How to Complete a Risk Assessment for CRISPR Experiments in Animals and Cell Culture

1. **Project Description:** CRISPR specific for [insert species] will be used to inactivate [insert gene] to create a model for [insert disease]. Include how CRISPR will be dosed: viral vector, plasmid, liposome, etc.
2. **Format of Gene Silencing:** Are you attempting random or specific gene silencing? Will silencing be one-step (Crispr/Cas9 and gRNA combined in one vector) or two-step (create cell line containing Crispr/Cas9, then add gRNA) or purchasing pre-transfected cell lines containing CRISPR-Cas9, then transfecting the RNA guide sequences?
3. **Containment Requirements:** Usually **BSL-1** and chemical hygiene practices, containment equipment and facilities for all activities involving non-virus dosing. For virus-vectored CRISPR, **BSL-2** practices including biological safety cabinets are recommended. Centrifuge safety precautions, secondary containers for transport between incubator and BSC. Keep hands away from the eyes, nose and mouth in order to avoid potential exposure of the mucous membranes; eye goggles or face shields may assist in accomplishing this objective.
4. **CRISPR Injection dosing precautions:** The use of sharps should be minimized. Safe-sharp technology is highly recommended during animal dosing.
5. **Spills:** If non-virus vectored, cleanup per the chemical hygiene plan. If virus vectored, the follow BSL-2 spill instructions.
6. **Biohazardous Waste:** Collect in double red bags and transport in a rigid container.
7. **Approved Disinfectants:**
   i. Non-virus vectored siRNA: soap and water
   ii. Virus-vectored; disinfectants appropriate for the virus.
8. **Disposal:** Non-virus vectored, as a chemical. Virus-vectored: Decontaminate before disposal; steam sterilization, incineration, chemical disinfection.
9. **Storage:** Store plasmids as per the chemical hygiene plan. Store virus vectors as BSL-2 organisms.
10. **Pathogenicity:** Mucous membranes, ingestion, broken skin and injection. Reasons can be sharps contact, failure to wash hands, skin contamination from dirty gloves or work surfaces.
11. **Modes of Transmission:** Liposomes and plasmids may cross the cell membrane of individual cells. If the gene target is present, it could result in silencing. Liposomes and plasmids are not infectious; once integrated into cells, they do not reproduce. For virus vectored, refer to appropriate virus vector sheet.
12. **Length of gene deletion:** In human and mammalian cells, as well as animals, CRISPR silencing is permanent. It is transmissible to off-spring.
13. **Communicability:** If virus vectored, accidental contact with live virus can result in CRISPR expression.
14. **Medical surveillance and clinical treatment procedure**: Immune suppression is required, as the silencing can affect the immune system. Clinical Operating

Procedure “Virus Vectors” must be listed on risk assessment if used to vector CRISPR.

15. **Stability in Environment:** Refer to appropriate virus vector sheet.
16. **CRISPR concentration, dosage per experiment:** State your stock concentration and the amount used per experiment or kg animal weight.
17. **CRISPR shedding from animals:** Animals will not shed CRISPR if dosed with plasmid formulations. For viral vectors, refer to specific viral vector risk assessment.
18. **CRISPER Information:** Discuss the desired effect of gene editing on the animal or cell line. You must address the potential effects due to accidental worker exposure. If unknown, state that. Points to consider are:

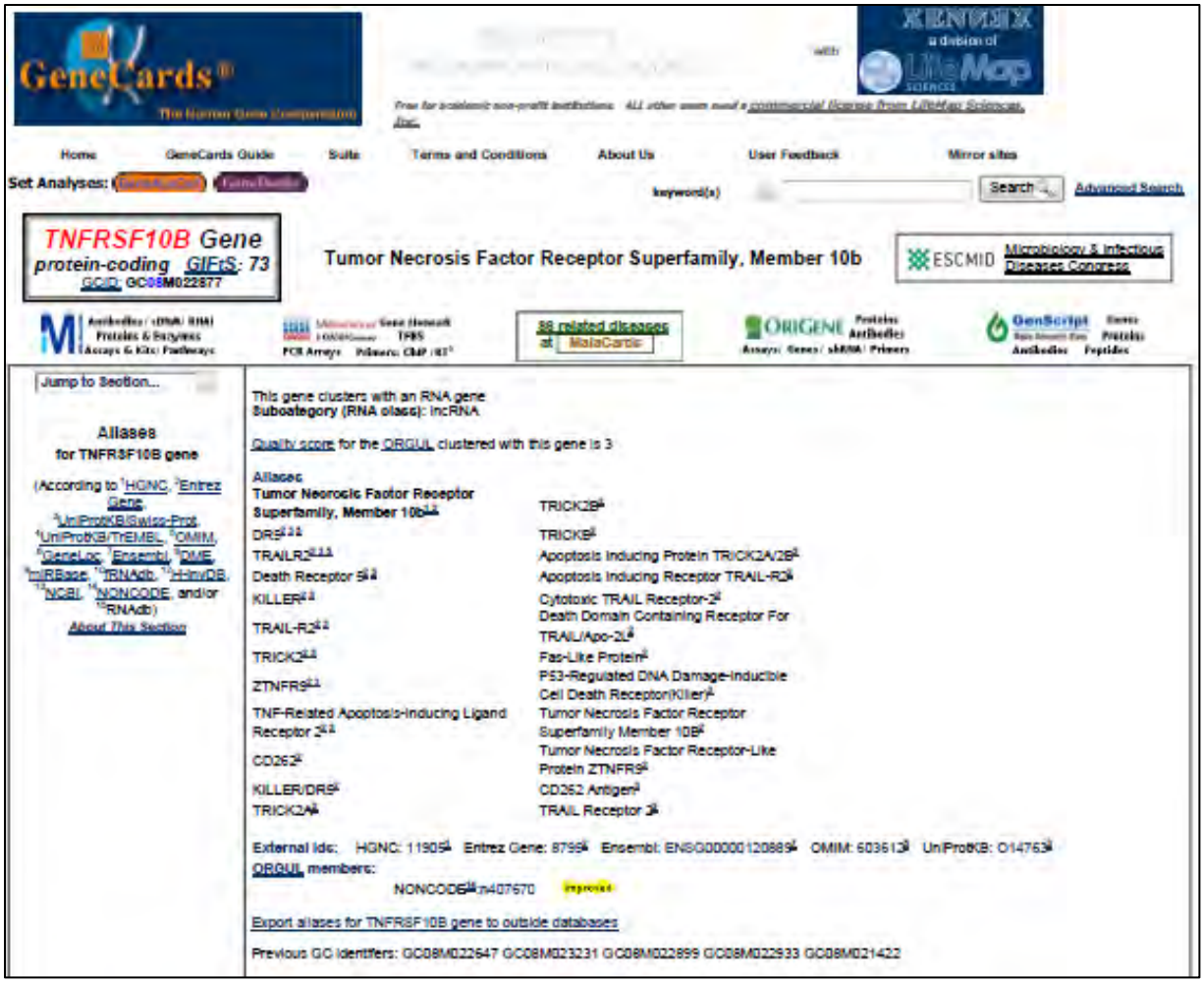
    a. Is the guide sequence specific to animals, humans or could it affect both? Similarity between human and animal guide sequences?

    b. What is known about off-target effects

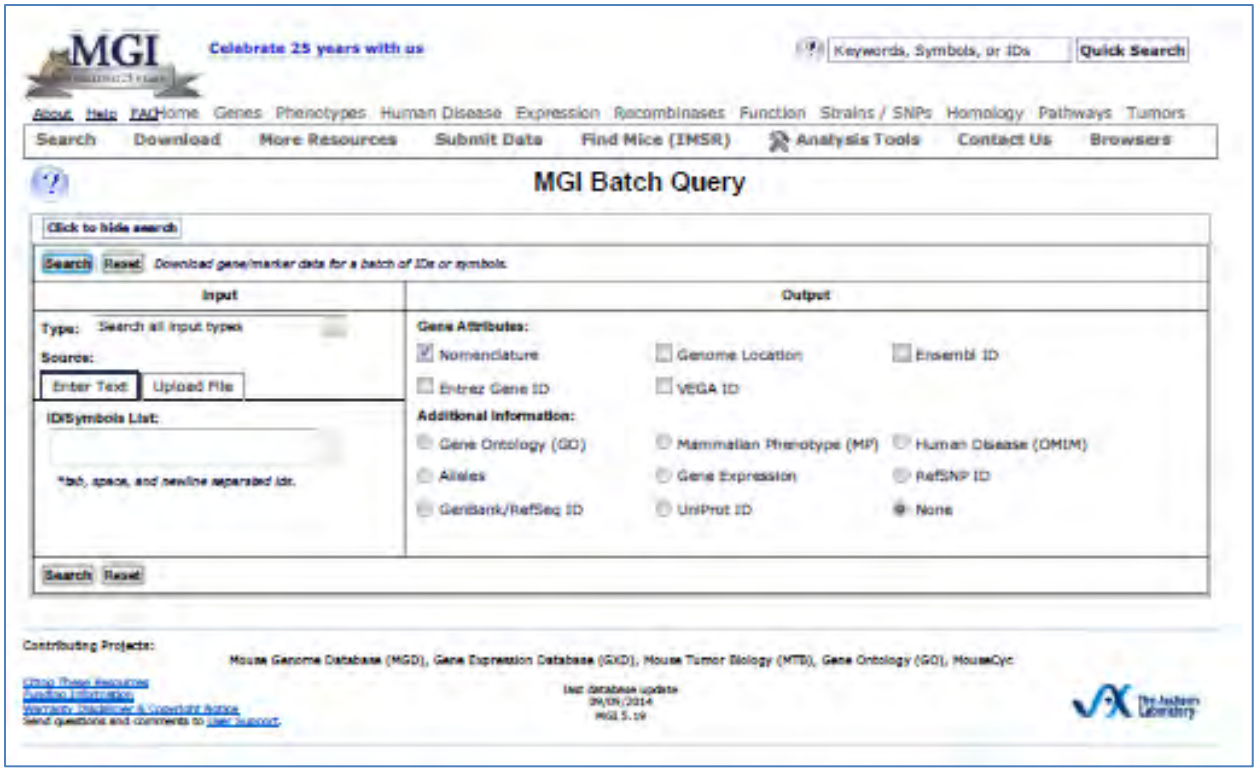
    c. How much genotype change (dose) is needed for a physical effect?

    d. How does route of exposure affect outcome?

A good source for understanding the transgene being silenced or over-expressed is GENE CARDS (http://www.genecards.org/). A snapshot of a sample gene card is shown below:



To better understand potential human outcomes from accidental silencing, you can see if information exists in the JAX Mouse Genome Informatics: (http://www.informatics.jax.org/batch). Enter the gene designation, and then look to see if a mouse knockout phenotype exists. If so, add that information to the risk assessment.



To gain more information on gene mutations related to cancer, the database Atlas of Genetics Oncology (http://atlasgeneticsoncology.org/index.html) can be consulted: