Biology 2 - genetics, heredity, and evolution

Unit 1: heredity (reproduction, mendel, inheritance/traits)

ONE PAGE SUMMARY:

NGSS concepts / standards to cover:

MS-LS3-2 - understand that asexual offspring are identical and sexual reproduction produces offspring with genetic variation.

1. **What makes a species?** - *introduce goals of course and spark curiosity*
2. **Life finds a way** - *asexual vs sexual introduction, an overview of the basic concepts*
   Friday extension:
   - *review questions for younger audience on terms (species, hybrid, propagation, spore, seed, advant and disadvant of asexual vs sexual reproduction)*
   - *Activity: vegetative propagation of potato (cut potato into 4th to make 4 clones)*

3. **Mendel's famous experiment** - *discovery of 'units of heredity' and concept of being diploid (one copy of information from each parent)*
4. **Laws of heredity 1** - *genotype and phenotype, recessive and dominant traits. Each organism inherits one allele from each parent.*
   Friday extension:
   - *Review questions for younger audience on terms (diploid, dominant, recessive, trait)*
   - *Deep dive: article about whether or not Mendel falsified his data?*

5. **Laws of heredity 2** - segregation and independent assortment - examples with cats.
6. **Punnett Squares** - Project to go through several punnett squares and practice different types (monohybrid, dihybrid etc)
7. **Pet pedigree puzzles** - *practical application with horse, python, and cat breeders to reinforce and practice the concepts learned.*
   Friday extension:
   - *Review questions for younger audience (heterozygous, homozygous etc)*
   - *Deep dive: article and pedigree puzzle about hemophilia and royal families in Europe?*
8. **Quiz show**

Unit 2: genetics (chromosomes, genes, genetic engineering)

ONE PAGE SUMMARY:

NGSS concepts / standards to cover:

MS-LS1-5 - growth of organism is influenced by environment and genetics
MS-LS3-1 - understand how mutations on chromosomes change proteins and result in harmful, neutral, or beneficial effects on structure and function.
MS-LS4-5 - appreciate the technologies and approaches humans use in artificial selection (genetic modification, gene therapy, animal husbandry…)
MS-LS4-4 - genetic variations in traits impact probability of surviving/reproducing

9. **What is a gene?** - *review of what DNA is. A relatively small sequence of nucleotides can control a physical trait.*
10. **Chromosomes and linked traits** - *what a chromosome is, how traits on the same chromosome are linked.*

    Friday extension:

    - *Review questions for younger audience on terms (DNA, gene, trait, chromosome, cell etc.)*
    - *Activity: gummy worm karyotype*

11. **The genetic code/Blood type explained** - *the information in DNA becomes a trait through transcription and translation. Blood type examples.*
12. **Protein synthesis** - *a closer look at the ribosome and how a sequence of nucleotides becomes protein.*

    Friday extension:

    - *review questions for younger audience on terms (DNA, translation, protein, blood type, dominant, recessive, etc)*
    - *Activity: What's the blood type?*

13. **Meiosis and Mistakes** - this is why the chance of inheriting Y or y is 50/50. Explore polyploidy, why are reptiles ZW while mammals are XY?
14. **Mutations** - *what things cause mutations and what are the common effects.*

    Friday extension:

    - *review questions for younger audience on terms (diploid, haploid, gamete, mutations)*
    - *Red-green colorblindness - deep dive, an interesting article.*

15. **Nature and nurture** - *how the environment impacts gene expression*
16. **Calico Cat Puzzle** - *applied activity to predict the likelihood of a calico cat.*

    Friday extension:

    - *review questions for younger audience on terms (gene expression, previous terms relating to genetics,)*
    - *Activity: Why Red Delicious apples are the least delicious apple.*

17. **Modifying genes / gene therapy** - all about genetic modification
18. **Genetics Quiz show**

Unit 3: evolution (natural selection, genes, meiosis)

ONE PAGE SUMMARY:

NGSS concepts / standards to cover:

MS-LS1-4 - specialized behaviors/structures affect probability of reproduction in animals/plants
MS-LS4-1 - use data from the fossil record to appreciate the change and diversity in life forms through the history of life on Earth.
MS-LS4-2 - infer evolutionary relationships between modern & fossil organisms by comparing anatomical similarities and differences.
MS-LS4-3 - analyze embryonic similarities across multiple species.
MS-LS4-6 - Use math to support how natural selection increases or decreases a trait in a population over time.

19. **Endangered vs invasive species** - *traits (alleles) vary and impact successful reproduction.*
20. **Darwin and the Galapagos islands** - history of the first publication on natural selection.
    Friday extension:
    - *review questions for younger audience on terms*
    - *Activity: Journey of the HMS Beagle.*
21. **What causes new viruses / Survival of the fittest / a title about spores?** - *resources are limited and the traits best suited for survival and reproduction will be selected for.*
22. **Color-changing moths** - an adaptation is favored by natural selection.
    Friday extension:
    - *review questions for younger audience on terms*
    - *Deep dive: When Sherpas climb Mt. Everest.*
23. **Genetic Drift** - The traits that are passed on aren't always the "best."
24. **Australia vs New Zealand** - natural selection in action, introduction to deeper exploration of speciation.
    Friday extension:
    - *review questions for younger audience on terms*
    - *Activity: model a gene in a population.*

25. **What is a species really?** - explore speciation and talk about areas of debate
26. **How are animals related? -** Examine similarities/differences between birds and bats,
    Friday extension:
    - *review questions for younger audience on terms*
    - *Deep dive: How DNA analysis rewrote phylogenetic trees?*

27. **Phylogenies and family trees** - focus on homologous traits and common ancestors (here's where we would satisfy the science standard about embryo structure and touch again on the concept of vestigial traits)
28. **The fossil record -**
    Friday extension:
    - *review questions for younger audience on terms*
    - *Activity: Build your own phylogeny*

29. **Timeline of life on earth** - Fossil history- put together timeline of notable events in Earth's history - focused on appearances of first animals, plants, etc… Final activity to make timeline
30. **Activity of looking at the three anchor diagrams and/or the life on Earth timeline?**
31. **Evolution Quiz Show**

Detailed Outlines:

Lesson 1: WHAT IS A SPECIES?

Can see the doodle notes for this lesson on pages 6-7 of this PDF:
https://science.mom/images/Biology/Biology2NotesPreview.pdf

Objective:

Introduction video that highlights learning objectives for the course and inspires curiosity and a sense of wonder about the concepts of heredity, traits, adaptation, and evolution.

1 min Introduction script:

Piper is a toy chihuahua. He loves to bark and chase tennis balls. When he goes out for a walk he's usually carried in a purse or backpack because he has a hard time crossing the curb of a sidewalk. Dog breeds this small are often called teacup dogs because as puppies, they're so small they can literally fit inside a teacup.

Winston is an English Mastiff. He loves drinking water from sprinklers and at 220 pounds he's so big, he can reach objects on top of the fridge. Strangers driving down the street will often stop to ask what breed he is, how much he weighs, or just to yell "That's a BIG dog!"

Piper and Winston are incredibly different animals, and yet they're both dogs. They're members of the same species. Seeing different dog breeds side by side, it makes one wonder, what exactly is a species? And how did various dog breeds become so drastically different from each other?

I'm science mom. And I'm math dad. Today's lesson explores what species is, and presents an overview of what we'll be learning in our units on heredity, genetics, and evolution.

Lesson outline:

*Compare several different dog breeds with different characteristics.
*How do you define a dog? According to your definition, is a cat also a dog?
*Could dogs become two different species -- like tigers vs lions or bears vs weasels, or horses & donkeys?
*How do we define what a species is? Why can some species hybridize (like donkey x horse = mule) but others can't?
*Finish with the promise of what we'll understand at the end of bio 2 (understand how traits are passed on, why a mule is sterile but a liger is not, how it is that selective breeding produced dogs with such different shapes/attributes, how the carnivora evolved and changed, with some

species (like saber-toothed cat) going extinct and others (canidae) diversifying into many related species)

Ending script that ties us into the next lesson:

To get there, we need to understand more about how living things reproduce. A dog will have a litter of puppies that are all unique individuals with different characteristics. But not every living thing reproduces this way! Certain bacteria, plants, fungi, and animals can clone themselves, intentionally breaking off pieces of themselves to form an army of clones. Why does this strategy work for some species, but not others, and are there advantages to not cloning yourself? That's what we'll cover in the next lesson, *life finds a way*.

Lesson 2: LIFE FINDS A WAY

Can see the doodle notes for this lesson on pages 8-9 of this PDF:
https://science.mom/images/Biology/Biology2NotesPreview.pdf

Objective:

Video covers the differences between asexual and sexual reproduction. Reinforces and clarifies terms such as clone, offspring, seed, spore, and propagation. Addresses the concepts in Next Generation Science Standard MS-LS3-2:

MS-LS3-2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]

1 min Introduction script:

Alice likes to think she's unique. Sure, she looks a little bit like her mom, and a little bit like her dad, and a little bit like her brother and sister. But when it comes down to it, there's no one else on Earth exactly like Alice.

But not all organisms can say that. Some produce offspring by literally cloning themselves: they sprout a bud or scatter spores into the wind, and those little offspring grow up to be genetically identical to the original organism. If humans did that, Alice would be an exact genetic copy of her mom or dad. In fact, she'd only have one parent!

That could come with some advantages. Alice could wear all her mom's clothes, and Alice's mom could go to school for her when she was sick! Nobody would ever have to find a partner,