How to Use the GTEx Histological Image Viewer

Introduction

The GTEx Histological Image Viewer gives the researcher access to a very large number of detailed tissue images online. The image viewer allows for searching based on meta data about the tissues (e.g., tissue type, autolysis, or age range), view the image of a specific tissue in great detail (including pan, and zoom), and downloading a file containing the Aperio image file (the source for all of the on-line images) for further analysis.

To Conduct a Term Search

1. At the top of any GTEx Image Viewer page, click on the “Term” menu. The screen now shows a list of terms used in the description of various tissues, and searchable categories
2. Clicking on the text in the Searchable Categories column, leads to a list of images matching that specific field and value.

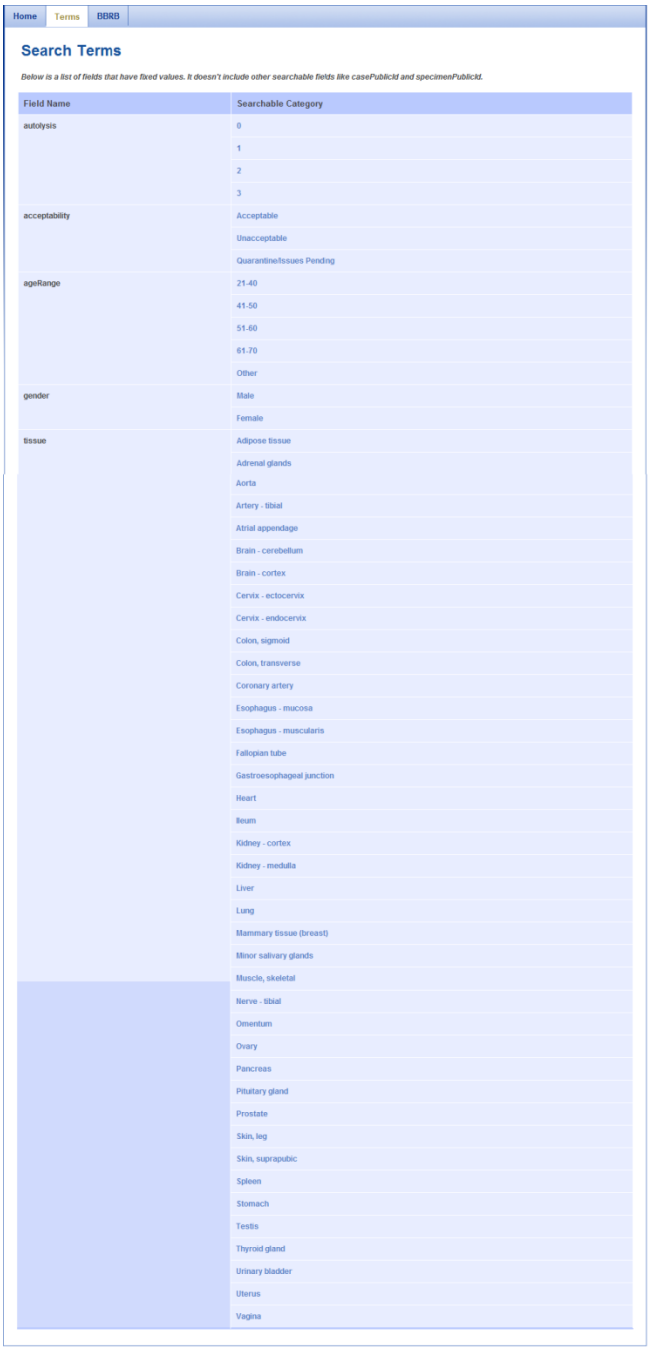
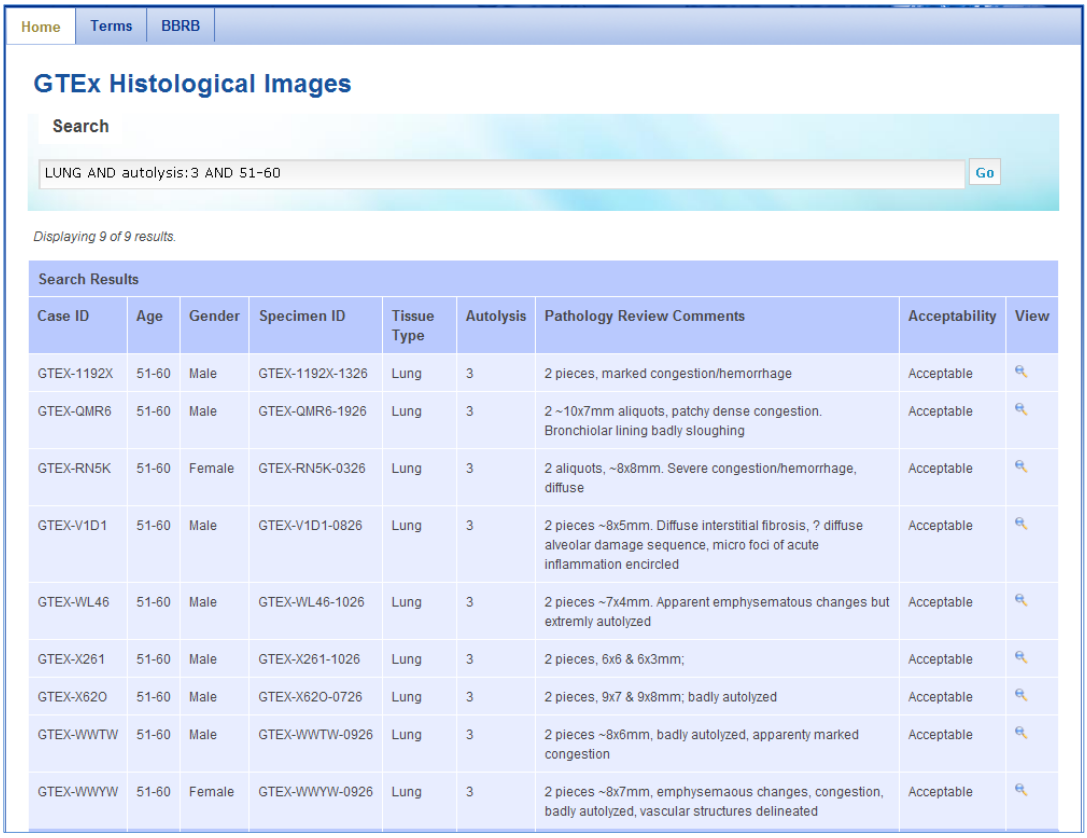


Figure 1- Search Terms Window (Zoom to see content wording)

To Conduct a More Specific Search

1. With the Home tab selected, find the **Search** box (Figure 3).

2. Enter text relevant to a specific tissue/specimen into the box. You can enter any keyword or multiple keywords separated by a space. In this case, the search is for “Lung” tissue, with an autolysis of 3, from a person who was between 51 and 60 years old.



Case ID	Age	Gender	Specimen ID	Tissue Type	Autolysis	Pathology Review Comments	Acceptability	View
GTEX-1192X	51-60	Male	GTEX-1192X-1326	Lung	3	2 pieces, marked congestion/hemorrhage	Acceptable	
GTEX-QMR6	51-60	Male	GTEX-QMR6-1926	Lung	3	2 ~10x7mm aliquots, patchy dense congestion. Bronchiolar lining badly sloughing	Acceptable	
GTEX-RN5K	51-60	Female	GTEX-RN5K-0326	Lung	3	2 aliquots, ~8x8mm. Severe congestion/hemorrhage, diffuse	Acceptable	
GTEX-V1D1	51-60	Male	GTEX-V1D1-0826	Lung	3	2 pieces ~8x5mm. Diffuse interstitial fibrosis, ? diffuse alveolar damage sequence, micro foci of acute inflammation encircled	Acceptable	
GTEX-WL46	51-60	Male	GTEX-WL46-1026	Lung	3	2 pieces ~7x4mm. Apparent emphysematous changes but extremly autolyzed	Acceptable	
GTEX-X261	51-60	Male	GTEX-X261-1026	Lung	3	2 pieces, 6x6 & 6x3mm;	Acceptable	
GTEX-X62O	51-60	Male	GTEX-X62O-0726	Lung	3	2 pieces, 9x7 & 9x8mm; badly autolyzed	Acceptable	
GTEX-WWTW	51-60	Male	GTEX-WWTW-0926	Lung	3	2 pieces ~8x6mm, badly autolyzed, apparenty marked congestion	Acceptable	
GTEX-WWYW	51-60	Female	GTEX-WWYW-0926	Lung	3	2 pieces ~8x7mm, emphysemaous changes, congestion, badly autolyzed, vascular structures delineated	Acceptable	

Figure 2 - Specimen List Matching Search Keywords

3. If the search is not specific enough, then the keywords for the subject can be adjusted, and the search done again.
4. Once a reasonable specimen is located, then clicking on the icon of the magnifying glass in the right hand column brings up a viewing window.

Conducting a Simple Search

You can conduct a Simple Search for an image from the Search Specimen Data page. Enter any keyword associated with the specimen of interest (such as a tissue type, case ID, specimen ID, and so on). The search for the key words is across all fields related to the image.

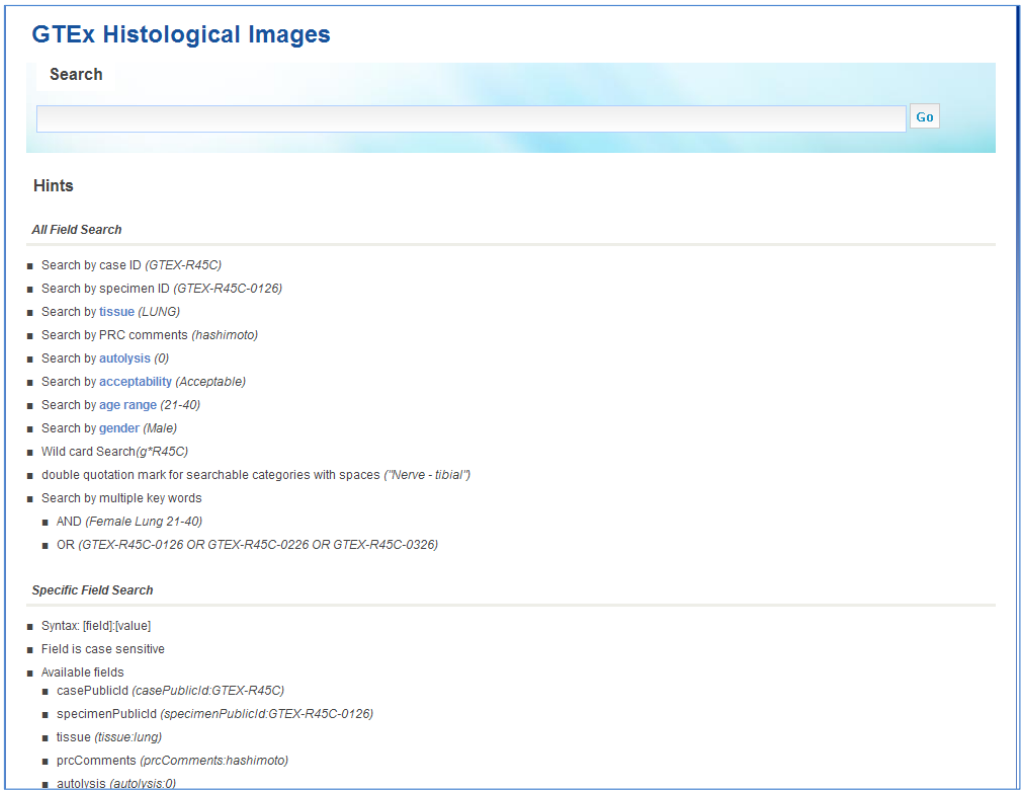


Figure 3- Initial Home Page

Increase specificity by including multiple words with or without search operators. If keywords are just separated by a space, as in Adipose tissue, then the search returns all items which reference "Adipose" and "tissue", whether related or not. If you searched for "Adipose tissue", then the search would return a much smaller number of specimens, where one or more of the fields contained both words, separated by white space. Finally, if you searched for tissue:"Adipose tissue", then the search would look for those two words, separated by white space, and only in the tissue field.

Search operators that are supported by Simple Search, example queries, and their anticipated results are summarized in the table below.

Simple Search Operators	Example	Results
Double quotes (" ") will return specimens that contain the exact phrase quoted, in any of the fields.	**"Adipose tissue"**	Images containing the exact phrase Adipose tissue **Note:** Some tissue types contain spaces, so searches should use double quotes.
An **asterisk (*)** is a *wild-card* search operator that can replace any number of characters in a search term. It can be used in the beginning, middle or end of a search term.	**tissue:*artery***	This will find all types of arteries: Coronary artery, Artery – tibial, and so on.

Simple Search Operators	Example	Results
It cannot be used in a quoted string.		
A **question mark (?)** is a *wild-card* search operator replacing a single character in the search term. It can be used in the beginning, middle or end of a search term. Multiple question marks can also be used within a single search term, each will match one character. Question marks cannot be used in quoted strings.	**casePublicId:GTEX-111??**	Collections with the public ID starting with GTEX-111 followed by two characters.
A **tilde (~)** is a search operator that will return terms that are spelled similarly to the term that prefaces it. It should follow a single word search term.	**prcComments:preserved~**	Specimens containing the terms **preserved**, or **presreved** in the PRC Comments field.
Search operators can be used together and parentheses can be used to group queries.	**"2 pieces" AND (internal OR external)**	Specimens containing **2 pieces** and either **internal** or **external**
Prefacing a search phrase with **casePublicId:** will limit the query for the search phrase to the Case ID field. Generally, this matches multiple specimens.	**casePublicId:GTEX-R45C**	All specimens from cases with the Case ID of *GTEX-R45C.*
Prefacing a search phrase with **specimenPublicId:** limits the query for the search phrase to the Specimen ID field. Generally, this will match a single specimen.	**specimenPublicId: GTEX-R45C-0626**	Returns a single reference to that one specimen.
Prefacing a search phrase with **tissue:** limits the query for the search phrase to the tissue type field.	**tissue:Skin**	All specimens having a tissue type of **Skin.**
Prefacing a search phrase with	**prcComments:"partly**	All specimens having the PRC

Simple Search Operators	Example	Results
prcComments: limits the query for the search phrase to the PRC Comments field.	**nodular"**	Comments field contain the words partly nodular, somewhere in the description.
Prefacing a search phrase with **autolysis:** limits the query for the search phrase to the autolysis field.	**autolysis:0** *or* **autolysis:(0 OR 1)**	The autolysis field contains only 0, 1, 2, or 3. The second example shows how to look for specimens having a range, 0-1, of values. You cannot use the "0-1" notation!
Prefacing a search phrase with **acceptability:** limits the query for the search phrase to the acceptability field, which records whether or not the tissue met the GTEx acceptability criteria.	**acceptability:Acceptable** *or* **acceptability:Unacceptable**	All specimens having Acceptable or Unacceptable in their acceptability field.
Prefacing a search phrase with **ageRange:** limits the query for the search phrase to the Age Range field.	**ageRange:21-40**	All specimens having donors in the age range 21-40. The only acceptable age ranges are 21-40, 41-50, 51-60, 60-71, and no others. There are no spaces in the range (e.g. not 21 - 40)
Prefacing a search phrase with **gender:** limits the query for the search phrase to the study's Summary of Findings field.	**gender:Male**	All specimens having donor sex as Male. The only other acceptable value allowed is Female.
Compound Searches **Any set of the above single searches can combined, making searches more focused, using the following notations. The examples all use single words, for clarity, but any of the above is acceptable.**		
Including **AND** or **+** between search phrases will return images that contain both search phrases. If more than one search term is entered, this search operator will be applied as the default. If the operator is in a quoted string, it will be ignored.	**muscle AND skeletal** or **muscle + skeletal** or **muscle skeletal**	Images containing both **muscle** and **skeletal**

Simple Search Operators	Example	Results
Including **OR** between search phrases will return images that contain either, or both, search term.	**cortex OR medulla**	Images containing either **cortex,** or **medulla,** or both.
Including **NOT** or **-** (minus) between search terms will return images that do not contain the term that follows the operator. This operator must be used with a search term that will return results. If the operator is in a quoted string, it will be ignored.	**cortex NOT brain**	Images containing **cortex** but not **brain** **Note:** One unexpected consequence of this comes from the tissue type: Artery – tibial. If this term is cut and pasted into the search box, the viewer will return all artery entries which do not contain tibial. To search for this type of tissue, enter the tissue type in double quotes: "Artery – tibial" or tissue:"Artery – tibial" **Note:** If you wanted to be certain that you were searching only for tissues (and, for example, not in the PRC comments), you could enter: **tissue:(cortex NOT brain)**

Using the Image Viewing Window

After finding a tissue image, clicking on the magnifying glass icon, in the far right column, brings up the Image Viewing window. At the top of the window is a header, giving information about the specimen. The image, which covers most of the window, initially shows the most comprehensive view of the specimen (e.g., fully zoomed out).


Pressing the plus icon causes the display to zoom in on the center of the image.


Pressing the minus icon causes the display to zoom out from around the center of the image, so that more tissue is visible.


Pressing the house icon returns the display to the initial view.


Pressing the box with the two arrows expands the display so that it covers the entire viewing screen.


The cursor scrolls the image around, by clicking on a point of interest, and moving the mouse while the left button is depressed. In many browsers, if your mouse has a thumb wheel, you can use this to change the zoom on the image.

The print button, at the top of the Image Viewing Window, sends a copy of the image to the printer with any browser on a system connected to a printer. Depending on your browser configuration, there might be an option to "Print to PDF". This option saves whatever is visible on the page at that time into a PDF file. It does not save the high quality image because it is prohibitively large.

Download Aperio image file The full Aperio format file of the image being displayed, can be downloaded by pressing the Download Aperio image file button in the top-right of the Image Viewing window. Pressing this button cause the Aperio file related to the image being viewed to be sent to the browser. Different browsers have individual ways of selecting where to store the file, once transferred. Each file transferred has the public GTEx case and specimen ID as the file name, and ".svs" as the file type. These files need a special Leica Biosystems/Aperio viewer application ImageScope[1]. ImageScope is freely available from Leica Biosystems. As the ImageScope software only allows viewing of one .svs file at a time, the image viewer downloads each image file into its own individual file.

Note: Aperio image files can be quite large (hundreds of megabytes), so file download may take substantial time.

Saving an Image on the Viewing Window

There are two ways to save an image being shown on the viewing window. The first is by downloading the Aperio-format image file directly (described previously). If this level of detail is not needed, the second method is by saving a copy of the current image by right clicking on the image, and selecting the menu item to save the image. Formats for files created vary between browsers (e.g., jpg, png, gif).

Glossary of Terms

Term	Definition
Acceptability	Acceptable – Acceptable for LDACC to proceed with molecular analysis Unacceptable – Not accepted for LDACC molecular analysis. Quarantine/Issues Pending – Issues need to be resolved to make this tissue acceptable.
Age	The range of ages of the Donor, at the time of tissue collection. Ages are binned for PHI protection of the donors.
Gender	The Donor's Identification of gender based on self-report, family/next of kin, or medical report abstraction.
Autolysis	A tissue's morphologic integrity due to post-mortem degradation, graded as 0 (none), 1 (slight), 2(moderate), or 3 (severe).
Case ID	Unique identifier common to all specimens collected from a single donor. Searching by case id brings up a list of all specimen images in the data base for that donor.
Tissue Type	The English name for the organ or tissue sampled. Tissue type is entered at collection, and confirmed by microscopic review.
Pathology Review Comments	Pathologists comments based on microscopic review of the specimen. The comment is in free text. For example: amount and location of extraneous tissue, purity of target tissue, components of complex tissues that are missing, presence of lesions (e.g., pneumonia, cirrhosis, or atherosclerosis).
Specimen ID	Unique identifier for each specific specimen. Each image is tagged with an individual identifier.

[1] http://www.leicabiosystems.com/digital-pathology/digital-pathology-management/imagescope/