

Gene Searcher

Joshua Gutwill and Adam Klinger

June 2005

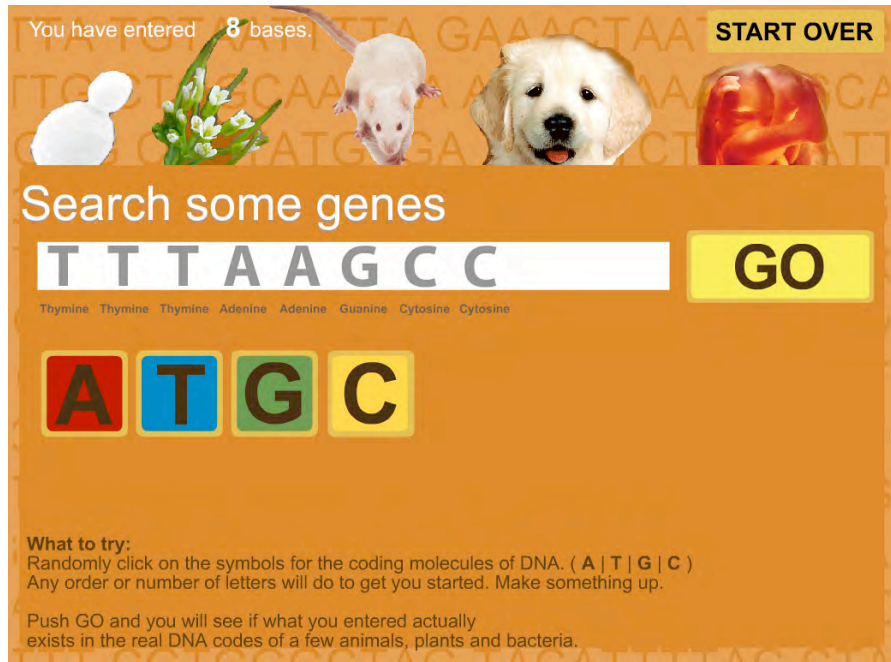
THIS IS **NOT** A DEFINITIVE FINAL REPORT

FORMATIVE evaluation studies like this one often:

- **are conducted quickly**, which may mean
 - small sample sizes
 - expedited analyses
 - brief reports

- **look at an earlier version** of the exhibit/program, which may mean
 - a focus on problems and solutions, rather than successes
 - a change in form or title of the final exhibit/program

Gene Searcher
Formative Evaluation
June 12, 2005
Joshua Gutwill and Adam Klinger



Goals

The main point of the Gene Searcher exhibit is to offer visitors some experience with the growing field of bioinformatics, the science of managing and analyzing biological data using advanced computing techniques. The developer, Kristen Sikes, hoped that visitors, exposed to real genetic information, would get some perspective on the size and vast amount of information contained in genes.

The goal of this formative evaluation study was to determine the extent to which visitors could successfully navigate the interface of the Gene Searcher multimedia exhibit and understand that they are searching for gene sequences within larger genomes. Specifically, the developer hoped that visitors would understand the meaning of each screen in the Gene Searcher.

Summary of Results

Overall, it seemed that visitors quickly figured out how to use the exhibit, and even the meaning of the information presented (though they wanted more explanations for terms used). However, they didn't seem to have a clear sense of the motivation behind the exhibit – the “So What?” aspect of it.

While using the exhibit:

- Visitors had little difficulty navigating the 3 different screens.
- On the first screen, Search Gene, many visitors mistakenly thought that the sequences they inputted should consist of only 4 letters.
- Visitors seemed impressed by the sheer number of characters in the genes.
- 3 of 9 visitors spontaneously asked for definitions of various terms.
- Sometimes visitors were confused about which pictures they could “hover” over or click on to get more information.

During the interview:

- Visitors did not seem particularly interested in the topic. This may have been due to their lack of understanding of the purpose of the exhibit.
- Early in the interview, visitors reported that they did not really understand what they were doing, but in later questions showed that they had a fairly good sense of each screen's main point.
- Mostly, visitors wanted more explanations of the terminology used in the exhibit.

Methods

We employed a cued interview method in which we recruited visitors, asked them to use the exhibit, observed them as they attempted to navigate the exhibit pages, and finally interviewed them about their experience.

We recruited 9 single visitors near the exhibit, in the Life Sciences area on the Mezzanine, in close proximity to other genetics exhibits. Individuals were randomly selected by choosing the third person to cross an imaginary line in the floor. We tried to recruit mainly individuals, but we allowed pairs of visitors to participate. When a pair of people participated together, the visitor who had been randomly selected was asked to answer each question first, then the other visitor was asked to answer.

The demographics of the randomly-selected visitors are shown below.




Demographics of interviewees

Age	Females	Males	Special training/interest in DNA	Total
8-18	1	1	None	2
19-29	2	0	None	2
30-39	1	1	Bio courses in college (female)	2
40-49	1	2	Spouse is a doctor (male)	3
Total	5	4	2	9

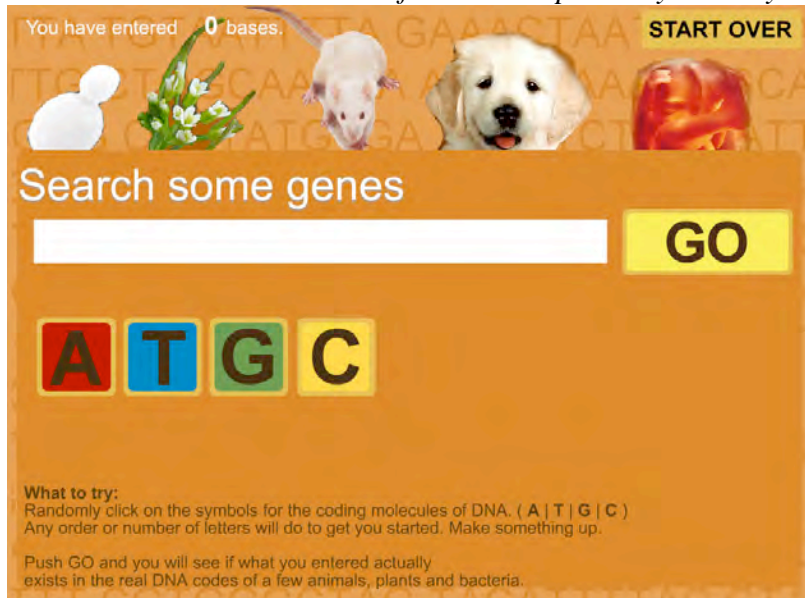
Detailed Results

Observations of visitors as they used the exhibit

While visitors worked with the exhibit, we noted the pages they explored and the problems they encountered. In general, visitors were able to find and use all 3 screens. The details are described below.

Screen Name	Screen shot	Visitors successfully exploring screen
Search Genes (first screen)		9
Results (second screen)		9
See Full Gene (third screen)		8

Search Genes screen: Visitors follow examples very literally



You have entered 0 bases. **START OVER**

Search some genes

GO

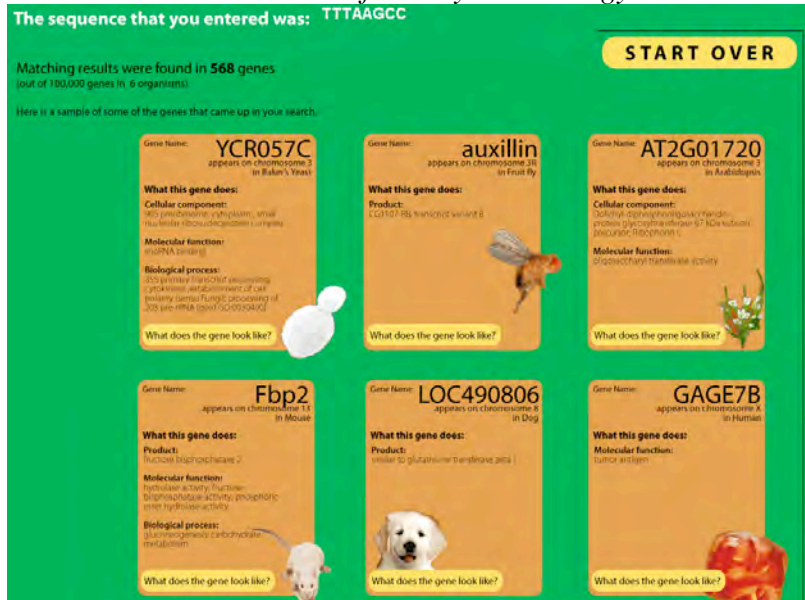
A T G C

What to try:
Randomly click on the symbols for the coding molecules of DNA. (A | T | G | C)
Any order or number of letters will do to get you started. Make something up.

Push GO and you will see if what you entered actually exists in the real DNA codes of a few animals, plants and bacteria.

We found that, while everyone was able to get started in the first screen, 6 of 9 visitors (66%) inputted only 4 characters for their search. When explicitly asked why they put in only 4 characters, several visitors mentioned that there were only 4 characters given.







Results screen: Visitors confused by terminology



The sequence that you entered was: **TTTAAGCC** **START OVER**

Matching results were found in **568 genes**
(out of 100,000 genes in 6 organisms)

Here is a sample of some of the genes that came up in your search.

<p>Gene Name: YCR057C appears on chromosome 2 in Baker's Yeast</p> <p>What this gene does: Cellular component: 80S ribosome, cytoplasm, small ribosomal subunit (ribosome) (organelle)</p> <p>Molecular function: tRNA binding</p> <p>Biological process: 20S primary ribosomal processing, protein, establishment of cell polarity (cell), Tumor necrosis factor (TNF) processing of 20S pre-mRNA (cell) (SC003040)</p> <p>What does the gene look like? </p>	<p>Gene Name: auxillin appears on chromosome 2B in Fruit Fly</p> <p>What this gene does: Product: CG147-8B, tracheal variant 2</p> <p>What does the gene look like? </p>	<p>Gene Name: AT2G01720 appears on chromosome 2 in Arabidopsis</p> <p>What this gene does: Cellular component: Golgi body, Golgi apparatus, Golgi vesicle, protein, glycoprotein, Golgi tubular network, Golgi apparatus, Golgi apparatus</p> <p>Molecular function: oligosaccharyl transferase activity</p> <p>What does the gene look like? </p>
<p>Gene Name: Fbp2 appears on chromosome 13 in Mouse</p> <p>What this gene does: Product: fructose biphosphate 2</p> <p>Molecular function: fructose biphosphate activity, phosphoric ester hydrolase activity</p> <p>Biological process: gluconeogenesis, carbohydrate metabolism</p> <p>What does the gene look like? </p>	<p>Gene Name: LOC490806 appears on chromosome 8 in Dog</p> <p>What this gene does: Product: tissue 10 glutamine transferase pita 1</p> <p>What does the gene look like? </p>	<p>Gene Name: GAGE7B appears on chromosome X in Human</p> <p>What this gene does: Molecular function: tumor antigen</p> <p>What does the gene look like? </p>

All visitors reached the Results screen. Visitors seemed to understand that the Results screen displayed genes that matched the sequence they had entered. However, 3 of 9 (33%) visitors spontaneously asked for definition of the terms presented, such as *gene*, *chromosome* and technical terms in the gene function descriptions.


See Full Gene screen: No obvious problems

This is what the sequence of this gene looks like:

Gene name: **auxillin**

Whole gene DNA sequence:

```
TCAGAAACAGACACAAAAAGGCCAATACCTTTATACACTTAAGCCCAAGTTTGACTACGAACATTAAACCTTAACTTACCGTTATTTGGCCAGC
CAAACACAGCCGACCTTTTCGCCCTACTCCAGCCCACTGTACAGTAAAACTGCTTAACCTTATTTGGCCGATATGCTGAGGTGCTTTGGCATTG
GAAATTACATACTGCGAGTATGCAAAATTTGAAAGACCAATGGGACTGAGGAAAGCCACTAGCAAGTGTGGGTGCCAAACTACATGTGTATGGCC
CCAACTAAACAGCAAAATCAGAAACAGACACAAAAAGGCCCACTTCCGTTTCCGGCTTTCAGCCAAATGCCGGCTTTTGTCCGATGGACTTAA
AGTTCAAGTTCCGGACTCCTGTTAAATTTTTCCCATGTGCACATATAGTATTATTAAGCCCTGCGATGAACCTTTTCACTTCACATGTTAAATC
TCATCTATCATCCGGCGTGCCTCAACTTTATAATAACTGAATTTCCGTCACTTAACCTTCAATTGCAAGTGAATAATTTGACTTTTAAATAACTTTGTATCC
CGGGGCGAGTGGCCCTTCACTGTGGGCCGCCGACTTGTGAAAGGCTGCCTTAAATTAATGATATATGTTTACAAAATATTTGATATATACGCAGCT
TGAATACCTCTTTATACACTTAAGCCCAAGTTTGACTACGAACATTAACTTTAACTTACCGTTATTTGCCACCCTAAACACAGCGACTTTTTG
GCCACTCCCAAGCCCACTGTACAGTAAAAACTGTCTAACTTTATTTGCCGATATGCTGAGGTGCTTTGGCCATTTGAAATACATACCTGCGAATA
TGC AAAATGAAAGACCAATGGGACTGAGGAAAGCGACTAGCAAGTGTGGGTGCCAAAC TACATGTGTATGGCCCCAACTAAACAGCAAAATCA
GAAACAG(TTTAAGCC)TTAACTTACCGTTATTTGCCACCCTAAACACAGCGACTTTTTGGCCACTCCAGCCCACTGTACAGTAAAAACTGTCT
AACTTTATTTGGCCGATATGCTGAGGTGCTTTGCCATTGAAATACATACCTGCGATATGCAAAATTTGAAAGACCAATGGGACTGAGGAAAGCGA
CTAGCAAGTGTGGGTGCCAAACTACATGTGTATGCCCCCAACTAAACAGCAAAATCAGAAACAGACACAAAAAGGCCCACTTCCGTTTCCGG
TTTCAGCCAAATGCCGGCTTTTGGTCCCGATGGACTTTAAGTTCAAGTTTGGGACTCCTGTTAAATTTTTTCCCATGTGCACATATAGTATTATTA
GCCCCCTGC
```

CLOSE 

Nearly all visitors (8 of 9) looked at the See Full Gene screen at least once. Several visitors made comments about the size of the genome, such as:

Wow, that's an amazing sequence for a simple creature.

Damn, that's a gene? I've never seen an actual code before.

That's a lot of gene. This is a piece of the chromosome that has TTTTTT [the sequence they entered] in it?

Interviews of visitors after they had finished using the model

After visitors used the exhibit, we interviewed them about their experience. The questions and results are described below.

1. First, how interesting was the exhibit for you? Would you say it was...

Not interesting	Somewhat interesting	Interesting	Very interesting
0	6	3	0

Visitors' responses to this question indicate a slightly lower level of interest in this exhibit as compared to other Exploratorium exhibits. It seems that visitors did not really understand enough of the information presented to feel that it was interesting (see responses to question 2).

2. Can you say why you chose ____ ?

I don't really understand it 3 of 9

Because I didn't really know what it all meant.

It wasn't totally clear to me what was going on - I understood genes and sequences, but I don't know why the random letters made part of a fruit fly or a mouse.

Because I think it was just - it had a lot of reading and little kids wouldn't like that. Maybe it could be more interactive [how?] Maybe add some sounds when you click on things, like the [picture of] the dog when it shows you the information.

Genes are (somewhat) interesting 2 of 9

I don't know, genes are cool. I really liked seeing what gene I found a sequence in.

I'm just not interested too much about genetics. [AE?] It's what I'm made of, so it's somewhat interesting.

Not enough depth 2 of 9

Very interesting at first blush, but needs more background info. On the whole, interesting, but I'd get bored quick and then move on.

Because you do it twice and basically you're done. And also there is a certain number of organisms you're looking at.

Life is so complex 2 of 9

Because looking at the combos and the number of combos was interesting, to see how complex something is and how the mouse is almost as complex as a human.

Because of the simple fact that you never know how much data a small organism can have vs. a big one. The complexity of life.

3. What kinds of questions would you like to have answered at this point

Want explanation of genes in more depth 3 of 9

Probably this [gestures to letter buttons on search page] It's good having the molecules [A-C-T-G] random, but I would like to know how my random letters made the DNA sequence [shown in results page].

What does the gene do? What specifically each gene is for. It's telling you what the gene does, but I don't know what that is.

Basically, a bit of background on genes and chromosomes, and to understand how they all interrelate with each other.

Want better explanation of terms 3 of 9

What's this thing? [pointing to picture of yeast] Oh, baker's yeast! Make the pictures bigger. I've never heard of arabidopsis.

A better explanation of what Adenine Guanine, Cytosine are. Do they do specific functions? So I would have a better idea of what I'm doing. Do certain letters occur more in animals or plants or what.

When you go to a combination, all the info that pops up, what it's saying.

Want greater variety of genes 2 of 9

Just more similar and different animals and plants. A greater variety of day to day things, not so complex. Common stuff, especially for my kids.

To see maybe if I clicked on the human to see what different sequences are in different-- Clicking on the human and clicking on organisms and to see how many different sequences might be for a particular organism.

None 1 of 9

I don't have any.

4a) [Search Gene screen] Did you get a sense from this screen of what you were supposed to do? What's your sense of that?

8 of 9 visitors said "yes" to this question, indicating that they felt they had known what they were supposed to do at the first screen.

It was easy to search 5 of 9

Yes. From the directions- you click on [the letters] to see what they mean, and then you click on the creature and you get the DNA and stuff.

Yes. I just pick a sequence and look for it.

Yeah. I say I'm going to search a gene, and you see what comes up.

Yeah. Randomly click on letters and hit go, and it matches it with combinations.

Yes. Just click in different order and patterns of the four letters to see what it came up with.

Only searched 4-letter sequences 2 of 9

Yeah. Read the instructions and push the letters. As soon as you push the letters it's clear. [why didn't you put in more than four letter sequence?] Because I saw four below, so I didn't know I could do more.

Yeah. I tried to click on [picture of organism at top of page]. Just click on the symbols and make what you want. Maybe says in the example that you don't have to use all four [further conversation led me to understand that she originally thought you had to put in four letters only, and you had to use each letter once.] [why did you only use 4?] You have 4 buttons, and only 4 as an example down here.

I wasn't sure what I was doing 2 of 9

The directions are clear, what to try, push go, but what I'm actually doing isn't clear. An introduction would be helpful, like "different combination of genes make different DNA."

Yes, as soon as I read the instructions. Before that I was clicking the pictures and nothing was happening.

4b) [Search Gene Screen] Did you get a sense of what this screen was trying to tell you? What was that?

7 of 8 visitors felt that they had understood the point of the screen. Their longer responses are shown below

Response	Number of visitors
You can search for codes within DNA	3
There are lots of similar gene combinations	2
Didn't understand	2
DNA is in anything	1

4c) [Search Gene Screen] Was there anything confusing about this screen?

No one reported anything confusing, though one visitor asked to be able to search within only a single type of animals (e.g., dog).

5a) [Results Screen] did you get a sense from this screen of what you were supposed to do? What's your sense of that?

Only one visitor reported that they did not know what to do.

5b) [Results Screen] Did you get a sense of what this screen was trying to tell you? What was that?

Of the 8 visitors who answered this question, many seemed to understand the purpose of the screen, despite the fact that 5 visitors felt the terminology was confusing.

The terms were confusing 5 of 8

All those words mean pretty much nothing. [Anything else?] That there's a lot of stuff going on- it's all the same and it's all different. The same sequence is in different animals.

I knew it was trying to tell me what the genes do, but I didn't know the words.

There were a lot of really big words. [Where?] What the different genes I looked at were for. [Was this info useful?] Cool, but not useful.

To give me an idea of more detail about genes. [What did you think of the gene description text?] I like it, but it needs to be less technical.

A lot of this stuff I don't understand. I know "cytoplasm."

Tells what the genes do 4 of 8

I knew it was trying to tell me what the genes do, but I didn't know the words.

That there's a lot of DNA in living things. [What about the detailed text for each result?] It tells you what the genes are and what they do. [Was it clear?] Yes.

I'm not sure. [What did you think the results were saying?] What it is, and what it does, and in what they show up. From the little I was on it that pulled up the same things- that there's the same stuff in all the animals and organisms.

It's info about the chromosome- what it's made of and what it does in a very scientific sense.

These are the genes 2 of 8

To give me an idea of more detail about genes. [What did you think of the gene description text?] I like it, but it needs to be less technical.

There were a lot of really big words. [Where?] What the different genes I looked at were for. [Was this info useful?] Cool, but not useful.

Same genes in different organisms 1 of 8

I'm not sure. [What did you think the results were saying?] What it is, and what it does, and in what they show up. From the little I was on it that pulled up the same things- that there's the same stuff in all the animals and organisms.

5c) [Results Screen] Was there anything confusing about this screen?

Terminology 5 of 9

Just the big words.

The gene name wasn't clear, the "YCR057C"

It's confusing because it has the name of the cellular components but people want to know what that is- put it in layman's terms.

It's cool. It tells you about chromosome. It's interesting, but I'd like to know what that chromosome does and what the gene does on that chromosome. And dumb it down.

[What about the actual text?] The biological process is beyond me. [Does that bother you?] I'd lose interest quickly if I was a kid.

Interface issues 2 of 9

Just that the [cursor] didn't change when you click on [*What Does the Gene Look Like?* button]

Only that it was coming up the same. [referring to the false search results we were using- he figured it out.]

Nothing 2 of 9

No.

No.

5e) [Results Screen] If it was possible to scroll or go to another page to see more results would that be interesting or useful for you?

Yes, but organize the information 6 of 8

Interesting, but only if you put them in categories or sorted by alphabet. Maybe just the main ones.

Sure. Just to see what's out there, divided into plant, animal, mineral categories.
 Yeah, interesting. I'd like to see if the sequences have similar roles [in different results]
 It would, because it would give me a larger sense of what there was out there, but I wouldn't
 want to see 568. 12 is more than enough to get the scope.
 Yeah, categorize them by plants, animals, etc.
 Yeah. Because it's good to get more info. You could get more info, like about dog genes.

Yes, to learn more 2 of 8

Yeah. To see all the different organisms.
 Yeah, so you could learn everything about the genes of all different animals.

6a) [See Gene Screen] did you get a sense from this screen of what you were supposed to do? What's your sense of that?

Visitors seemed less sure about what they should do at the See Gene Screen.

Just look at it 4 of 5

No, I had no idea, just that I had to read.
 Just look.
 I guess just see where part of the sequence appears in bold.
 I'm looking at the pattern and the size of the sequences- the bigger the sequence, the more
 complex the chromosomes, even with simple things.

Don't know 1 of 5

[Shrugs.]

6b) [See Gene Screen] Did you get a sense of what this screen was trying to tell you? What was that?

Most visitors understood that the text was showing the sequence for a *gene* or *DNA* or *chromosome*, but few visitors noticed that the sequence of letter they had typed in were shown in bold.

The full gene/sequence of DNA 6 of 8

That there's a lot of DNA. I see a bunch of ACTs. [What do you think the letters represent?]
 The form that the DNA comes in. [What about the bold letters?][I had no idea.
 [Is this result (gene) a gene or a chromosome?] Chromosome. [did you notice the bold?] No, it
 would have to stand out more.
 Just this is the gene, and this is what the sequence looks like. [notice the bold?] Yeah. [What is
 it?] I don't know. [I explained that it was her sequence.] That's not clear.
 Telling me the sequence of this particular gene, but it doesn't mean anything to me. [notice bold
 text?] No, but it might have been what I typed in- make that bigger.
 It's a code [for what?] Enzymes.

It's giving you the sequencing of the four letters in the combination with others to make a specific gene.

I didn't notice/understand letters in bold 4 of 8

That there's a lot of DNA. I see a bunch of ACTs. [What do you think the letters represent?]

The form that the DNA comes in. [What about the bold letters?] I had no idea.

[Is this result (gene) a gene or a chromosome?] Chromosome. [Did you notice the bold?] No, it would have to stand out more.

Just this is the gene, and this is what the sequence looks like. [Did you notice the bold?] Yeah.

[What is it?] I don't know. [I explained that it was her sequence.] That's not clear.

Telling me the sequence of this particular gene, but it doesn't mean anything to me. [notice bold text?] No, but it might have been what I typed in- make that bigger.

The full gene containing searched sequence 2 of 8

I think that it's the piece of the gene that has the sequence I pick. [What's the bold part?] That's the sequence that we picked.

Like a sequence. [Of what?] DNA. It shows you where the letters you enter come in.

6c) [See Gene Screen] Was there anything confusing about this screen?

Nothing confusing

4 of 9

Didn't understand various terms 3 of 9

The gene name- what does that mean? And the whole DNA sequence. I don't know what it means. I know that it's part of a chromosome, but it could use a definition, maybe a visual of where it [physically appears].

You need more explanation: "the 'GG' is," for example.

Could you have a picture [of the gene] as well as the sequence?

Didn't know I could get to this page 1 of 9

I didn't know you could click in [the button to get to this page]

Didn't understand meaning of boldface type 1 of 9

No. [Did you see the bold?] I did notice it, but don't know what that means.

8) Do you have any other comments or suggestions?

Additions to software

3 of 7

Maybe when you pick a fly [gene on the results page] you could have the letters [of the sequence] in the shape of a fly, 'imagery poetry.'

Pretty cool- make your own creature would be cool.

Maybe a visual of where [gene physically] appears in the [chromosome]

Simplifications or explanations

2 of 7

Just if you could give me an intro and a picture of a helix to give it context- or a picture of what it's a part of.

It could be simplified. When it talks about function, can you use common names? It's overwhelming the way it is.

Make it more inviting

1 of 7

If I saw all this tech stuff I'd walk away.

Conclusions

Based on our limited number of interviews with visitors, the interface for the Gene Searcher exhibit prototype seems to be working fairly well: visitors were able to find and explore the various screens. However, many visitors complained about the terminology used, and asked for more explanatory text.

Most visitors understood the meaning of the information presented. They said that the results of the search showed organisms and their gene sequences that contained the genetic sequences originally inputted by the visitor. Many visitors also took away the notion that genes contain a lot of information, or contain information that is identical across organisms. Unfortunately, visitors did not seem very interested in the exhibit, possibly because there was so much confusing jargon that they felt confused more than satisfied. The confusion over the jargon also may have prevented visitors from seeing the larger point behind the exhibit – that genetic information can be analyzed and processed to reveal various biological mechanisms.

Recommendations

We recommend finding ways to reduce the jargon used in the exhibit. We would not advocate trying to present and explain difficult terms by, say, adding a glossary (even a pop-up one), because explaining jargon terms might just add complexity to an already complicated exhibit. Rather, we would suggest finding ways to automatically translate jargon terms from the raw database into something that a layperson could understand.

Also, we propose adding some kind of layer of interpretation that helps visitors understand the larger point of the exhibit, namely that bioinformatics is a relatively new scientific field in which scientists use advanced computing techniques to manage and analyze huge amounts of biological data. Perhaps we should even allow interested visitors to learn more about the inner-workings of the search process itself.

A minor improvement would be to communicate in the first screen that visitors ought to try searching for sequences that are longer than 4 characters and that do not have to include all four of the bases.