Muntiacus reevesi hits              |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Cervus canadensis              | even-toed ungulates | 696             | 1              | Cervus canadensis hits              |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Cervus elaphus                 | even-toed ungulates | 696             | 1              | Cervus elaphus hits                 |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Cervus elaphus yarkandensis    | even-toed ungulates | 696             | 1              | Cervus elaphus yarkandensis hits    |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Odocoileus virginianus texanus | even-toed ungulates | 696             | 1              | Odocoileus virginianus texanus hits |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Cervus elaphus hippelaphus     | even-toed ungulates | 621             | 1              | Cervus elaphus hippelaphus hits     |  |          |  |                         |  |     |  |  |  |  |  |  |  |
| . . . . . . . . . . . . . . . Monodon monoceros              | whales & dolphins   | 679             | 2              | Monodon monoceros hits              |  |          |  |                         |  |     |  |  |  |  |  |  |  |

Fig9. Taxonomy for Rhodopsin in PSI-BLAST

| NIH U.S. National Library of Medicine National Center for Biotechnology Information                             |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
|---|---|-------------|--|----------------------------------|--------------|---|-----------------------|---------------|--|-------------------------------------|-------------|--|--|--|--|--|
| BLAST® » blast suite » results for RID-S04KTK64016  |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| Edit Search   |   | Save Search |  | Search Summary                   |              | How to read this report? BLAST Help Videos Back to Traditional Results Page |                       |               |  |                                     |             |  |  |  |  |  |
| Job Title   | sp P02699 OPSD_BOVIN Rhodopsin OS=Bos taurus... | RID         | S04KTK64016  | Search expires on 11-03 00:14 am | Download All | Program   | PSI-BLAST Iteration 2 | Citation      | Database   | nr                                  | See details |  |  |  |  |  |
| Query ID  | Icl Query_27215                                 | Description | sp P02699 OPSD_BOVIN Rhodopsin OS=Bos taurus OX... | Molecule type                    | amino acid   | Query Length  | 348                   | Other reports | Distance tree of results Multiple alignment MSA viewer |                                     |             |  |  |  |  |  |
| Filter Results  |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| Organism only top 20 will appear <input type="checkbox"/> exclude   |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| Type common name, binomial, taxid or group name   |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| + Add organism  |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| Percent Identity  |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| E value   |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| Query Coverage  |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| PSI-BLAST incl.   |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| threshold   |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| 0.0001  |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| Run PSI-BLAST iteration 3   |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| Descriptions  | Graphic Summary                                 | Alignments  | Taxonomy   | Number of sequences              | 500          | Run   |                       |               |  |                                     |             |  |  |  |  |  |
| Sequences producing significant alignments  |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| Download Select columns Show 500  |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| 500 sequences selected 0 sequences newly added this iteration   |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| GenPept Graphics Distance tree of results Multiple alignment MSA Viewer   |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| Sequences with E-value BETTER than threshold  |   |             |  |                                  |              |   |                       |               |  |                                     |             |  |  |  |  |  |
| Select all 500 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                  | Newly added |  |  |  |  |  |
| rhodopsin [Microtus ochrogaster]  | Microtus ochr...                                | 695         | 695  | 98%                              | 0.0          | 92.15%  | 723                   | KAH0519671_1  | <input checked="" type="checkbox"/>                    | <input checked="" type="checkbox"/> |             |  |  |  |  |  |
| Crystal structure of rhodopsin bound to arrestin by femtosecond X-ray laser [Mus musculus]                      | Mus musculus                                    | 675         | 675  | 99%                              | 0.0          | 92.51%  | 906                   | 4ZVU_A        | <input checked="" type="checkbox"/>                    | <input checked="" type="checkbox"/> |             |  |  |  |  |  |
| Crystal structure of rhodopsin bound to visual arrestin determined by X-ray free electron ... [Enterobacteri... | Enterobacteri...                                | 673         | 673  | 99%                              | 0.0          | 92.22%  | 906                   | 5WDP_C        | <input checked="" type="checkbox"/>                    | <input checked="" type="checkbox"/> |             |  |  |  |  |  |
| Crystal structure of rhodopsin bound to visual arrestin determined by X-ray free electron ... [Enterobacteri... | Enterobacteri...                                | 672         | 672  | 99%                              | 0.0          | 91.03%  | 906                   | 5WDP_A        | <input checked="" type="checkbox"/>                    | <input checked="" type="checkbox"/> |             |  |  |  |  |  |

Fig10. Result page for Iteration 1

| Run PSI-BLAST Iteration 3 with max number of sequences [ 500 ]   |                    |     |     |      |     |        |     |                                |  | Run |
|--|--------------------|-----|-----|------|-----|--------|-----|--------------------------------|--|-----|
| ✓ <a href="#">rhodopsin 1 [Sinomicrurus japonicus boettgeri]</a> | Sinomicrurus...    | 610 | 610 | 100% | 0.0 | 81.25% | 352 | <a href="#">BCF80145.1</a>     |  |     |
| ✓ <a href="#">rhodopsin 1 [Latilacerta colubrina]</a>            | Latilacerta col... | 610 | 610 | 100% | 0.0 | 81.53% | 352 | <a href="#">BCF80149.1</a>     |  |     |
| ✓ <a href="#">Rhodopsin [Tinamus guttatum]</a>                   | Tinamus gutta...   | 610 | 610 | 97%  | 0.0 | 87.32% | 350 | <a href="#">KGL82536.1</a>     |  |     |
| ✓ <a href="#">rhodopsin [Thamnophis proximus]</a>                | Thamnophis...      | 610 | 610 | 100% | 0.0 | 81.25% | 352 | <a href="#">ALX35611.1</a>     |  |     |
| ✓ <a href="#">rhodopsin [Rhinatremma blivittatum]</a>            | Rhinatremma bli... | 610 | 610 | 97%  | 0.0 | 82.75% | 354 | <a href="#">XP_029453475.1</a> |  |     |
| ✓ <a href="#">rod visual pigment [Arizona elegans]</a>           | Arizona elegan...  | 610 | 610 | 100% | 0.0 | 81.25% | 352 | <a href="#">AMD82575.1</a>     |  |     |
| ✓ <a href="#">rod opsin [Melopsittacus undulatus]</a>            | Melopsittacus...   | 610 | 610 | 97%  | 0.0 | 85.55% | 351 | <a href="#">AAC41247.1</a>     |  |     |
| ✓ <a href="#">rhodopsin [Eygascalops antarcticus]</a>            | Eygascalops an...  | 610 | 610 | 97%  | 0.0 | 84.96% | 351 | <a href="#">KAF1488653.1</a>   |  |     |
| ✓ <a href="#">PREDICTED: rhodopsin [Aptenodytes forsteri]</a>    | Aptenodytes fo...  | 610 | 610 | 96%  | 0.0 | 85.37% | 353 | <a href="#">XP_009282077.1</a> |  |     |
| ✓ <a href="#">PREDICTED: rhodopsin [Thamnophis sirtalis]</a>     | Thamnophis s...    | 609 | 609 | 100% | 0.0 | 80.97% | 352 | <a href="#">XP_013914613.1</a> |  |     |
| ✓ <a href="#">rhodopsin [Macroscelides proboscideus]</a>         | Macroscelide...    | 609 | 609 | 94%  | 0.0 | 91.77% | 328 | <a href="#">ADB45247.1</a>     |  |     |
| ✓ <a href="#">rhodopsin 1 [Hydrophis platirhinos]</a>            | Hydrophis pla...   | 609 | 609 | 100% | 0.0 | 82.67% | 352 | <a href="#">BCF80151.1</a>     |  |     |
| ✓ <a href="#">rhodopsin 1 [Aleyuraura mosiacus]</a>              | Aleyuraura mo...   | 609 | 609 | 100% | 0.0 | 82.39% | 352 | <a href="#">QKK13243.1</a>     |  |     |
| ✓ <a href="#">rhodopsin [Rhinolophus pusillus]</a>               | Rhinolophus...     | 609 | 609 | 94%  | 0.0 | 92.38% | 328 | <a href="#">ADB45231.1</a>     |  |     |
| ✓ <a href="#">rhodopsin [Pantherophis guttatus]</a>              | Pantherophis...    | 609 | 609 | 100% | 0.0 | 81.53% | 352 | <a href="#">XP_034287482.1</a> |  |     |
| ✓ <a href="#">rhodopsin Freshwater form [Polyodon spathula]</a>  | Polyodon spa...    | 609 | 609 | 98%  | 0.0 | 82.46% | 353 | <a href="#">XP_041130833.1</a> |  |     |
| ✓ <a href="#">rhodopsin 1 [Hydrophis peronii]</a>                | Hydrophis per...   | 609 | 609 | 100% | 0.0 | 82.39% | 352 | <a href="#">QKK13266.1</a>     |  |     |
| ✓ <a href="#">unnamed protein product [Ranitomeya imitator]</a>  | Ranitomeya i...    | 609 | 609 | 98%  | 0.0 | 81.92% | 354 | <a href="#">CAF4984554.1</a>   |  |     |
| ✓ <a href="#">visual pigment [Cynops pyrrhogaster]</a>           | Cynops pyrr...     | 608 | 608 | 98%  | 0.0 | 83.09% | 354 | <a href="#">BAB55452.1</a>     |  |     |
| ✓ <a href="#">rhodopsin [Mauremys reevesii]</a>                  | Mauremys re...     | 608 | 608 | 97%  | 0.0 | 83.87% | 352 | <a href="#">XP_039403751.1</a> |  |     |
| ✓ <a href="#">rod visual pigment [Hypsilema janii]</a>           | Hypsilema jan...   | 608 | 608 | 100% | 0.0 | 82.67% | 352 | <a href="#">AMD82576.1</a>     |  |     |
| ✓ <a href="#">rhodopsin [Hypsilema tortugae]</a>                 | Hypsilema to...    | 608 | 608 | 100% | 0.0 | 82.39% | 352 | <a href="#">AWC68091.1</a>     |  |     |
| ✓ <a href="#">fresh water rod opsin [Anguilla australis]</a>     | Anguilla austr...  | 608 | 608 | 98%  | 0.0 | 84.55% | 352 | <a href="#">ASK09485.1</a>     |  |     |
| ✓ <a href="#">freshwater form rhodopsin [Anguilla japonica]</a>  | Anguilla japon...  | 608 | 608 | 98%  | 0.0 | 85.42% | 352 | <a href="#">BBJ55013.1</a>     |  |     |
| ✓ <a href="#">rhodopsin [Probatochthys microsquamatus]</a>       | Probatochthys...   | 607 | 607 | 100% | 0.0 | 81.53% | 352 | <a href="#">XP_015678958.1</a> |  |     |
| ✓ <a href="#">rhodopsin Freshwater form [Anguilla anguilla]</a>  | Anguilla anguilla  | 607 | 607 | 98%  | 0.0 | 85.42% | 352 | <a href="#">XP_035239401.1</a> |  |     |
| ✓ <a href="#">rhodopsin [Acipenser ruthenus]</a>                 | Acipenser rut...   | 607 | 607 | 98%  | 0.0 | 82.46% | 353 | <a href="#">XP_033876574.1</a> |  |     |

**Fig11. Newly added sequences in iteration 1**

BLAST® » blastp suite » results for RID-S04TMMDX016

[Edit Search](#) [Save Search](#) [Search Summary](#)

How to read this report? [BLAST Help Videos](#) [Back to Traditional Results Page](#)

Job Title: sp|P02699|OPSD\_BOVIN Rhodopsin OS=Bos taurus...

RID: [S04TMMDX016](#) Search expires on 11-03 00 17 am [Download All](#)

Program: PSI-BLAST Iteration 3 [Citation](#)

Database: nr [See details](#)

Query ID: lcl|Query\_27215

Description: sp|P02699|OPSD\_BOVIN Rhodopsin OS=Bos taurus OX...

Molecule type: amino acid

Query Length: 348

Other reports: [Distance tree of results](#) [Multiple alignment](#) [MSA viewer](#)

**Filter Results**

**Organism** only top 20 will appear  exclude

Type common name, binomial, taxid or group name

+ Add organism

**Percent Identity**  to  **E value**  to  **Query Coverage**  to

PSI-BLAST incl. threshold  0.0001 [Filter](#) [Reset](#)

**Run PSI-Blast iteration 4**

Number of sequences: 500 [Run](#)

**Descriptions** Graphic Summary Alignments Taxonomy

Sequences producing significant alignments

500 sequences selected   sequences newly added this iteration [?](#)

Download [Select columns](#) Show 500 [?](#)

GenPept Graphics Distance tree of results Multiple alignment [MSA Viewer](#)

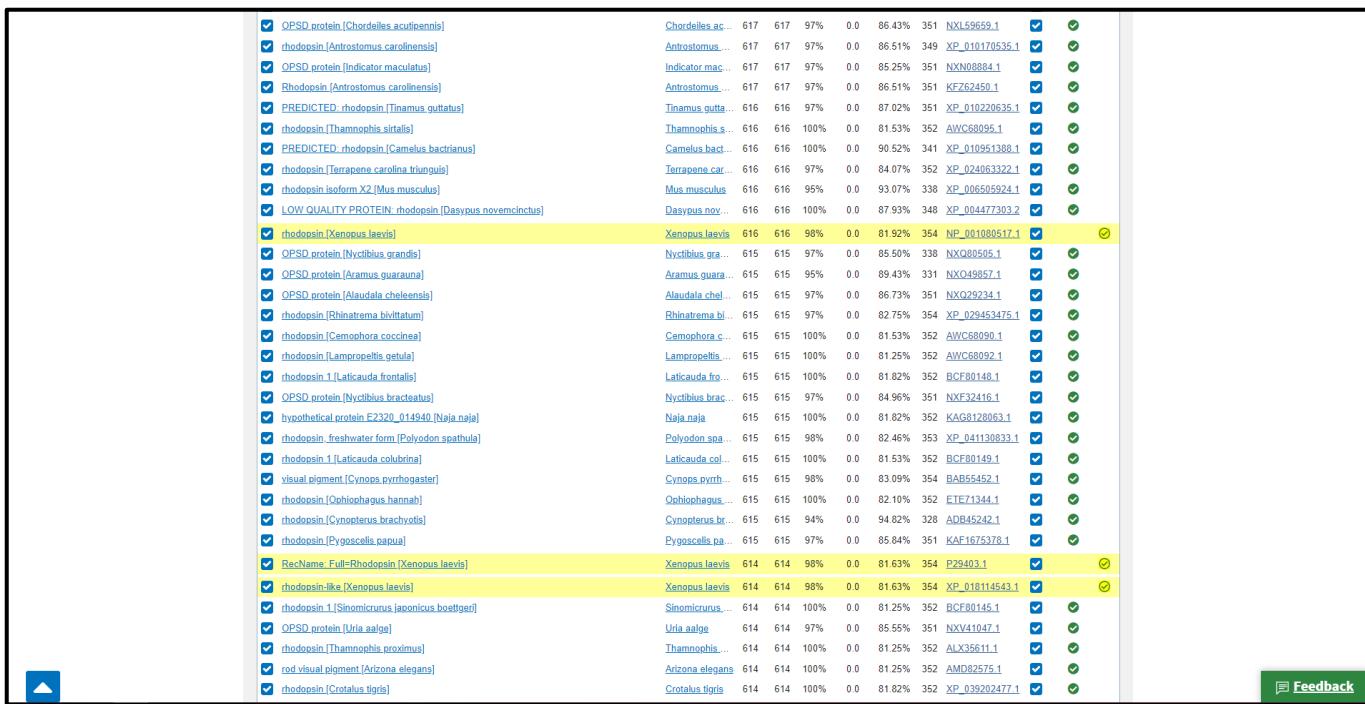
Sequences with E-value BETTER than threshold

select all 500 sequences selected [Skip to the first new sequence](#)

PSI-BLAST iteration 3

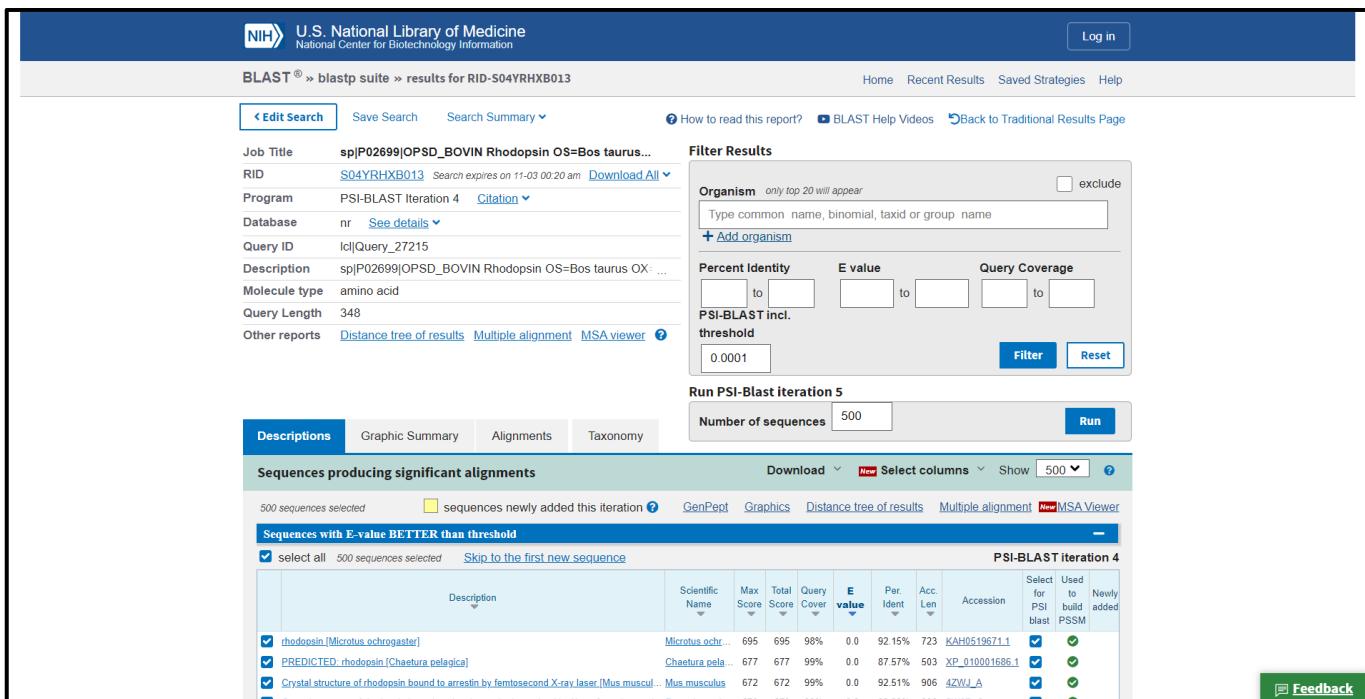
| Description  | Scientific Name  | Max Score | Total Score | Query Cover | E value | Per. Ident | Acc. Len | Accession      | Select for PSI blast                | Used to build PSSM                  | Newly added |
|--|------------------|-----------|-------------|-------------|---------|------------|----------|----------------|-------------------------------------|-------------------------------------|-------------|
| <input checked="" type="checkbox"/> rhodopsin [Microtus ochrogaster]   | Microtus ochr... | 696       | 696         | 98%         | 0.0     | 92.15%     | 723      | KAH0519671_1   | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> PREDICTED:rhodopsin [Chaetura pelasgica]   | Chaetura pels... | 675       | 675         | 99%         | 0.0     | 87.57%     | 503      | XP_010001686_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> Crystal structure of rhodopsin bound to arrestin by femtosecond X-ray laser [Mus musculus] | Mus musculus     | 674       | 674         | 99%         | 0.0     | 92.51%     | 906      | 4ZWJ_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |

## Fig12. Result page for Iteration 2



|  |                            |     |     |      |     |        |     |                 |                                     |                                     |
|--|----------------------------|-----|-----|------|-----|--------|-----|-----------------|-------------------------------------|-------------------------------------|
| <input checked="" type="checkbox"/> QPSD_protein [Chordeliae acipenseris]                | Chordeliae_ac...           | 617 | 617 | 97%  | 0.0 | 86.43% | 351 | NXL59659_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin [Antrostomus carolinensis]                 | Antrostomus_c...           | 617 | 617 | 97%  | 0.0 | 86.51% | 349 | XP_010170535_1  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> QPSD_protein [Indicator maculatus]                   | Indicator_mac...           | 617 | 617 | 97%  | 0.0 | 85.25% | 351 | NXN08841_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> Rhodopsin [Antrostomus carolinensis]                 | Antrostomus_c...           | 617 | 617 | 97%  | 0.0 | 86.51% | 351 | KF262450_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> PREDICTED_rhodopsin [Tinamus guttatus]               | Tinamus_gutta...           | 616 | 616 | 97%  | 0.0 | 87.02% | 351 | XP_010220635_1  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin [Thamnocephalus sirtalis]                  | Thamnocephalus_s...        | 616 | 616 | 100% | 0.0 | 81.53% | 352 | AWC68095_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> PREDICTED_rhodopsin [Camelus bactrianus]             | Camelus_bact...            | 616 | 616 | 100% | 0.0 | 90.52% | 341 | XP_010951388_1  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin [Terrapene carolina trilineata]            | Terrapene_car...           | 616 | 616 | 97%  | 0.0 | 84.07% | 352 | XP_024063322_1  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin isoform X2 [Mus musculus]                  | Mus_musculus...            | 616 | 616 | 95%  | 0.0 | 93.07% | 338 | XP_006505924_1  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> LOW QUALITY PROTEIN_rhodopsin [Dasypus novemcinctus] | Dasypus_nove...            | 616 | 616 | 100% | 0.0 | 87.93% | 348 | XP_004477302_2  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin [Xenopus laevis]                           | Xenopus_laevis...          | 616 | 616 | 98%  | 0.0 | 81.92% | 354 | NP_0010800517_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> QPSD_protein [Nyctibus grandis]                      | Nyctibus_gran...           | 615 | 615 | 97%  | 0.0 | 85.50% | 338 | NXQ88505_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> QPSD_protein [Aramus guarauna]                       | Aramus_guara...            | 615 | 615 | 95%  | 0.0 | 89.43% | 331 | NXQ49857_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> QPSD_protein [Alaudala cheleensis]                   | Alaudala_chel...           | 615 | 615 | 97%  | 0.0 | 86.73% | 351 | NXQ29234_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin [Rhinatremabivittatum]                     | Rhinatremabiv...           | 615 | 615 | 97%  | 0.0 | 82.75% | 354 | XP_029453475_1  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin [Cemophora coccinea]                       | Cemophora_c...             | 615 | 615 | 100% | 0.0 | 81.53% | 352 | AWC68090_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin [Lampropeltis getula]                      | Lampropeltis_g...          | 615 | 615 | 100% | 0.0 | 81.25% | 352 | AWC68092_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin 1 [Latilauda frontalis]                    | Latilauda_fron...          | 615 | 615 | 100% | 0.0 | 81.02% | 352 | BCF80148_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> QPSD_protein [Nyctibus bracteatus]                   | Nyctibus_brac...           | 615 | 615 | 97%  | 0.0 | 84.96% | 351 | NXF32416_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> hypothetical protein E2320_014940 [Naja naja]        | Naja_naja...               | 615 | 615 | 100% | 0.0 | 81.82% | 352 | KAG8128063_1    | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin [freshwater form Polyodon spathula]        | Polyodon_spat...           | 615 | 615 | 98%  | 0.0 | 82.46% | 353 | XP_041130833_1  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin 1 [Latilauda colubrina]                    | Latilauda_col...           | 615 | 615 | 100% | 0.0 | 81.53% | 352 | BCF80149_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> visual pigment [Cynops cyrnochaster]                 | Cynops_cyrn...             | 615 | 615 | 98%  | 0.0 | 83.09% | 354 | BAB55452_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin [Ophiophagus hannah]                       | Ophiophagus_h...           | 615 | 615 | 100% | 0.0 | 82.10% | 352 | ETE71344_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin [Cynopterus brachyotis]                    | Cynopterus_br...           | 615 | 615 | 94%  | 0.0 | 94.82% | 328 | ADB45242_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin [Pygoscelis papua]                         | Pygoscelis_pa...           | 615 | 615 | 97%  | 0.0 | 85.84% | 351 | KAF1675378_1    | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> RecName_Full=Rhodopsin [Xenopus laevis]              | Xenopus_laevis...          | 614 | 614 | 98%  | 0.0 | 81.63% | 354 | P29403_1        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin-like [Xenopus laevis]                      | Xenopus_laevis...          | 614 | 614 | 98%  | 0.0 | 81.63% | 354 | XP_018114543_1  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin 1 [Sinomicrurus japonicus boettgeri]       | Sinomicrurus_j...          | 614 | 614 | 100% | 0.0 | 81.25% | 352 | BCF80145_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> QPSD_protein [Uria aalge]                            | Uria_aalge...              | 614 | 614 | 97%  | 0.0 | 85.55% | 351 | NXV41047_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin [Thamnocephalus proximus]                  | Thamnocephalus_proximus... | 614 | 614 | 100% | 0.0 | 81.25% | 352 | ALX35611_1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rod visual pigment [Arizona elegans]                 | Arizona_elegans...         | 614 | 614 | 100% | 0.0 | 81.25% | 352 | AMD082575_1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> rhodopsin [Crotalus tigris]                          | Crotalus_tigris...         | 614 | 614 | 100% | 0.0 | 81.82% | 352 | XP_039202477_1  | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |

Fig13. Newly found sequences in Iteration 2



U.S. National Library of Medicine  
National Center for Biotechnology Information

Log in

BLAST® » blastp suite » results for RID-S04YRHXB013

Home Recent Results Saved Strategies Help

Edit Search Save Search Search Summary

How to read this report? BLAST Help Videos Back to Traditional Results Page

Job Title: sp|P02699|QPSD\_BOVIN Rhodopsin OS=Bos taurus...

RID: S04YRHXB013 Search expires on 11-03 00:20 am Download All

Program: PSI-BLAST Iteration 4 Citation

Database: nr See details

Query ID: lclQuery\_27215

Description: sp|P02699|QPSD\_BOVIN Rhodopsin OS=Bos taurus OX...

Molecule type: amino acid

Query Length: 348

Other reports: Distance tree of results Multiple alignment MSA viewer

Filter Results

Organism: only top 20 will appear  exclude

Type common name, binomial, taxid or group name

+ Add organism

Percent Identity: [ ] to [ ] E value: [ ] to [ ] Query Coverage: [ ] to [ ]

PSI-BLAST incl. threshold: 0.0001 Filter Reset

Run PSI-BLAST iteration 5

Number of sequences: 500 Run

Sequences producing significant alignments

Download Select columns Show 500

500 sequences selected sequences newly added this iteration Skip to the first new sequence

GenPept Graphics Distance tree of results Multiple alignment MSA Viewer

Sequences with E-value BETTER than threshold

select all 500 sequences selected Skip to the first new sequence

PSI-BLAST iteration 4

| Description  | Scientific Name  | Max Score | Total Score | Query Cover | E value | Per. Ident. | Acc. Len | Accession      | Select for PSI blast                | Used to PSSM                        | Newly added |
|--|------------------|-----------|-------------|-------------|---------|-------------|----------|----------------|-------------------------------------|-------------------------------------|-------------|
| <input checked="" type="checkbox"/> rhodopsin [Microtus ochrogaster]   | Microtus_ochr... | 695       | 695         | 98%         | 0.0     | 92.15%      | 723      | KAH0519671_1   | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> PREDICTED_rhodopsin [Chaetura pelasgus]  | Chaetura_pela... | 677       | 677         | 99%         | 0.0     | 87.57%      | 503      | XP_010001686_1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |
| <input checked="" type="checkbox"/> Crystal structure of rhodopsin bound to arrestin by femtosecond X-ray laser [Mus musculus] | Mus_musculus...  | 672       | 672         | 99%         | 0.0     | 92.51%      | 906      | 4ZVJ_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |             |

Fig14. Result page for Iteration 3

Run PSI-BLAST Iteration 5 with max number of sequences  **Run**

**Fig15. Newly found sequences in Iteration 3**

**Fig16. Result page for iteration 4**

Run PSI-BLAST Iteration 6 with max number of sequences  **Run**

|   |                   |     |     |      |     |        |     |                |                                     |                                     |
|---|-------------------|-----|-----|------|-----|--------|-----|----------------|-------------------------------------|-------------------------------------|
| <input checked="" type="checkbox"/> <a href="#">rhodopsin [Thamnophis proximus]</a>               | Thamnophis ...    | 612 | 612 | 100% | 0.0 | 81.25% | 352 | ALX35611.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">PREDICTED: rhodopsin [Thamnophis sirtalis]</a>    | Thamnophis s...   | 612 | 612 | 100% | 0.0 | 80.97% | 352 | XP_013914613.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rod visual pigment [Arizona elegans]</a>          | Arizona elegans   | 612 | 612 | 100% | 0.0 | 81.25% | 352 | AMT082575.1    | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin isoform X2 [Mus musculus]</a>           | Mus musculus      | 612 | 612 | 95%  | 0.0 | 93.07% | 338 | XP_006505924.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin-like [Xenopus laevis]</a>               | Xenopus laevis    | 612 | 612 | 98%  | 0.0 | 81.63% | 354 | XP_018114543.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">PREDICTED: rhodopsin [Camelus bactrianus]</a>     | Camelus bact...   | 612 | 612 | 100% | 0.0 | 90.52% | 341 | XP_010951388.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin 1 [Hydrophis platensis]</a>             | Hydrophis pla...  | 611 | 611 | 100% | 0.0 | 82.67% | 352 | BCF80151.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">RecName: Full-Rhodopsin [Xenopus laevis]</a>      | Xenopus laevis    | 611 | 611 | 98%  | 0.0 | 81.63% | 354 | P29403.1       | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin 1 [Aleyurus mosaceus]</a>               | Aleyurus mo...    | 611 | 611 | 100% | 0.0 | 82.9%  | 352 | QKK13243.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin [Pantherophis guttatus]</a>             | Pantherophis ...  | 611 | 611 | 100% | 0.0 | 81.53% | 352 | XP_034287482.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin 1 [Hydrophis peronii]</a>               | Hydrophis per...  | 611 | 611 | 100% | 0.0 | 82.39% | 352 | QKK13266.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin-like [Xenopus laevis]</a>               | Xenopus laevis    | 611 | 611 | 98%  | 0.0 | 82.22% | 354 | XP_018116851.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin [Mauremys reevesii]</a>                 | Mauremys re...    | 611 | 611 | 97%  | 0.0 | 83.48% | 352 | XP_039403751.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin [Xenopus tropicalis]</a>                | Xenopus trop...   | 611 | 611 | 98%  | 0.0 | 81.92% | 354 | NP_001090803.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin [Bufo gargarizans]</a>                  | Bufo gargariz...  | 611 | 611 | 98%  | 0.0 | 82.51% | 354 | XP_044157448.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin freshwater form [Polyodon spathula]</a> | Polyodon spa...   | 610 | 610 | 98%  | 0.0 | 82.46% | 353 | XP_041130833.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin [Bufo bufo]</a>                         | Bufo bufo         | 610 | 610 | 98%  | 0.0 | 82.22% | 354 | XP_040264312.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin [Cyprinus brachyotis]</a>               | Cyprinus br...    | 610 | 610 | 94%  | 0.0 | 94.82% | 328 | ABR45242.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rod visual pigment [Hypsilema janii]</a>          | Hypsilema jan...  | 609 | 609 | 100% | 0.0 | 82.67% | 352 | AMD82576.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin [Hypsilema torquata]</a>                | Hypsilema to...   | 609 | 609 | 100% | 0.0 | 82.39% | 352 | AWC8891.1      | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin [Proboscithrops microscoumatus]</a>     | Proboscithrops... | 609 | 609 | 100% | 0.0 | 81.53% | 352 | XP_015678958.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin [Pseudonaja textilis]</a>               | Pseudonaja t...   | 609 | 609 | 100% | 0.0 | 80.97% | 352 | XP_026578966.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> <a href="#">rhodopsin [Aciapenser ruthenus]</a>               | Aciapenser rut... | 609 | 609 | 98%  | 0.0 | 82.46% | 353 | XP_033876574.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |

Support Center

National Center for Biotechnology

Popular Resources Actions Feedback

Fig17. Newly found sequences in Iteration 4

U.S. National Library of Medicine  
National Center for Biotechnology Information

Log in

BLAST® » blastp suite » results for RID-S05AP0M5013

How to read this report? [BLAST Help Videos](#) [Back to Traditional Results Page](#)

**Filter Results**

Organism: only top 20 will appear  exclude  
Type common name, binomial, taxid or group name  
+ Add organism

Percent identity:  to  E value:  to  Query Coverage:  to

PSI-BLAST incl. threshold: 0.0001 **Filter** **Reset**

Run PSI-Blast iteration 7  
Number of sequences: 500 **Run**

**Descriptions** Graphic Summary Alignments Taxonomy

Sequences producing significant alignments  
Download [Manage Columns](#) Show 500

0 sequences selected [sequences newly added this iteration](#) GenPept Graphics Distance tree of results Multiple alignment MSA viewer

Sequences with E-value BETTER than threshold  
Select all 0 sequences selected [Skip to the first new sequence](#)

PSI-BLAST iteration 6

| Description   | Scientific Name | Common Name  | Taxid | Max Score | Total Score | Query Cover | E value | Per. Ident. | Acc. Len       | Accession                           | Select for PSI blast                | Used to build PSSM | Newly added |
|---|-----------------|--------------|-------|-----------|-------------|-------------|---------|-------------|----------------|-------------------------------------|-------------------------------------|--------------------|-------------|
| <input type="checkbox"/> <a href="#">rhodopsin [Microtus ochrogaster]</a>   | Microtus ...    | prairie v... | 79684 | 697       | 98%         | 0.0         | 92.15%  | 723         | KAH0519671.1   | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |                    |             |
| <input type="checkbox"/> <a href="#">PREDICTED: rhodopsin [Chætura pelagica]</a>                                      | Chætura ...     | chimney ...  | 8897  | 678       | 99%         | 0.0         | 87.57%  | 503         | XP_010001686.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |                    |             |
| <input type="checkbox"/> <a href="#">Crystal structure of rhodopsin bound to arrestin by femtosecond X-ray las...</a> | Mus mu...       | house ...    | 10050 | 675       | 99%         | 0.0         | 92.51%  | 906         | 4ZWJ_A         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |                    |             |

Feedback

Fig18. Result page for Iteration 5

| <input checked="" type="checkbox"/> | rhodopsin [Bufo gargarizans]                   | Bufo_gargariz... 614  | 614 | 98%  | 0.0 | 82.51% | 354 | XP_044157448.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
|-------------------------------------|--|-----------------------|-----|------|-----|--------|-----|----------------|-------------------------------------|-------------------------------------|
| <input checked="" type="checkbox"/> | rhodopsin [Ophiophagus hanhai]                 | Ophiophagus_... 614   | 614 | 100% | 0.0 | 82.10% | 352 | ETE71344.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin [Thamnophis proximus]                | Thamnophis_... 614    | 614 | 100% | 0.0 | 81.25% | 352 | ALX35611.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin [Cynopterus brachyotus]              | Cynopterus_br... 614  | 614 | 94%  | 0.0 | 94.82% | 328 | ADB45242.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin [Mauremys reevesii]                  | Mauremys_re... 614    | 614 | 97%  | 0.0 | 83.48% | 352 | XP_039403751.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin_freshwater form [Polyodon spathula]  | Polyodon_spa... 614   | 614 | 98%  | 0.0 | 82.46% | 353 | XP_041130833.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin_1 [Sinomicrurus japonicus boettgeri] | Sinomicrurus_... 614  | 614 | 100% | 0.0 | 81.25% | 352 | BCF80145.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin_1 [Latilauda colubrina]              | Latilauda_col... 614  | 614 | 100% | 0.0 | 81.53% | 352 | BCF80149.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | PREDICTED_rhodopsin [Thamnophis sirtalis]      | Thamnophis_s... 613   | 613 | 100% | 0.0 | 80.97% | 352 | XP_013914613.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rod visual pigment [Arizona elegans]           | Arizona_elega... 613  | 613 | 100% | 0.0 | 81.25% | 352 | AMD02575.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin [Bousettus leschenaultii]            | Bousettus_le... 613   | 613 | 94%  | 0.0 | 94.51% | 328 | ADB45233.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin [Bufo bufo]                          | Bufo_bufo 613         | 613 | 98%  | 0.0 | 82.22% | 354 | XP_040264312.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin_1 [Hydrophismiurus]                  | Hydrophismi... 613    | 613 | 100% | 0.0 | 82.67% | 352 | BCF80151.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin_1 [Aleyurus mosaicus]                | Aleyurus_mo... 613    | 613 | 100% | 0.0 | 82.39% | 352 | QKK13243.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin_1 [Hydrophismiurus peronii]          | Hydrophismi... 613    | 613 | 100% | 0.0 | 82.99% | 352 | QKK13266.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin [Acipenser ruthenus]                 | Acipenser_rut... 613  | 613 | 98%  | 0.0 | 82.46% | 353 | XP_033876574.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin [Acipenser baerii]                   | Acipenser_baer... 613 | 613 | 98%  | 0.0 | 82.46% | 353 | BBH55933.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin [Pantherophis guttatus]              | Pantherophis_... 612  | 612 | 100% | 0.0 | 81.53% | 352 | XP_034287482.1 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin [Dobsonia viridis]                   | Dobsonia_virid... 612 | 612 | 94%  | 0.0 | 94.82% | 328 | ADB45243.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> | rhodopsin [Nyctimene cephalotes]               | Nyctimene_ce... 612   | 612 | 94%  | 0.0 | 94.21% | 328 | ADB45249.1     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |

Run PSI-BLAST Iteration 7 with max number of sequences 500

National Center for Biotechnology Information Popular Resources Actions Support Center Feedback

**Fig19. Newly found sequences in iteration 5**

## Results:

In PHI-BLAST the result is divided into 4 parts. Description, Graphic summary alignment, taxonomy. We can also iterate through multiple result pages where the database searches for more and more sequence alignments

## Conclusion:

The PSI-blast is used to find distantly related proteins, what you need is the results in the final iteration. The PSI-blast runs in the following five steps: Repeat steps [3] and [4] iteratively, typically 5 times. At each new search, a new PSSM is used as the query. Hope my answer could help you to understand the use of PSI-blast.

## References:

1. (n.d.). Retrieved from <https://www.uniprot.org/uniprot/P02699.fasta>
2. NCBI Blast:sp|P02699|OPSD\_BOVIN Rhodopsin OS=Bos taurus... (n.d.). Retrieved from [https://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Get&VIEW\\_RESULTS=FromRes&RID=S04D359T013&UNIQ\\_OBJ\\_NAME=A\\_SearchResults\\_1mhZtz\\_215p\\_diTl0YKm2MJ\\_GTXQ1\\_fSITZ&QUERY\\_INDEX=0](https://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Get&VIEW_RESULTS=FromRes&RID=S04D359T013&UNIQ_OBJ_NAME=A_SearchResults_1mhZtz_215p_diTl0YKm2MJ_GTXQ1_fSITZ&QUERY_INDEX=0)
3. NCBI Blast:sp|P02699|OPSD\_BOVIN Rhodopsin OS=Bos taurus... (n.d.). Retrieved from [https://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Get&VIEW\\_RESULTS=FromRes&RID=S04KTK64016&UNIQ\\_OBJ\\_NAME=A\\_SearchResults\\_1mhZxS\\_8Gf\\_du382JTU5wJ\\_GTXQ1\\_1aKLYe&QUERY\\_INDEX=0](https://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Get&VIEW_RESULTS=FromRes&RID=S04KTK64016&UNIQ_OBJ_NAME=A_SearchResults_1mhZxS_8Gf_du382JTU5wJ_GTXQ1_1aKLYe&QUERY_INDEX=0)
4. NCBI Blast:sp|P02699|OPSD\_BOVIN Rhodopsin OS=Bos taurus... (n.d.). Retrieved from [https://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Get&VIEW\\_RESULTS=FromRes&RID=S04TMMDX016&UNIQ\\_OBJ\\_NAME=A\\_SearchResults\\_1mha0S\\_2tWP\\_dgi0SViy52a\\_GTWIT\\_s8Vri&QUERY\\_INDEX=0](https://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Get&VIEW_RESULTS=FromRes&RID=S04TMMDX016&UNIQ_OBJ_NAME=A_SearchResults_1mha0S_2tWP_dgi0SViy52a_GTWIT_s8Vri&QUERY_INDEX=0)
5. NCBI Blast:sp|P02699|OPSD\_BOVIN Rhodopsin OS=Bos taurus... (n.d.). Retrieved from

- [https://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Get&VIEW\\_RESULTS=FromRes&RID=S04YRHXB013&UNIQ\\_OBJ\\_NAME=A\\_SearchResults\\_1mha36\\_1HG1\\_dh5iZ3ya7Ag\\_GTW6B\\_1xr8fY&QUERY\\_INDEX=0](https://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Get&VIEW_RESULTS=FromRes&RID=S04YRHXB013&UNIQ_OBJ_NAME=A_SearchResults_1mha36_1HG1_dh5iZ3ya7Ag_GTW6B_1xr8fY&QUERY_INDEX=0)
6. NCBI Blast:sp|P02699|OPSD\_BOVIN Rhodopsin OS=Bos taurus... (n.d.). Retrieved from [https://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Get&VIEW\\_RESULTS=FromRes&RID=S055DV\\_D0016&UNIQ\\_OBJ\\_NAME=A\\_SearchResults\\_1mha6X\\_2snk\\_dhWv52Lw3FN\\_GTWIT\\_TnXX2&QUERY\\_INDEX=0](https://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Get&VIEW_RESULTS=FromRes&RID=S055DV_D0016&UNIQ_OBJ_NAME=A_SearchResults_1mha6X_2snk_dhWv52Lw3FN_GTWIT_TnXX2&QUERY_INDEX=0)
  7. NCBI Blast:sp|P02699|OPSD\_BOVIN Rhodopsin OS=Bos taurus... (n.d.). Retrieved from [https://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Get&VIEW\\_RESULTS=FromRes&RID=S05AP0M5013&UNIQ\\_OBJ\\_NAME=A\\_SearchResults\\_1mha9H\\_1211\\_dwXZcxLU55P\\_GTXQ1\\_1s3jJ9&QUERY\\_INDEX=0](https://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Get&VIEW_RESULTS=FromRes&RID=S05AP0M5013&UNIQ_OBJ_NAME=A_SearchResults_1mha9H_1211_dwXZcxLU55P_GTXQ1_1s3jJ9&QUERY_INDEX=0)
  8. Rhodopsin. (n.d.). Retrieved from <https://www.britannica.com/science/rhodopsin>