



# The JCMS Colony Management Software System

**Adopting a database for Colony Management  
Introducing JCMS  
Discussion and Considerations**

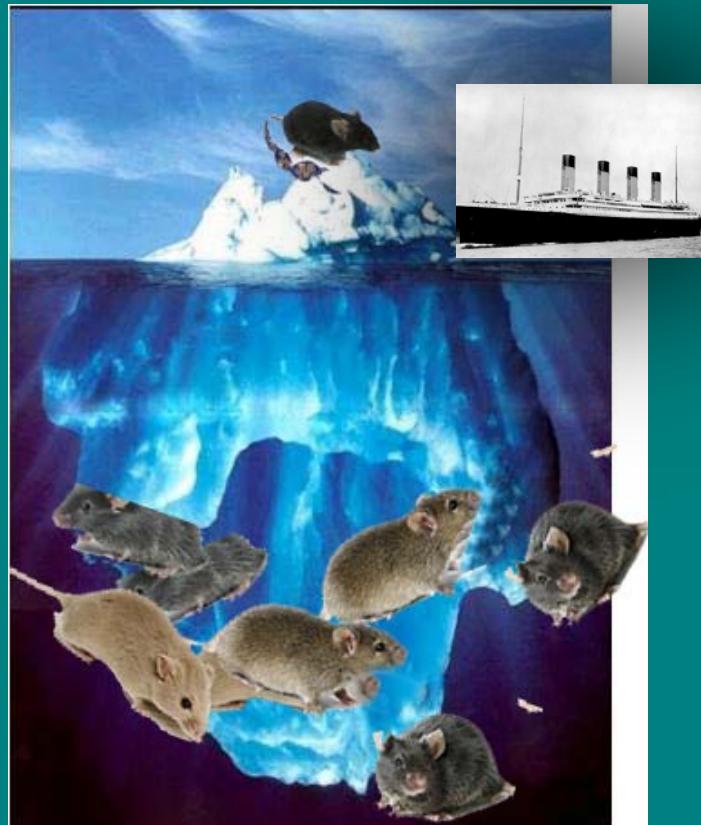
**The Jackson Laboratory  
Bar Harbor Maine**

# Welcome

## Outline

- Why use a database vs paper or MS Excel
- Adopting a database/managing change
- Grow your own? What to consider.
- Introduction to JCMS
  - Overview
    - Managing Colonies (mice, matings, litters)
    - Reports and Queries
    - Samples
    - Experiments

# Managing the whole iceberg.

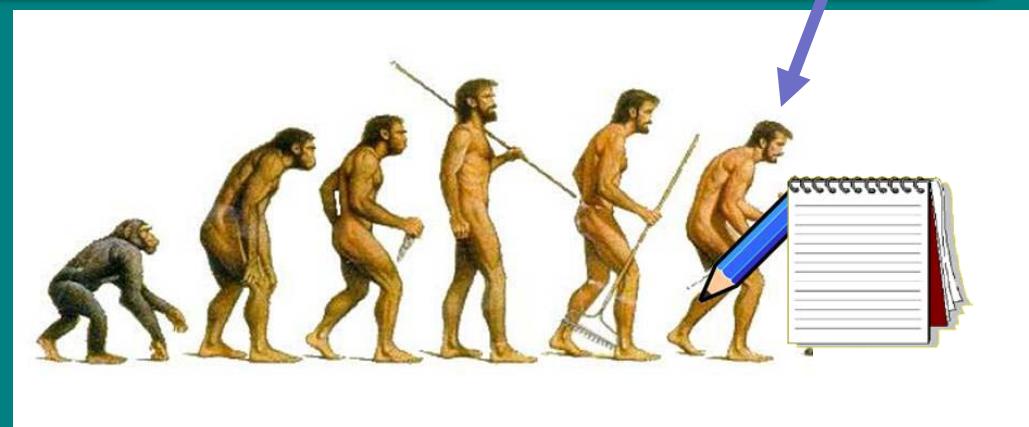


Oftentimes we don't know how bad our data organization is until it is too late.

*When our observations only detect the tip of the iceberg, we take great comfort because we think all is well... we then choose to spruce up and rearrange the deck chairs...*

# Prehistoric method

- Paper notebooks
  - Easy to work with
  - Familiar
  - Cheap
  - Don't need batteries
  - Drop resistant
  - Minimal training required



# ... prehistoric method

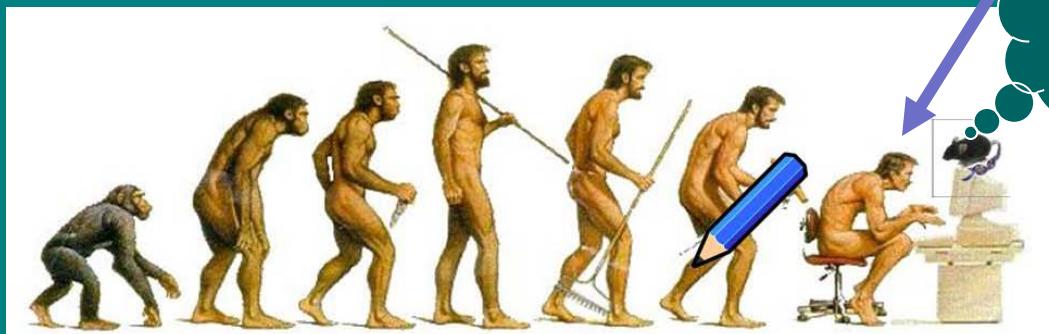
## Paper notebooks

- Difficult to search and cross reference
- Hard to backup; disaster recovery (what happens if the notebook is lost, one copy!)
- Easy to make mistakes
- Labor intensive; does not scale well
- Depends on individual handwriting quality
- Paper gets rumpled and difficult to read over time (coffee spills on it!)
- Does not enforce any standards on data entry
- Easy to loose
- Does not allow concurrent multi user access from different locations

# A method from the last millennium

## MS Excel

- Typically considered a huge step forward from paper only
- Easy to work with
- Familiar to most people
- Cheap
- Minimal training required
- Has limited search and sort capabilities
- Built in functions



They of limited intelligence, sigh... still use Excel

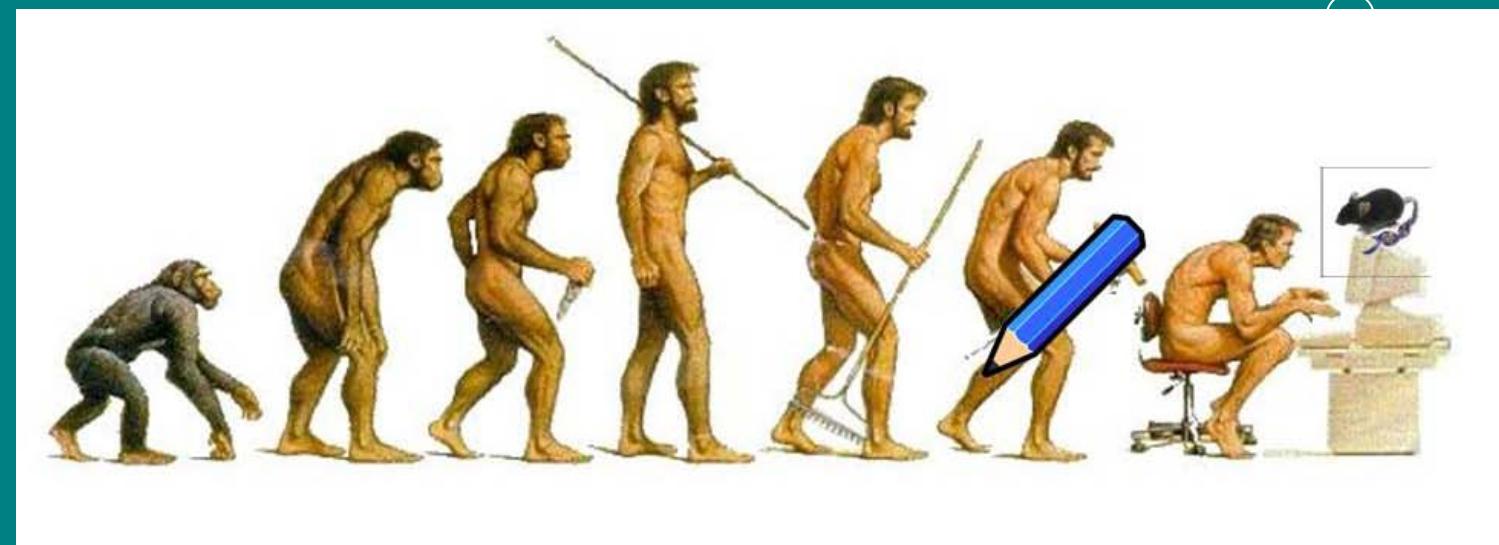
# ...a method from the last millennium

## MS Excel

- Designed for financial ledgers, not relational data
- Multi constraint queries are difficult to write.
- Data corrupted easily during editing or data entry.
- Data rules difficult to enforce (e.g. age of pups must be less than age of parents)
- No transaction management
- No data integrity constraints
- Difficult to abstract data concepts/objects (e.g. what is a strain or a genotype?)
- Difficult to enforce controlled vocabulary annotations
- Minimal security – authentication and authorization
- Labor intensive data entry
- What happens if the Excel file leaves with a post-doc
- No capability to enforce data types
- Limits career growth potential, because key staff are the only data experts.

# Data management evolution..

The relational database management system



# Relational database management systems: the new millennium has arrived!

## RDBMS

- Colony data are inherently relational
  - Mice
  - Litters
  - Matings
  - etc
- Controlled data input
- Multiuser safe
- Transaction management
- Data are easily semantically annotated and have value long after the person who entered it has moved on.
- Improved mouse room efficiency
- Reduced cage and animal counts (reduce the burden on research animals)

**CAUTION:** considerable planning is still needed too effectively adopt

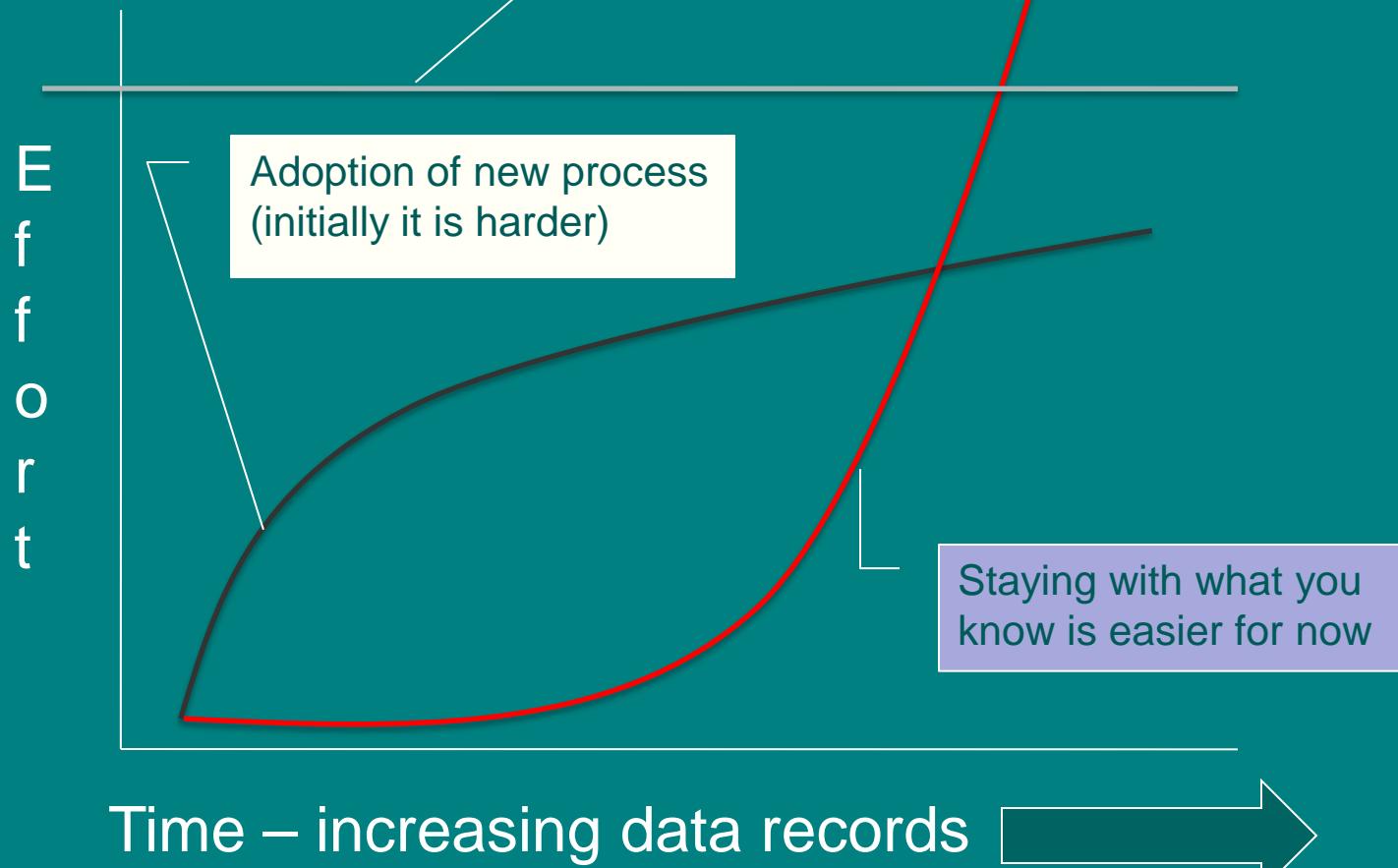
# Costs of not doing it right

- Places a heavy burden on total research dollars available
- Lost strains
- Loose track of your pedigree tree
- Unnecessarily high cage counts
- Compromised scientific results
- High labor costs to manage data
- Only one or two people understand the data
- Undo burden on research animals
- Etc....

# Adopting more efficient processes

Process improvements require an initial investment which increases effort in the near term but makes it possible to function in the long term

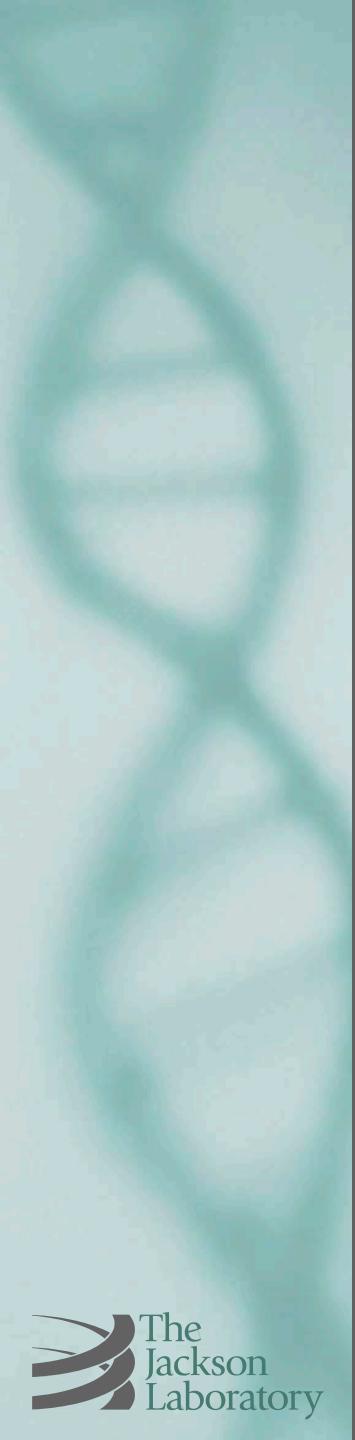
Effort exceeds capacity to deliver (rate limiter on science)



# Adopting a database is not easy

- Review your process
- Organize your workflow to include the database
- Deal with ID numbers
- The adoption curve can be difficult
- Requires Input and engagement at all levels
  - PI, Lab Managers, Lab Techs, and Animal Care Takers

**THE PAY-OFF IS HUGE**



# It is tempting to build your own...

But be careful...

(THIS HAPPENS OFTEN)

# Home grown database solutions are often implemented without future vision

- Knee-jerk design solutions are like band-aids on a festering wound.
- Designed to relieve the “pain” now.
- Delay the problem for a later time.
- Compound the problem by creating an atmosphere of denial (everything is fine)
- After years of patching your valuable data are at risk
- Upgrades are needed in order to stay current with modern computers (e.g. FM Pro 5 does not run on the latest operating systems)
- The HERO model (one expert in the lab)

# Home grown solutions...

Common hobby technologies

FileMaker Pro

MS Access

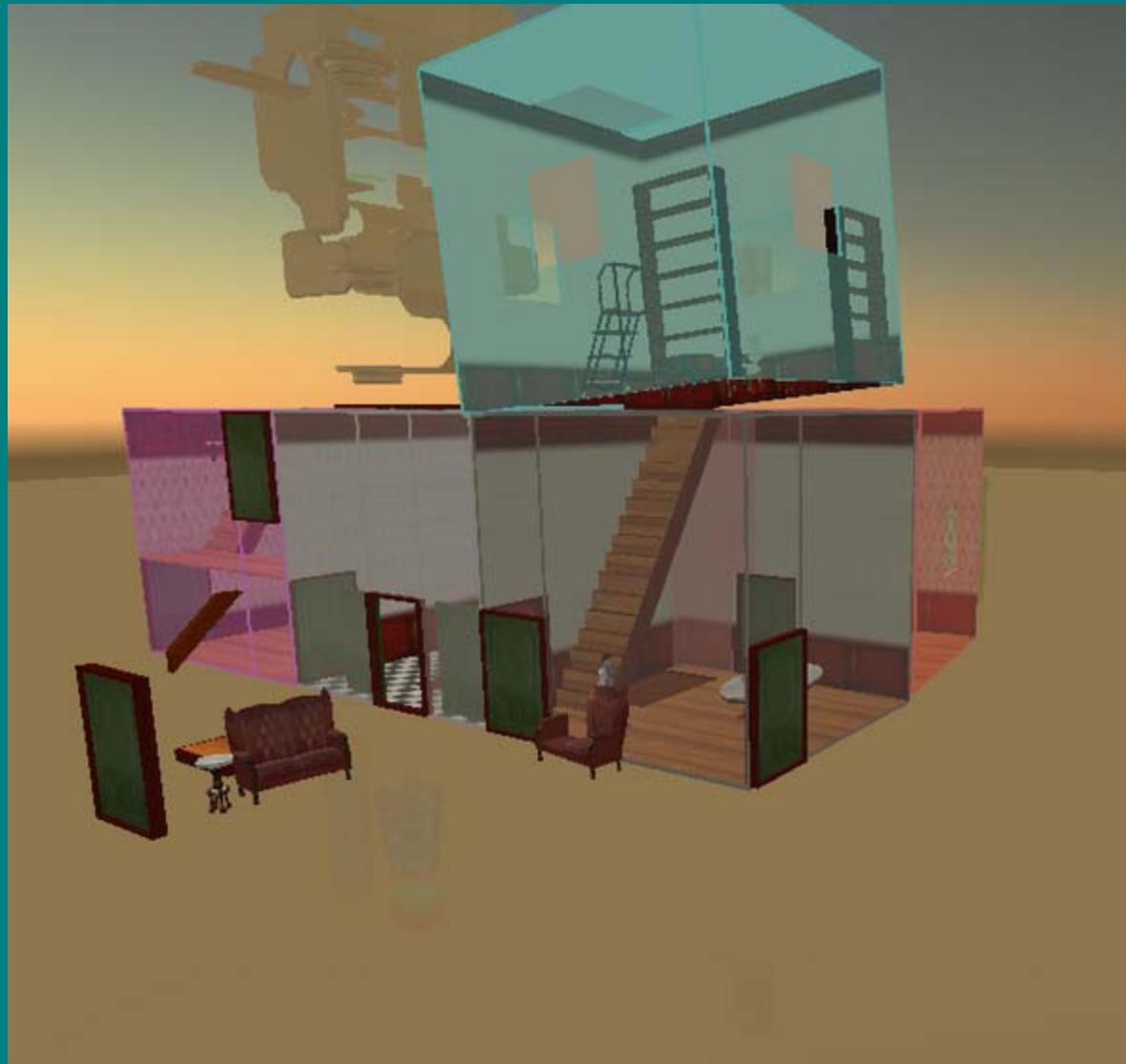
PHP and MySQL

These technologies are excellent technologies  
when appropriately applied (we use them)  
But if not engineered correctly they can result  
in....

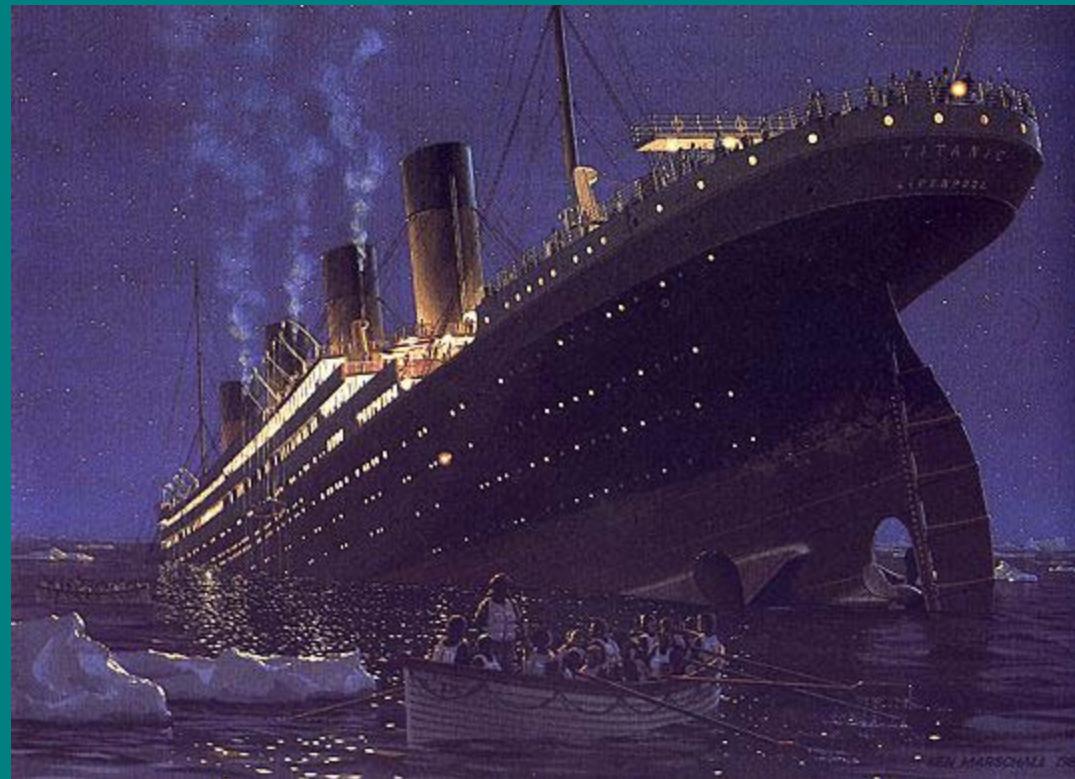
... yikes! we need a super hero to keep our database alive



... a fragile poorly designed system...



or at worst ...you end up with the  
Titanic™....



# Introducing JCMS...

# One solution to rule them all?

It isn't possible to develop a solution that works exactly right for everyone.

Even so, JCMS has a broad user base (1500+ members on the JCMS support list)

It does not do everything you want it to do, but...

- the benefits are real and can improve scientific outcomes
- significant cost savings may be achieved

Continued improvement/no HERO required

# The JCMS Tool Kit

JCMS – The Jax Colony Management System(JCMS)

*This is the application you will use regularly*

JCMS – MySQL Converter (JMyC)

*Converts from MS Access MySQL*

JCMS – MS Access Upgrader (JMAU)

*Upgrades to latest release*

JCMS – MySQL Upgrader (JMyU)

*Upgrades a MySQL instance to the latest release*

JCMS – Pedigree Tracker (JPT)

*Connects to JCMS and draws pedigree trees*

# Recommended adoption approach

- JCMS is rich with functionality, however....
  - You don't need to use all the features
  - Adopt the pieces and functions you need.
  - Expand your usage of it over time.

# Adoption STEP 1

- Meet with your lab group
  - Establish the use model for your lab
    - Will you have one lab owner OR will you have individual mouse owners (usually posdocs will be owners of their mice, but there is no universal model)

# Adoption STEP 2

- What is a strain (often referred to as a “line”)
  - JCMS attaches a “strain name” to a mouse
  - Genotype calls also are associated with individual mice
  - How will this work in your lab?

# Adoption STEP 3

- Establish a unique Mouse ID system
  - If you already have one, us it
  - There are many ways to do this, here are some suggestions that you can adapt from
    - MatingID-LitterNum-MouseNumber
      - E.g. 134-02-04
    - StrainCode-Protocol-SequenceNumber
      - E.g. B6-A432-0078
    - OwnerID-SequenceNumber
      - E.g. OVS-00023
    - EarTag Number
      - E.g. 004503

# Adoption STEP 4

- Think through how your work flow will be organized to use the database
  - Do you want to generate wean reports? If yes, you will need to enter litters into the database when they are observed?
  - If you do not care about wean reports, you can enter the litter and the mice in a one step operation (add litter with pups form)
  - Do you genotype your mice before you wean them? If yes, do you want a report that tells you which mice need to be genotyped? If yes, you will need to add litters first.

*Comprehensive workflow analysis is beyond the scope of this presentation.  
JCMS supports many different workflows. You will pick the forms appropriate for your workflow.  
Experiment with different workflows to find the best ones for your lab.*

# Adoption STEP 5

- Begin adding mice
- Set up matings
- Add litters
- Learn to use the reports and queries
- Record Genotypes
- Schedule mice for uses (if needed)

*Get comfortable using JCMS before considering tracking samples and/or experiments.*

# JCMS runs on a PC, but...

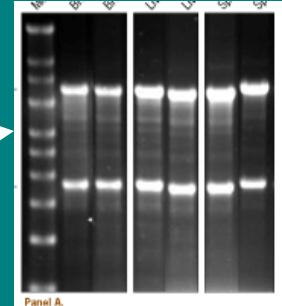
Most of our users at Jackson have Macintosh computers

Macintosh users can install under “Parallels” or other PC Virtual Machine solutions.

Macintosh and PC users can share a work group instance via the web using Citrix or other middleware solutions.

Table 1  
Experimental data and theoretical results for febrifugine, isofebrifugine and derivatives

Comp.	Antimalarial Activity ( $\text{IC}_{50}$ ) <sup>a</sup>	Cytotoxicity ( $\text{IC}_{50}$ ) <sup>a</sup>	Selectivity <sup>a</sup>	Quantum Indexes (eV)					
				$E_{\text{HOMO}}$	$E_{\text{LUMO}}$	$E_{\text{LUMO-HOMO}}$	$\Delta E_{\text{LH}}$	$\Delta E_{\text{LLH}}$	
I	$7.0 \times 10^{-9}$	$1.7 \times 10^{-7}$	243	-9.842	-9.214	-0.375	0.227	8.839	10.069
II	$3.4 \times 10^{-9}$	$1.8 \times 10^{-7}$	53	-9.640	-9.273	-0.438	0.171	8.835	9.311
III	$9.1 \times 10^{-7}$	$>2.9 \times 10^{-5}$	>32	-9.133	-8.950	-0.733	-0.308	8.217	8.825
IV	$4.8 \times 10^{-8}$	$>1.7 \times 10^{-5}$	>3.5	-8.881	-8.287	-0.454	-0.046	7.833	8.835
V	$2.0 \times 10^{-8}$	$1.0 \times 10^{-5}$	500	-9.863	-8.999	-0.553	-0.134	8.443	9.729
VI	$2.0 \times 10^{-8}$	$1.5 \times 10^{-5}$	750	-9.445	-8.890	-0.473	-0.069	8.417	9.376
VII	$3.7 \times 10^{-9}$	$3.8 \times 10^{-6}$	1027	-9.397	-8.916	-0.480	-0.066	8.401	9.301
VIII	$8.4 \times 10^{-9}$	$>2.4 \times 10^{-5}$	>10	-9.404	-8.876	-0.556	-0.155	8.424	9.349
IX	$6.0 \times 10^{-9}$	$>1.5 \times 10^{-5}$	>2.2	-10.032	-9.221	-0.655	0.686	8.566	10.719
X	$4.0 \times 10^{-8}$	$7.0 \times 10^{-6}$	175	-10.001	-9.059	-0.471	1.150	8.582	11.151
XI	$5.0 \times 10^{-7}$	$>1.6 \times 10^{-5}$	>32	-8.799	-8.786	-0.243	0.263	8.543	9.062
XII	$2.1 \times 10^{-8}$	$>6.3 \times 10^{-5}$	>3	-9.797	-8.653	-0.104	0.374	8.549	10.171

<sup>a</sup> Reference 8.

Easy to use, multi-user, transaction-based, relational database system designed for medium size work groups managing research mouse colonies and associated experimentally derived data and samples.

# JCMS Overview

## Colony management

- Mice
- Matings / Timed matings
- Litters
- Cage tracking w/ history
- Procedure Scheduling
- Genotyping
- Bulk operations

## Experiments

- Protocols
- Test scheduling
- Data tracking
- Bulk data loads

## Reports

- Ad-hoc queries
- Work reports
- Colony status report
- Line viability reports
- Plug dates
- Historical cage usage

## Samples

- Tracking samples to source
- Sample storage management

## Misc

- Handheld devices
- Pedigree tracking (JPT)
- MySQL database

## Next Releases: Q4 2010

- Advanced experimental/phenotype data management
- Web interfaces (for reporting)

# A Quick Intro JCMS

The Jackson Laboratory

Welcome To JAX JCMS Release: 4.0.0  
Logged in as: mtsadmin

JCMS

[Check for updates](#)

[Report a problem](#)

[Start \(Workstation\)](#)

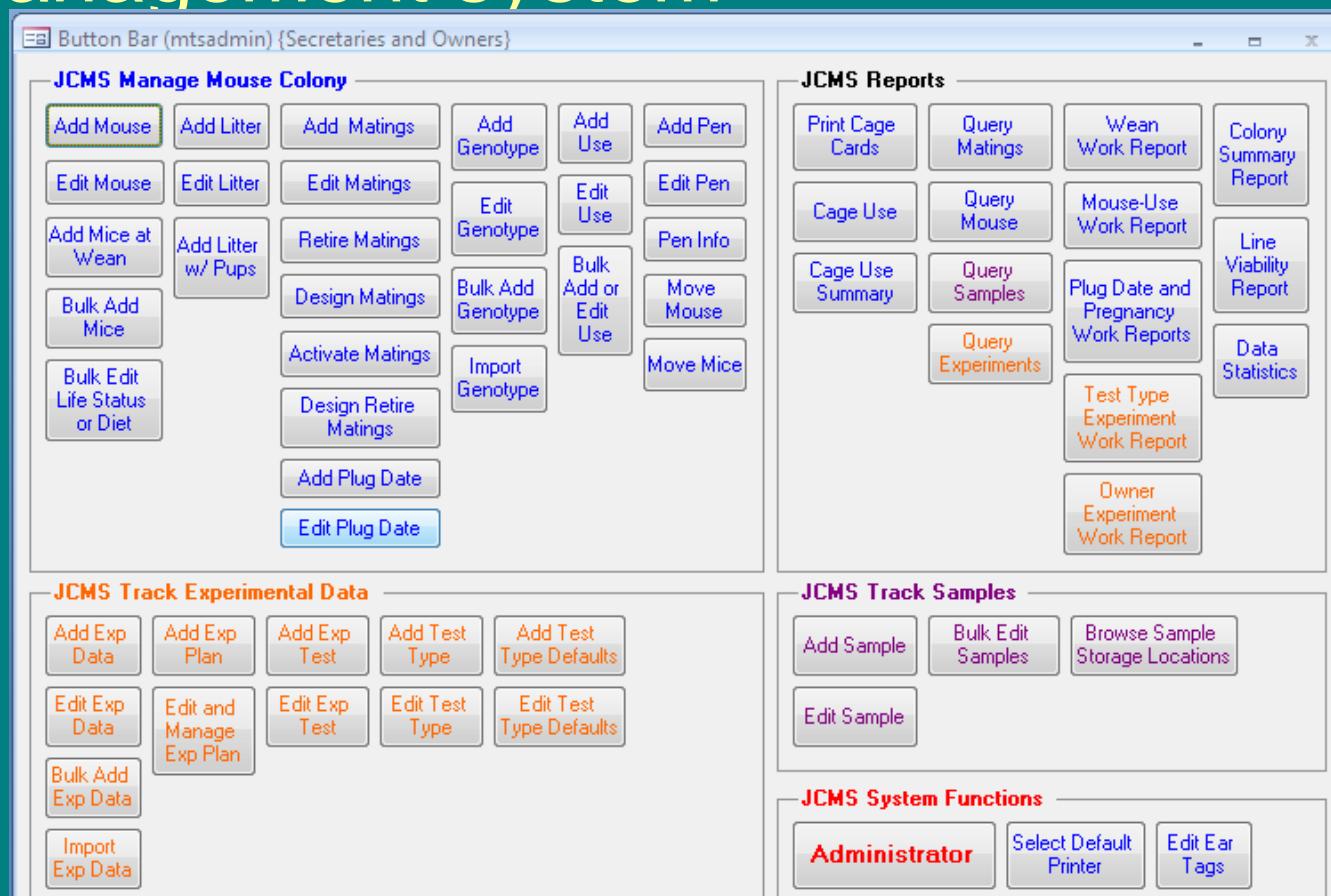
[Start \(Handheld Device\)](#)

**JAX JCMS**



The development and distribution of this software is made possible by generous grants from  
The National Institute for General Medical Sciences (NIGMS) [Grant number: 1R01GM072863-01]  
The National Cancer Institute (NCI) [Grant number: P30 CA034196-20]  
and  
The Howard Hughes Medical Institute

# JCMS is a work-group colony management system



Organized by functional areas

# Cage cards

- Mating
- Wean
- Detail

# – Bar codes

	P.I. PI Name 555-1212 (office)	Owner OWN1	
Activation date: <b>12/20/2005</b>	Sec:	Count / sex: <b>3 F</b>	Pen# <b>P57</b>
Put card note here (dbsetup)			
Expt #:			



# Hand held devices

- Symbol MC50
- PSION TEKLOGIX

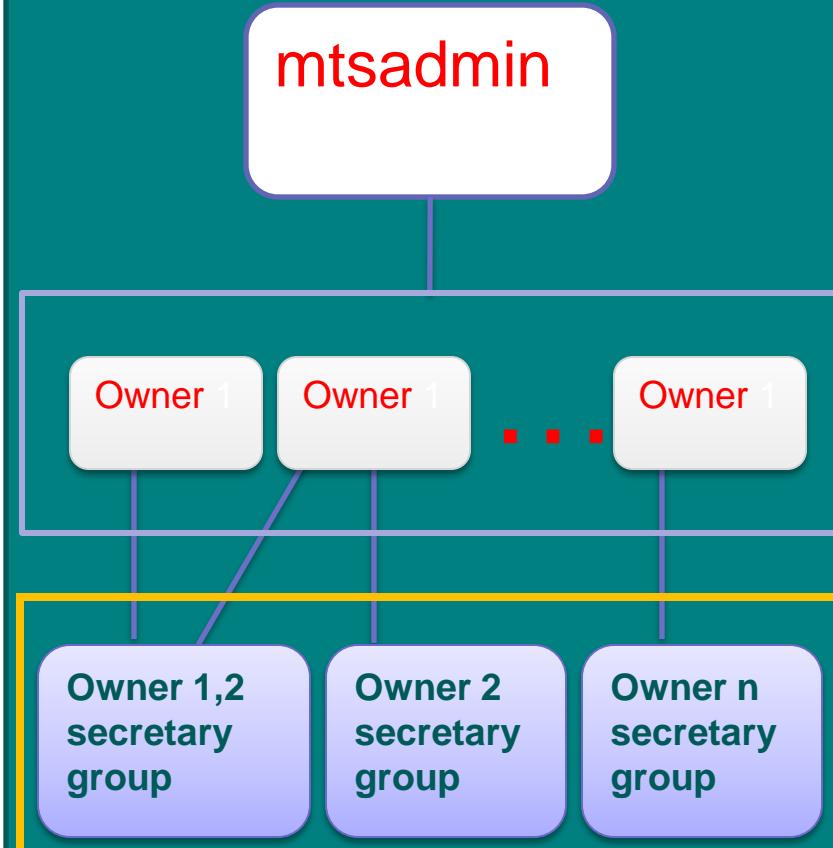


*Using handheld devices with JCMS requires a third party middleware solution such as Citrix to deliver the application to the device over wifi network.*

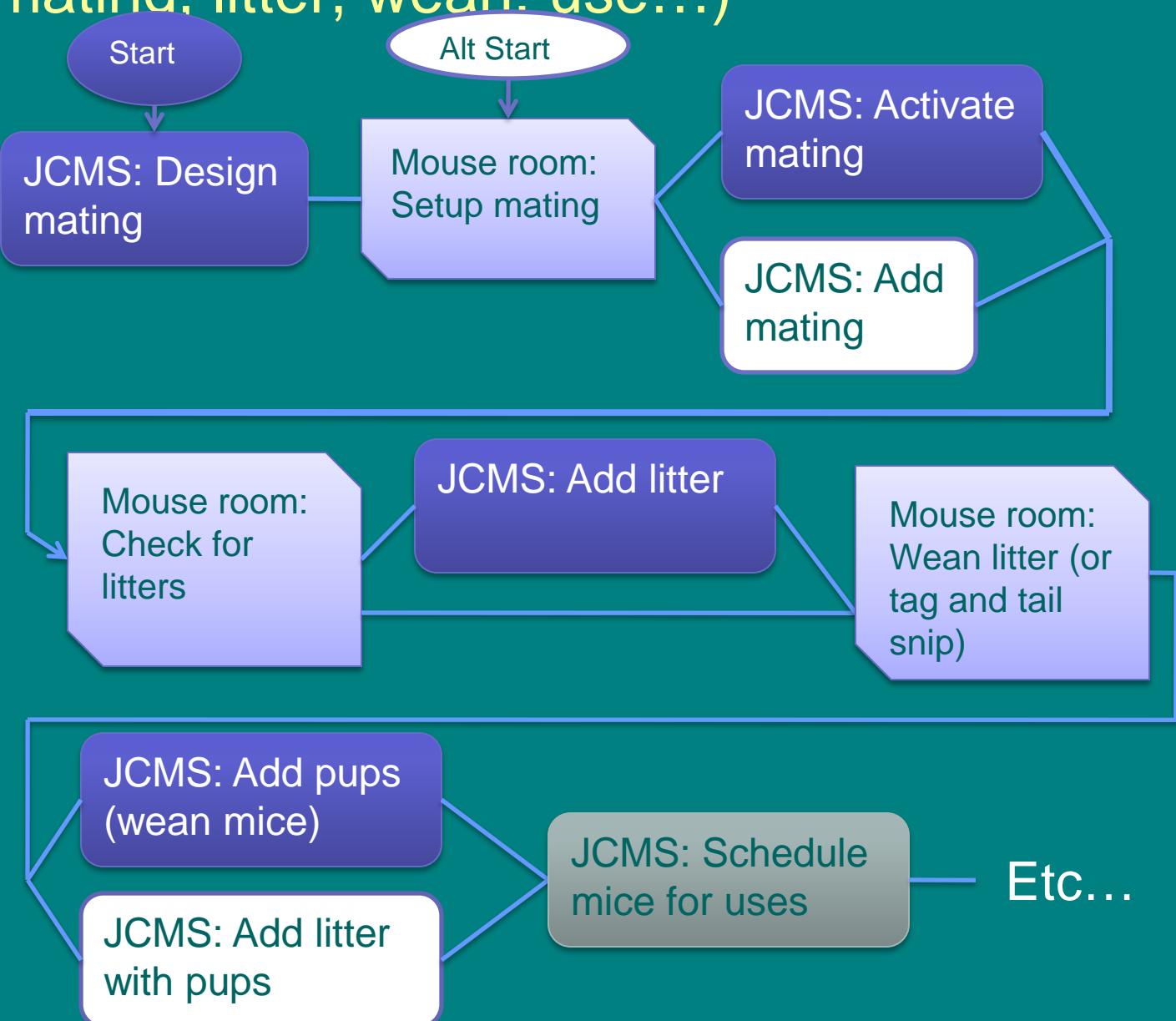
# JCMS Security Model

(collaborative workgroup security)

- **mtsadmin** is all powerful
- **Owners** can only work on their mice.
- **Owners** can view all mice
- **Owners** can give their mice to other owners.
- **Owners** cannot access the administrators menu
- **Secretaries** have (configurable) limited access to the mice of all owners they are associated with



# JCMS alternate workflows (example: mating, litter, wean, use...)



# JCMS is supported by

NIGMS - 1R01GM072863-01

HHMI

The Jackson Laboratory

# Credits

- Carol Bult
- Gary Churchill
- Simon John
- Derry Roopenian
- Olga Savinova
- Tom Sproule
- Larry Wilson
- Anne Peaston
- Susan Sheehan
- JCMS Users
- Martha Abbott
- Abigail Ames
- Kirk Barsanti
- Peter Blauth
- Chuck Donnelly
- Michael McFarland
- Dave Springer
- Beth Sundberg
- Kavitha Rama

# JCMS Live...

- Download JCMS from our web site
  - <http://colonymanagement.jax.org/>
- You can download the JCMS tutorials and use the on-line demo database
  - <http://colonymanagement.jax.org/tutorials.html>

# JCMS data trails

# Coordinating the data trail from the mouse-room to the computer and back

- Paper still plays an important role
  - Wireless laptops on carts.
  - Wireless printers
  - Handheld devices
  - Cage Cards play an important role

# Current JCMS Software Technologies

## MS Access 2003/2007

(we are dropping support for Access 2003 soon)

**MySQL Option for backend database  
ODBC Driver/Database conversion tool**

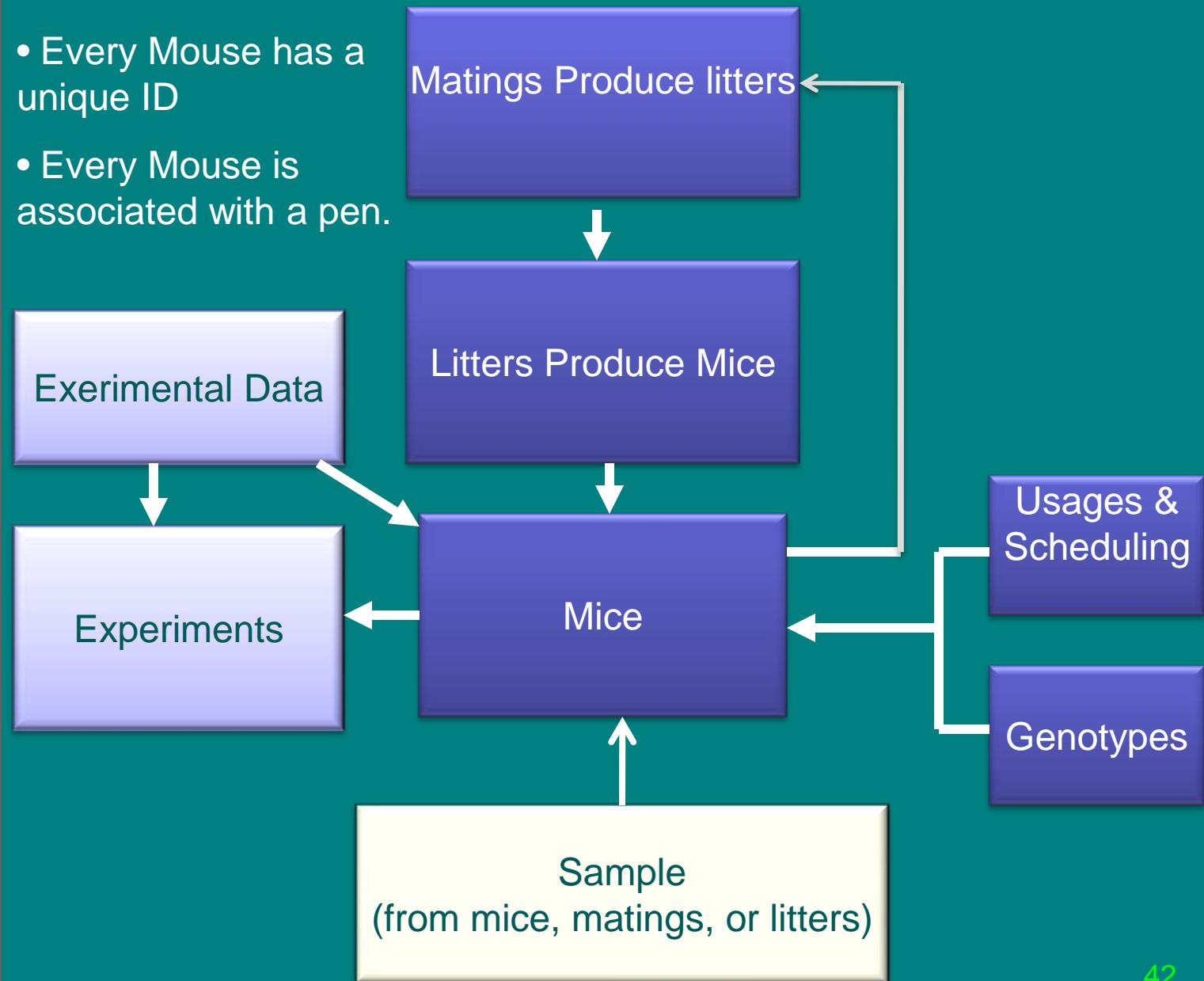
**Middleware Citrix MetaFrame Client/Server  
Thin client  
Web Browser accessible**

**Java for JPT  
Java VM  
ODBC**

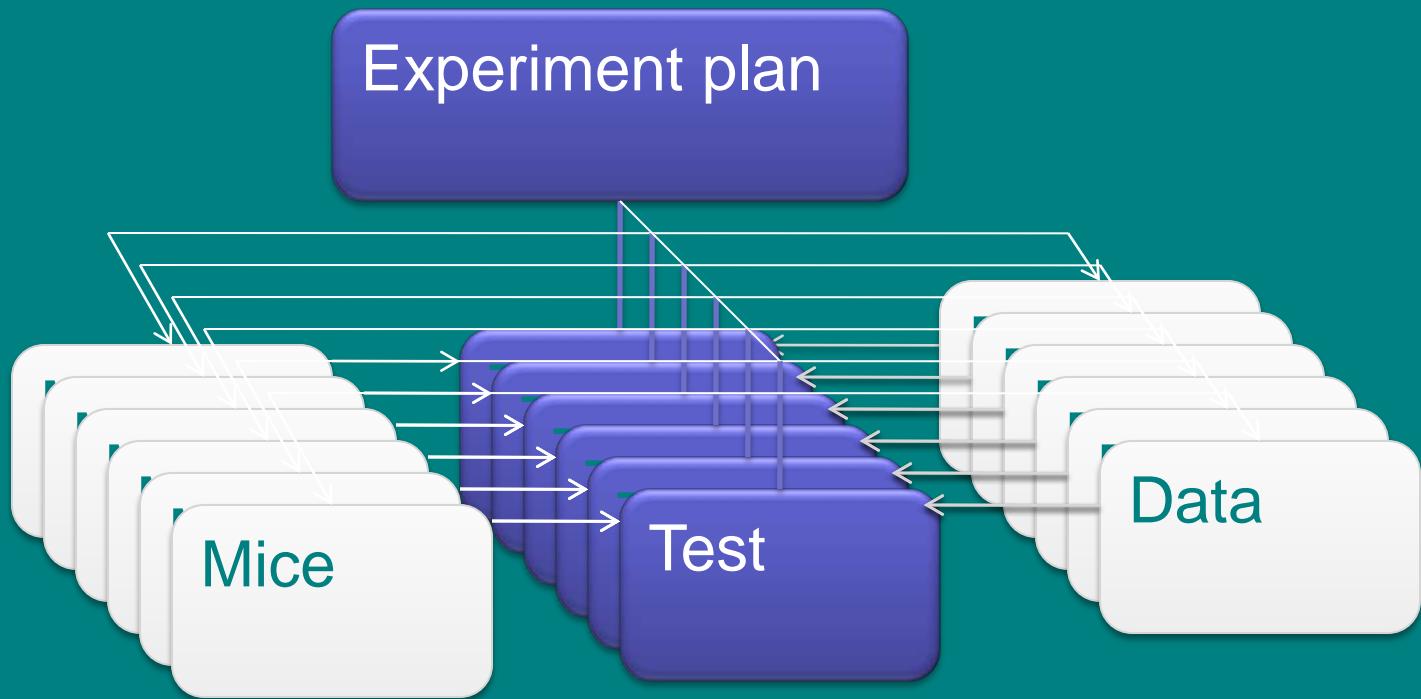
**Macintosh Virtual Machine (VM) software  
Parallels  
vmWare**

# JCMS Data Model (high level)

- Every Mouse has a unique ID
- Every Mouse is associated with a pen.



# The JCMS Experiment Plan



- Mice, data, and test information are encapsulated in a JCMS experimental plan
- Using the experimental plan allows you to schedule activities and associate the data with a hypothesis

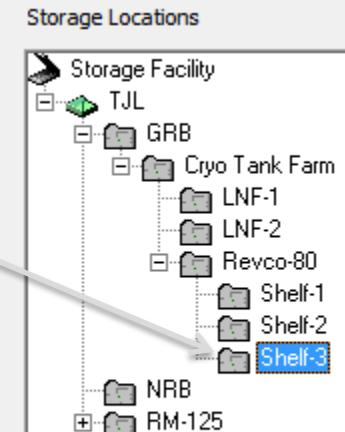
# Sample Tracking

Sample source: mice, mating,  
litter, parent sample, or other

Sample (s)

Storage location

Sample  
attributes



# Available Support Resources

JCMS Web Site: Download JCMS Tool Kit. General Information, FAQ, Tutorials, and Upgrade Tools, Pedigree Tracker tool etc.

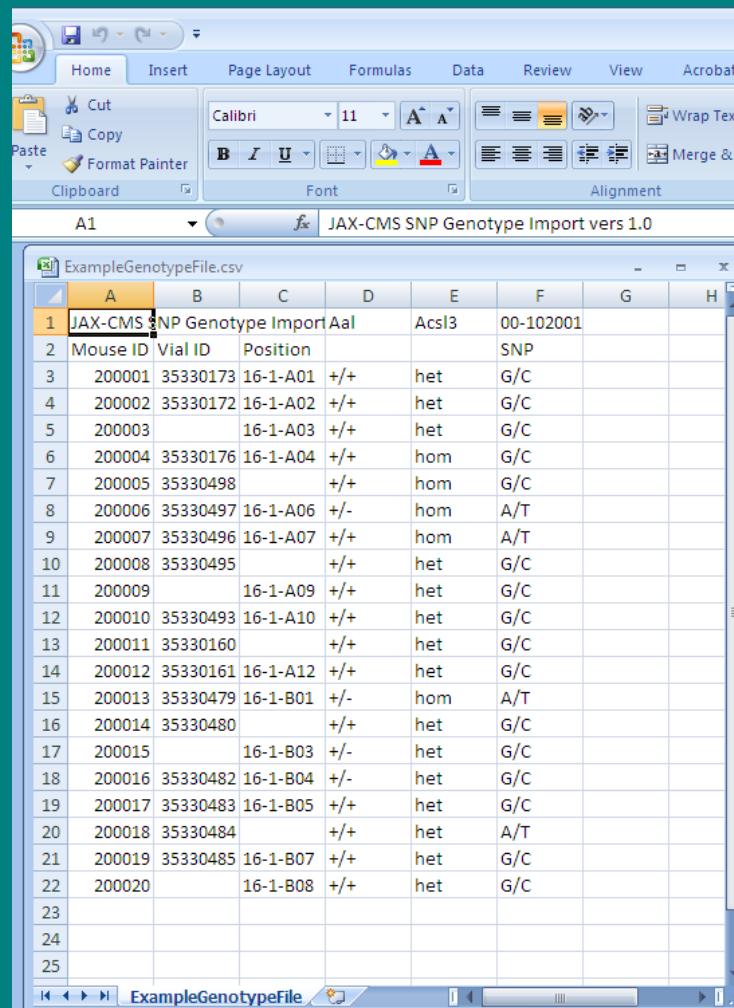
<http://colonymanagement.jax.org/index.html>

Discussion Forum:

<http://community.jax.org/forums/default.aspx?GroupID=7>. All questions posted on the forum are answered.

Discussion email group : [jaxcms@lists.jax.org](mailto:jaxcms@lists.jax.org) (sign up required for posting). Used mostly for announcements, but all questions are answered.

# Example JCMS Genotype format

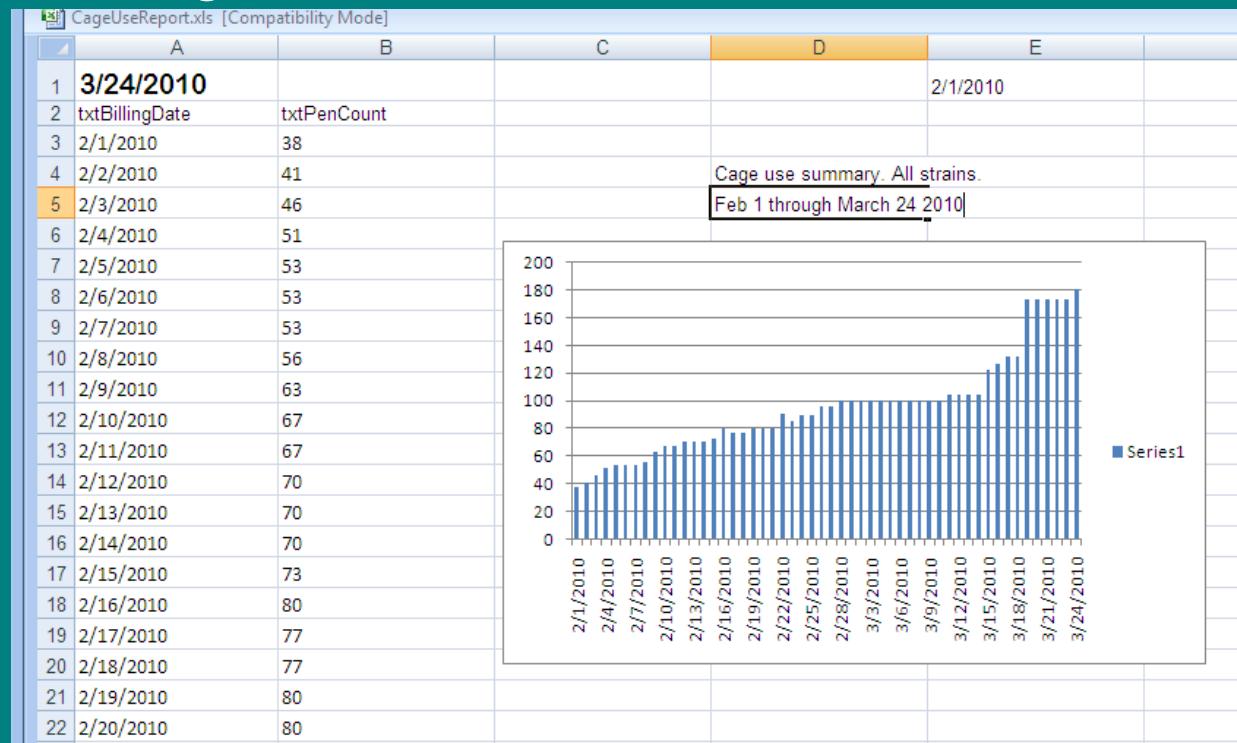


The screenshot shows a Microsoft Excel spreadsheet titled "ExampleGenotypeFile.csv". The spreadsheet has a header row with columns A through H. Column A contains numerical IDs from 1 to 25. Columns B and C contain "Mouse ID" and "Vial ID" respectively. Column D contains "Position". Columns E, F, and G represent genotypes. Column H is empty. The data starts at row 2. Row 1 contains the header information: "JAX-CMS SNP Genotype Import Aal" in cell A1, "AcsI3" in cell E1, and "00-102001" in cell F1.

A	B	C	D	E	F	G	H
1	JAX-CMS SNP Genotype Import Aal			AcsI3	00-102001		
2	Mouse ID	Vial ID	Position		SNP		
3	200001	35330173	16-1-A01	+/+	het	G/C	
4	200002	35330172	16-1-A02	+/+	het	G/C	
5	200003		16-1-A03	+/+	het	G/C	
6	200004	35330176	16-1-A04	+/+	hom	G/C	
7	200005	35330498		+/+	hom	G/C	
8	200006	35330497	16-1-A06	+-	hom	A/T	
9	200007	35330496	16-1-A07	+/+	hom	A/T	
10	200008	35330495		+/+	het	G/C	
11	200009		16-1-A09	+/+	het	G/C	
12	200010	35330493	16-1-A10	+/+	het	G/C	
13	200011	35330160		+/+	het	G/C	
14	200012	35330161	16-1-A12	+/+	het	G/C	
15	200013	35330479	16-1-B01	+-	hom	A/T	
16	200014	35330480		+/+	het	G/C	
17	200015		16-1-B03	+-	het	G/C	
18	200016	35330482	16-1-B04	+-	het	G/C	
19	200017	35330483	16-1-B05	+/+	het	G/C	
20	200018	35330484		+/+	het	A/T	
21	200019	35330485	16-1-B07	+/+	het	G/C	
22	200020		16-1-B08	+/+	het	G/C	
23							
24							
25							

# JCMS 4.0

- Comprehensive cage (pen) tracking
  - Historical cage activity reports (example below)
  - Health level tracking
  - cage names



# Future plans

## Four areas of development

- Functionality
- Technology
- Scalability
- User Support

# New Functionality

Major new functionality planned:

- Continue to respond to user requests for new features
- Improved protocol and experimental data management
- Improved cage management
- Multiple model organisms
- Connecting samples to experiments
- Technical matings (e.g. ovary transplant)
- Track data and image files
- Advanced sample tracking
- Tracking Embryos with matings

# New Technologies

Major new technologies in planning:

- Platform independent JAVA application framework
  - Eventually end the use of MS Access
  - MySQL is currently planned as primary future database backend
- Web browser interfaces
  - Wherever possible use web browser interfaces
  - Web browsers are easy to use, but require technical support to install and maintain web servers

# Changes to Support Scalability

Moving toward enterprise use cases:

- One JCMS instance for multiple workgroups
- Support for data/mouse sharing between workgroups
- Enterprise security model

# Growing User Support

Expand on-line presence:

- Webinars
- Video tutorials
- Training
- Continue to grow the web site
- Continue to grow the use of the community forum

# Sample Tracking

- A Sample IS a biological specimen associated with a strain.
  - Samples are typically derived from entities already in the database
    - One or more Mice (e.g, organs, sperm)
    - One or more Matings (e.g. fertile embryos)
    - One or more Litters (e.g. harvest pups)
  - Samples that are not derived from one of the above may be specified as from “Other” (e.g. a cell line)

# Sample storage tracking

- Example
  - Room – M32
    - Freezer LN2
      - Sector A
        - » Rack – 1- Arbitrary level of detail
- Can query for list of all samples in freezer (as an example)



Chronicle / Michael Macor

# Mouse line viability report

A mouse line is viable if you have a sufficient number of breeders under a specified age.

User configurable Red and yellow limits for each strain

Min # males

Max age males

Min # females

Max age females

## Line Viability Report

Strain: B6.129P2-Apoe<tm1Unc>/J      Warning Level    YELLOW

Age Limits	Red	Yellow
Female	200	190
Male	200	190

### Minimum Number Mice Required

	Red	Yellow
Female	4	4
Male	4	4

### Number of Mice in Inventory

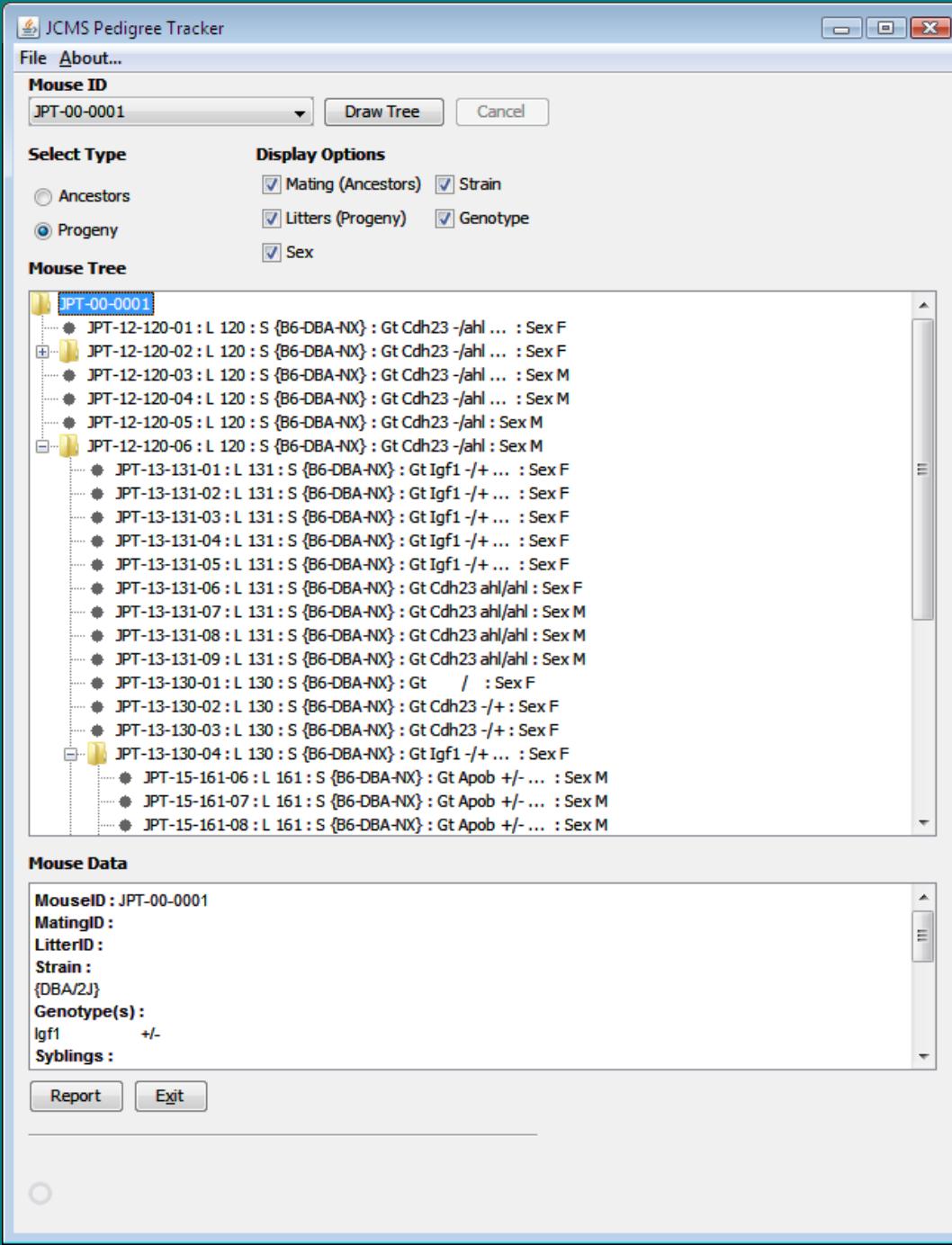
	# Mice <= Red Age AND > Yellow Age	# Mice <= Yellow Age
Female	5	0
Male	5	0

Strain: B6D2F1/J      Warning Level    RED

Age Limits	Red	Yellow
------------	-----	--------

# JCMS Pedigree Tracking Tool (JPT)

- Tracks pedigree several generations
  - Progeny
  - Ancestors
- Easy tree walk
- View details as you go
- Printable reports



# Colony Managers Summary Report

- Summarizes all current colony activities in research program
  - Number of live mice in the colony
  - Number of active strains
  - Number of active pens
  - Number of active breeding units
  - Number of active experimental plans
  - Number of active experimental tests
  - Number of mice currently scheduled for tests
- Summarizes for each mouse owner individually
  - Number of active breeding units
  - Number of live mice/strain
  - Number of active pens
  - Number of experiments
  - Number of tests broken down by plan with proposed mice for each test
  - Number of mice currently scheduled for testing

## Colony Summary Report For 8/18/2008

### Summary Statistics

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Number of live mice for all owners: 49  
Number of active strains for all owners: 6  
Number of active pens for all owners: 6  
Number of active matings for all owners: 0  
Number of active plans for all owners: 6  
Number of active tests for all owners: 6  
Number of mice scheduled for testing for all owners: 27

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### Detail Reports

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Number of live mice by owner and strain

---

Owner: joe

Strain name	#live mice
B6D2F1/J	11
FVB/NJ	10

Total mice for joe: 21

Total active strains for joe: 2

Owner: peter

Strain name	#live mice
BALB/cByJ	4
BALB/cJ	5
NOD.CB17-Prkdc<scid>/J	10
NOD/ShiLtJ	9

Total mice for peter: 28

Total active strains for peter: 4

Number of pens by owner and room

---

Owner: joe

Room	# pens

Owner: joe

Room	# pens
	3

Total active pens for joe: 3

Owner: peter

Room	# pens
	2
	1

Total active pens for peter: 3

Number of active matings by owner

Total active matings for joe: 0

Total active matings for peter: 0

Number of active plans and tests by owner

Active plans and tests for joe

Plan Name: joe\_active plan\_1

Test ID	Test Name	Proposed # mice
5	joe_active test_a	
6	joe_active test_b	

number of active tests for joe\_active plan\_1: 2

Plan Name: joe\_active plan\_2

Test ID	Test Name	Proposed # mice
9	joe_done test_2	

number of active tests for joe\_active plan\_2: 1

Total active plans for joe: 3

Total active tests for joe: 3