Principles of Genetics: Job Aide

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Author Note

Graduate School Project for LTEC 5510: Technology-Based Learning Environments

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Principles of Genetics: Job Aide

Principles of Genetics is a 6-week, 45-hour course that focuses on freshmen level, high school biology. This job aide will cover the learning theory behind the course, scheduling, tips and tricks, goals and objectives, assessments, and the environment along with including keys to all the worksheets.

Learning Theory

This course uses a combination of learning theories to reach all students. Gardner's theory of multiple intelligences is used in the course's material in various forms: video, reading, and games. This course also uses a constructivist learning theory with a problem-based approach. In the Geniverse game, played throughout the course, a scaffolding model used to help students "predict, observe, explain, and evaluate (POEE)" genetic outcomes (Mamun, Lawrie, & Wright, 2020). Group discussion, in this course in this course, allows students to self-evaluate, helping students to help clarify and crystalize their knowledge of what they have learned.

Prerequisite knowledge

Prerequisites for this course include DNA structure and function and its base-pair rules. An understanding of mitosis is also helpful for this class.

Goals and Objectives

This course is designed to teach sections B1, B2, C2c, C6b, c, d, f, and g of the Texas Essential Knowledge and Skills TEKS Biology. These can be found at http://ritter.tea.state.tx.us/rules/tac/chapter112/ch112c.html#112.34.

Goal 1. Describe the process of Meiosis and how it leads to the independent assortment of genes.

1.1. The learner can describe the phases of Meiosis.

1.2. The learner can describe how the separation of homologous chromosomes and the process of crossing over can lead to genetic diversity.

1.3. The learner can determine the number of chromosomes in somatic cells and gametes

1.4. The learner can interpret a karyotype to determine the gender of an individual and if there is a genetic abnormality

Goal 2. Predict the outcomes of a monohybrid mendelian genetic crosses

2.1. The learner understands how Mendel's experiments discovered the laws of independent assortment and segregation

2.2. The learner can determine the genotype and phenotype of heterozygous and homozygous allele combinations

2.3. The learner can construct a Mendelian monohybrid cross

2.4. The learner can determine the genotypic and phenotypic ratios and percentages of a monohybrid genetic cross.

2.5. The learner can understand the difference between an expected outcome and a predicted outcome.

Goal 3. Predict the outcomes of a monohybrid Non-Mendelian genetic crosses

3.1. The learner can construct a Non-Mendelian monohybrid cross

3.2. The learner can determine the genotypic and phenotypic ratios and percentages of a Non-Mendelian monohybrid genetic cross.

3.3. The learner can describe how the concept of multiple alleles causes different blood types

3.4. The learner can distinguish between codominance and incomplete dominance

3.5. The learner can explain how sex-linked inheritance happens, and why males are more likely to inherit sex-linked recessive traits

Goal 4. Predict the outcomes of a dihybrid mendelian genetic crosses

4.1. The learner can construct a Mendelian dihybrid cross given a word problem

4.2. The learner can determine the phenotypic ratios and percentages of a dihybrid genetic cross.

Goal 5. Determine the protein sequence that a DNA sequence. Describe how this process occurs in cells.

5.1. The learner understands the differences between DNA and RNA.

5.2. The learner can transcribe the mRNA sequence given a DNA template

5.3. The learner can describe the molecular process transcription

5.4. The learner, using an mRNA codon chart can decode a DNA sequence to determine the genetic sequence of a protein simulating translation

5.5. The learner can describe the molecular process translation

Goal 6. Explain how point and chromosomal mutations occur and their potential effects on an organism and its offspring.

6.1. The learner can describe what a point mutation is and a chromosomal mutation.

6.2. The learner can describe how point mutations can affect the phenotype of an organism.

Goal 7. The learner can interpret a pedigree. (Optional)

7.1. The learner can able to interpret the symbols on a pedigree chart.

7.2. Given a pedigree, the learner can determine if a trait is autosomal dominant, autosomal recessive, or sex-linked.

Assessments

Assessment will take place with a combination of weekly online quizzes and free-response short-answer assignments. Online quizzes measure basic vocabulary and concepts. They also will be good STAAR test practice questions. Free-response questions, done with paper and pencil and scanned or photographed, will be used to determine gaps in learner procedural knowledge that cannot be measured by a multiple-choice quiz.

Assignments have been divided into six different weighted categories:

- Learning games 15%
- Worksheets 15%
- Discussions- 10%
- Quizzes- 20%
- Midterm exam - 20%
- Final exam - 20%

Point values for each assignment only determine how much an assignment is worth within a category, the student's whole grade. Weighted categories should make it easy to add and remove material.

Environment

This course was created in the Canvas Learning Management Platform and meant to be taken entirely online. When the learner first enters the course, they are presented a screen that introduces genetics to students and provides a link to the course's modules. This screen may also be accessed in the sidebar along with the course's discussions, grades, people in the course, syllabus, assignments, and the course rubrics.

The first module in this course is a "instructors only" module, which has this document along with other helpful tips. The next module, the first that students can see, is an introduction section with general information about the course. The six weekly modules start with an instructions module, a discussion module, and video modules. Additional activities are listed out

for each module that are due at the end of the week. Each week is automatically unlocked after the activities of the previous week are complete. Each exam is in separate modules, that can be unlocked at the instructor's digression.

A typical student should start a module by reading the weekly directions. They should at least look at the discussion to plan what they want to write. Each week also has a Geniverse assignment. Students are expected to create an account in the first week. By the end of the week, students should complete their worksheets, learning games, and a quiz.

This course includes over two hours of original screencast videos, and at least the same about of external videos. The course has eleven learning game assignments, consisting of Geniverse, Bioman, and the Making Babies Assignment. Because of the changing nature of the web, the only content that we know for sure will be online when this course is administered is the screencast videos. Worksheets have been added to the class to provide learning opportunities for students in this situation. However, if all learning games are present, it is possible to shorten or eliminate the worksheet assignments, should an instructor determine that is best for their course.

Course Setup Checklist

- Create Geniverse and Bioman accounts (See appendixes). Make sure you update the Geniverse page with class code and the Bioman assignment with your email account. If these games are unavailable, see the games section of the Tips and Tricks section.
- Write first announcement welcoming students to your class and setting expectations
- Write a paragraph or two, introduction about yourself in the "Meet the Instructor: Introduce Yourself" discussion board. A picture is suggested but not required

- Create a Zoom meeting or a similar video conferencing system for the first-week synchronous class meeting. Feel free to create more throughout the course. The week one directions have a section where the meeting link should be placed.
- Browse through assignments and adjust content to fit your student population. Worksheets in this course were created purposely long and may need to be shortened.

Scheduling

This course has 45 hours of instruction spread over a six-weeks. The topics covered are as follows:

- Week 1: Introduction to Genetics and Meiosis
- Week 2: Gregor Mendel and Punnett Squares
- Week 3: Non-Mendelian Inheritance
- Week 4: Dihybrid crosses/Protein Synthesis
- Week 5: Protein synthesis
- Week 6: Mutations and Pedigrees

The course has two exams, a midterm in the middle of the course, and a final at the end of week six. Throughout the course, students will be participating in the gaming-based learning system, Geniverse. Geniverse has four weeks of activities that students will do in parallel with their original assignments, along with initial and final assessment taken the first and last weeks, respectively.

Table of Activities

Assignment	Week	Due Date	Objectives
Week 1			
Meiosis Overview Screencast	1	Day 4	1.1, 1.2, 1.3
Karyotype Screencast	1	Day 4	1.4
Meiosis – Amoeba Sisters	1	Day 4	1.1, 1.2, 1.3
Chromosome Numbers During Division: Demystified!	1	Day 4	1.3
Sex Determination – Ted Ed	1	Day 4	1.4
Week 1: Discussion	1	Day 5	Goal 1
Geniverse: Initial Assessment	1	Day 5	Goals 2, 3, 4
Bioman: Meiosis Mover	1	Day 4	1,1

Practice Meiosis Problems	1	Day 4	1.1, 1.2, 1.3
Week 1 Quiz	1	Day 4	Goal 1
Week 2			
Mendel and Heredity Screencast	2	Day 4	2.1, 2.2
Punnett Square Screencast	2	Day 4	2.3
DNA, Chromosomes, Genes, and Traits: An Intro to Heredity - Amoeba Sisters	2	Day 4	2.2
Alleles and Genes - Amoeba Sisters	2	Day 4	2.1-2.2
How Mendel's pea plants helped us understand genetics - Ted Ed	2	Day 4	2.1
Monohybrids and the Punnett Square Guinea Pigs- Amoeba Sisters	2	Day 4	2.2, 2.3, 2.4, 2.5
Greatest Genetics Discoveries: Gregor Mendel – Video	2	Day 4	2.1
Week 2: Discussion	2	Day 5	Goal 2
Geniverse: Training Level	2	Day 5	Goals 2, 3, 4
Week 2 Punnett Squares Worksheet	2	Day 5	2.2, 2.3, 2.4, 2.5
Monsters Genetics Lab	2	Day 5	2.2, 2.3, 2.4, 2.5
Mendel and Punnett Squares Quiz	2	Day 5	Goal 2
Week 3			
Non-Mendelian Genetics Screencast	3	Day 4	Goal 3
Multiple Alleles (ABO Blood Types) and Punnett Squares - Amoeba Sisters	3	Day 4	3.3
Why do blood types matter? - Ted-Ed	3	Day 4	3.3
Incomplete Dominance, Codominance, Polygenic Traits, and Epistasis! - Amoeba Sisters	3	Day 4	3.4
Punnett Squares and Sex-Linked Traits- Amoeba Sisters	3	Day 4	3.5
Secrets of the X chromosome - Ted-Ed	3	Day 4	3.3
Week 3: Discussion	3	Day 4	Goal 3
Geniverse: Apprentice Level	3	Day 5	Goals 2, 3, 4
Who’s My Daddy	3	Day 4	3.3
Week 3 Non-Mendelian Genetics Quiz	3	Day 4	Goal 3
Midterm Review	3	Day 4	Goals 1-3
Midterm Exam	3	Day 4	Goals 1-3
Week 4			
Dihybrid Crosses Screencast	4	Day 3	Goal 4
Dihybrid and Two-Trait Crosses- Amoeba Sisters	4	Day 3	Goal 4
A Beginner's Guide to Punnett Squares- Bozeman Science	4	Day 3	Goal 2, 4
Week 4: Discussion	4	Day 3	Goal 4
Bioman: Snurfle Meiosis and Genetics 2: Diversity and Dihybrid Crosses	4	Day 3	1.1, 1,2, 4.1, 4.2
Geniverse: Journeyman Level	4	Day 3	Goals 2, 3, 4
Making Babies	4	Day 3	Goals 2, 3, 4
Week 4 Dihybrid Cross Quiz	4	Day 4	Goal 4
RNA Screencast	4	Day 5	5.1
Protein Structure and Folding - Amoeba Sisters	4	Day 5	Goal 5
Week 5			

Transcription Screencast	5	Day 5	5.2, 5.3
Translation Screencast Part 1	5	Day 5	5.2, 5.3
Translation Part 2 Screencast	5	Day 5	5.3
Protein Synthesis - Amoeba Sisters	5	Day 5	Goal 5
Transcription Animation	5	Day 5	5.5
Translation Animation	5	Day 5	5.3
From DNA to protein - 3D	5	Day 5	5.3, 5.5
Week 5: Discussion	5	Day 5	Goal 5
Bioman: Protein Synthesis Race	5	Day 4	Goal
Geniverse: Master Level	5	Day 4	Goals 2, 3, 4
Worksheet: Protein Synthesis Worksheet	5	Day 4	Goal 5
Week 5 Protein Synthesis Quiz	5	Day 4	Goal 5
Week 6			
Pedigree Screencast	6	Day 3	Goal 7
Point Mutation Screencast	6	Day 3	6.1
Chromosomal Mutation Screencast	6	Day 3	6.2
Pedigrees- Amoeba Sisters	6	Day 3	Goal 7
Mutations - Bosman Biology	6	Day 3	6.1, 6.2
Mutations - Amoeba Sisters	6	Day 3	Goal 6, 7
What happens when your DNA is damaged? - Ted-Ed	6	Day 3	Goal 6
Week 6: Discussion	6	Day 3	Goals 6, 7
Geniverse Final Assessment	6	Day 4	Goals 2, 3, 4
Pedigree Analysis Simulation (Due Week 6, Day 4)	6	Day 3	Goal 7
Final Review	6	Day 5	All
Final Exam	6	Day 5	All

Tips and Tricks

Introduction to the Course

Send out an announcement when the course begins welcoming the class and providing links to the course's first screencast. In this screencast, you should emphasize to sign up for Geniverse as soon as possible. Also, students should start the Meet the instructor discussion board ASAP.

Discussion Boards

A discussion rubric for grading each discussion post that targets the average student. However, discussion prompts can be adjusted for different populations. Should your district have access to a classroom discussion management system like Packback (https://www.packback.co/), feel free to good substitute these for the discussion board questions given on this course.

Quizzes and Exams

Quizzes and tests each week are generated by several question banks. Links to the question bank are located in the teacher's only section. The quiz bank allows you to create new quizzes for reassessment. While there is no foolproof method to prevent cheating, you may have students use the Lockdown can prevent some forms of cheating. Remember that assignments in this course are weighted by category, not by points. Instructors should not worry that adding or removing questions will affect how grades are weighted.

Troubleshooting Games

If these games are not available, try Geniventure, a similar Geniverse program created by the same company. There is enough content in this course to completely cut out learning games. Removing learning games should be the last case scenario. If your school district has access to Brain Pop or some proprietary textbook site, feel free to change, add or replace the learning games in this course with them.

Worksheets

This course has many worksheets. Keys for them are found in the course files. They are unpublished. You may decide to publish answers to these worksheets a few days after the assignment is due so students can check their work.

Course Evaluation

Course evaluations have been created in Google Forms. Feel free to replace it with an alternative survey program like SurveyMonkey.

Notes for each unit

Week 1

This week goes over the topic of Meiosis. There is a lot of Mitosis vs. Meiosis material. If this material hasn't been covered in your course, you may want to go over mitosis with students quickly. As with most first weeks, make sure you give students through feedback on their discussion board posts. Once they understand the expectations, discussions should be much easier to maintain. The Ted-Ed sex determination video is especially engaging

Week 2

As one could expect, Punnett squares are at the core of this course. They are present in some form for weeks 2, 3, and 4. Make sure students understand the vocabulary. Without it, word problems would be very difficult for students. It is also of note that Geniverse does not follow the curriculum of the course week by week. It is on its own track. Students may learn material this week on Geniverse that will not be present in this course until weeks later. The monster's genetic lab is quite fun. There is no real way to grade for accuracy. It is more of a completion grade.

Week 3

This is the midterm exam week. The topic of non-Mendelian genetics should not take more than three days to cover. Be sure to remind students that the quiz due much is earlier this week. Students should be studying for their midterm and should have the whole day Friday to take their midterm. Students should be able to answer the question and get immediate feedback.

Week 4

Dihybrid crosses are challenging to teach because they take so long to solve. I generally do not ask students for genotypic ratios when solving these crosses. Be sure to remind kids to download the Reference worksheet before doing the "Making Babies" activity. This week also ends early on day four. On day five, there is introduction material over RNA. You may want to review with students what the base-pairing rules are, and the structure of DNA.

Week 5

This week probably could be longer than what it is. You may be able to some week six material if you cannot finish the content this week. First off, make sure students download the codon chart before starting the unit. Be sure to remind students that the codon chart uses mRNA and not the template DNA sequence.

Week 6

The pedigree section of this page is not hit hard on the STAAR test. If more time is needed for students, that is what preferably should cut out. This week does not have a quiz. The final review focuses on material taught in the latter half of the course. Remind students to look over their midterm review in addition to completing their final review to prepare for the final.

References

Mamun, M. A. A., Lawrie, G., & Wright, T. (2020). Instructional design of scaffolded online learning modules for self-directed and inquiry-based learning environments. *Computers & Education, 144*, 103695. doi: 10.1016/j.compedu.2019.103695

Savery, J., & Duffy, M. (1995). Problem based learning: An instructional model and its constructivist framework. *Educational Technology*, 35, 31-38.

Appendix: **Notes on Various Assignments**

Monsters Genetics Lab: The monster's genetics lab is designed to be engaging and fun for the students. There are many possible monster combinations. I recommend you use teacher's digression when it comes to how to grade this. This could very easily be a completion grade. Make sure the student fills out the worksheet and posts the monster on the discussion board. Students love to show off their work.

Making Babies: This lab is a bit long. It has a whole bunch of Punnett squares. Make sure you have your students download the reference material, so they know what alleles they are talking about. You might want to tell the students only to go through one generation of problems. Of making a baby. Make sure you show students how to take a screenshot with this assignment. This also may be a completion grade.

Pedigree Analysis Simulation: This is a short assignment that might be cut out. Just letting the students play with the tools is the best thing for them. As with the Making Babies assignment, make sure you teach students how to make screenshots.

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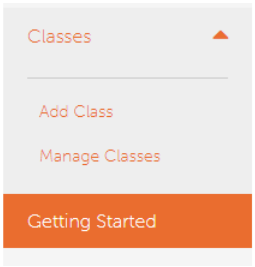
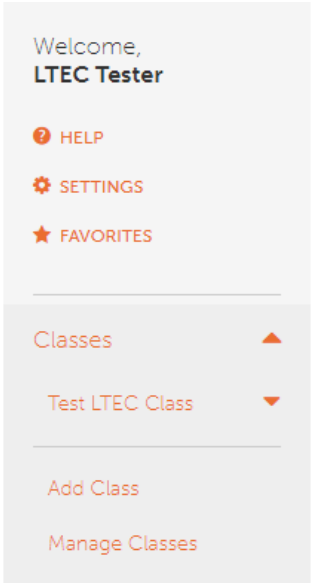
Appendix: Geniverse Set Up Instructions

1. Go to https://learn.concord.org/geniverse and sign up for an account
2. On the top right-hand corner click My Classes

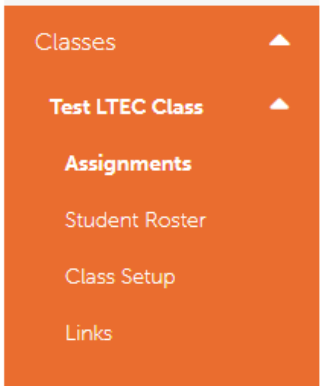
3. Click Add class on the menu on the wide bar.?



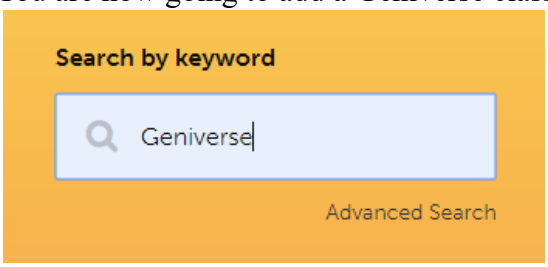
4. Set up a class. Make sure you copy down the class word
5. Place the class word on the Geniverse page of your course.
6. Now that you created a course go to classes on the sidebar, and select your new class.



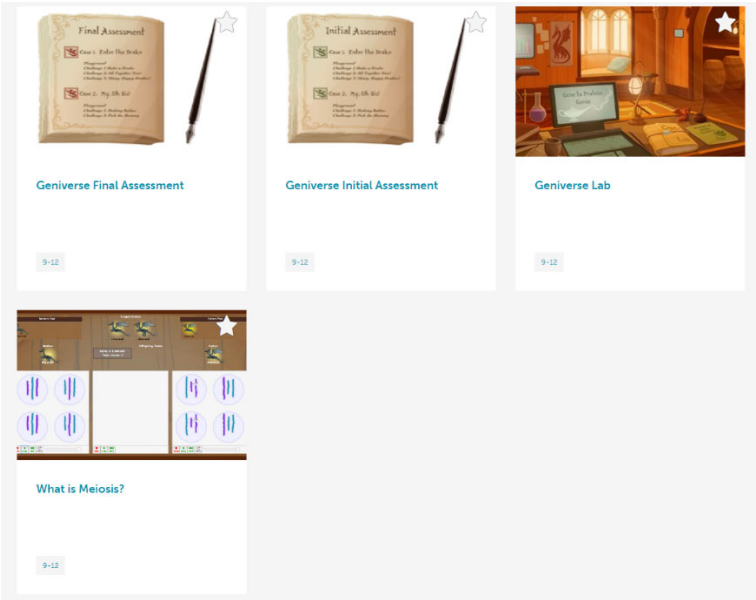
7. Create a class word for your class and post it on the Geniverse page.
8. Select assignments and click add assignments



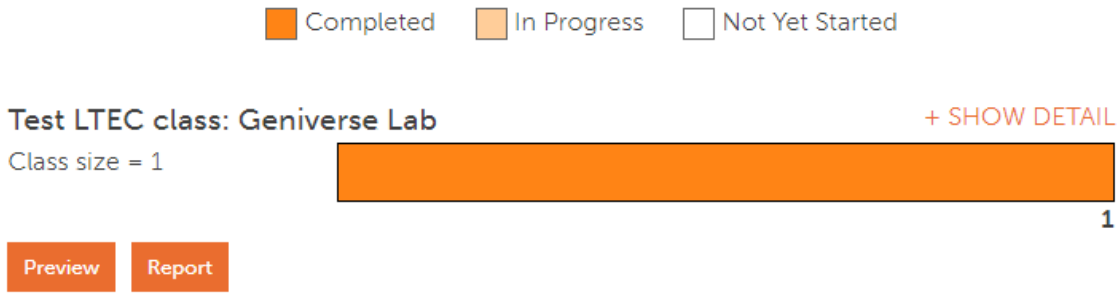
9. You are now going to add a Geniverse class.



10. Select the Geniverse Initial Assessment and assign the initial assessment. This will be done week 1

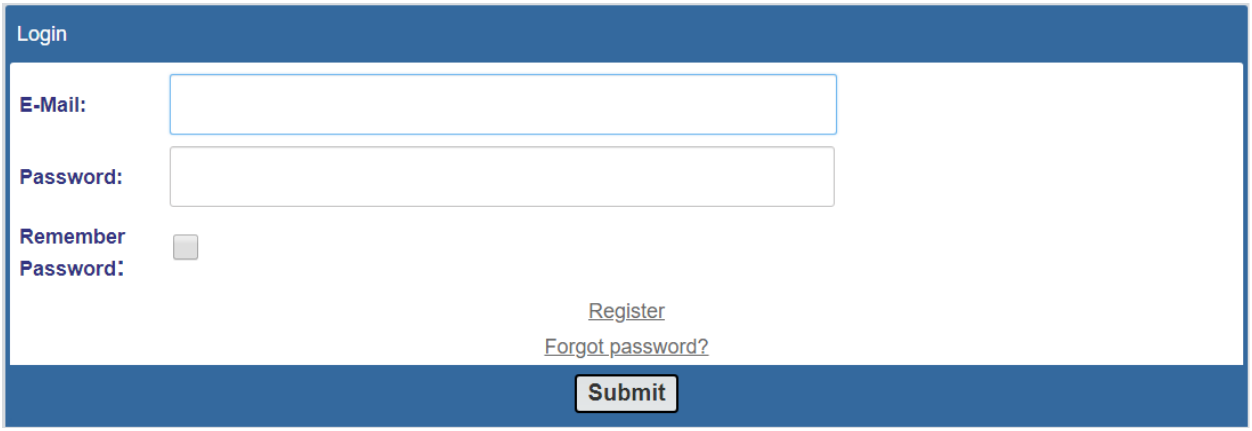


11. Do the same for the Geniverse Lab, and the Geniverse Final Assessment.
12. You can check your students' progress by clicking my class and viewing their reports.



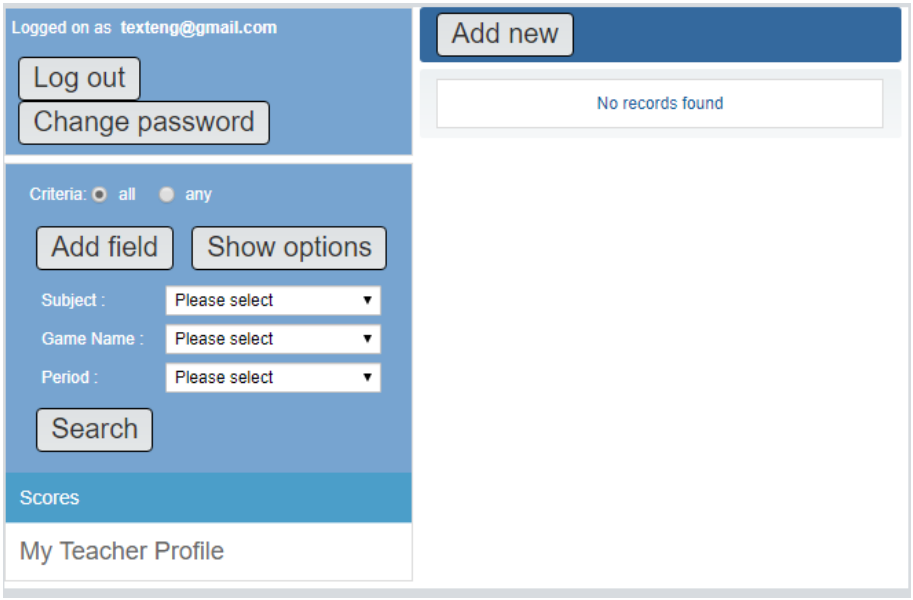
Appendix: Bioman Set Up Instructions

1. Go to https://www.biomanbio.com/gradebook.html



2. Click register. Create a login with our email address

3. Now you can log in. You should see a screen like one below.



4. Make sure you update the bioman assignment with your email address. Students can submit their scores to that email address, and you can see their grades on that assignment.

Appendix: Practice Meiosis Problems Key

Word versions of these keys are found on canvas course

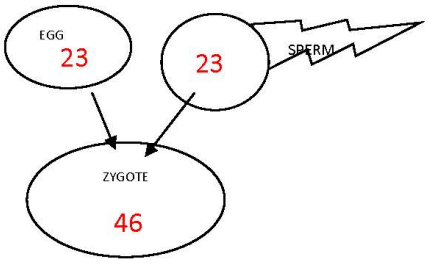
Practice Meiosis Problems: Key

Meiosis vs. Mitosis

1. Mitosis and meiosis are both methods of Cell division/ Cell reproduction
2. Meiosis only occurs in Reproductive cells.
3. Mitosis only occurs in Somatic (includes reproductive) cells.
4. Is meiosis needed for reproduction? Meiosis is needed for sexual reproduction
5. Is mitosis needed for reproduction? Mitosis is not for sexual reproduction. It is used for asexual reporduction
6. During the process of meiosis, the number of chromosomes is Half from the number of original chromosomes.
7. During the process of mitosis, the number of chromosomes is the same as the number of original number of chromosomes.
8. A duck has 36 chromosomes in its feather cells. How many chromosomes are in its sex cells 18
9. How many chromosomes will the duck above have after two mitotic divisions? 36
10. A fish has 10 chromosomes in its egg cells. How many chromosomes are in its eye cells? 20
11. A female horse has 26 chromosomes in her egg cells. How many chromosomes will her zygote have in its muscle cells? 52
12. A male chicken has 12 chromosomes in his sperm cells. How many chromosomes are in his feather cells? 24
13. A kangaroo has 60 chromosomes in his skin cells. How many chromosomes are in his sperm cells? 30

Karyotype Questions:

1. How many chromosomes did the mom contribute? 23
2. How many chromosomes did the dad contribute? 23
3. How many chromosomes does your baby have? 46
4. How many autosomal chromosomes does your baby have? (Autosomal chromosomes are all the chromosomes except X and Y chromosomes) 44 (2 are sex chromosomes
5. A baby has the sex chromosomes XX. What is the sex of the baby? Female (XY is guy)
6. 46 chromosomes is the (haploid/diploid) number of chromosomes. Diploid
7. 23 chromosomes is the (haploid/diploid) number of chromosomes. Haploid
8. How many chromosomes are in each cell of the human body? 46, (23 pairs)
9. What is the purpose of fertilization in terms of chromosomes? To combine two gametes (sperm and egg) to create complete chromosome
10. Draw the correct number of chromosomes in each structure. (Assume we are making a human zygote)



Appendix: Punnett Square Practice Problem Key

Word versions of these keys are found on canvas course

Name _____ **Date**_____ **Period**_____

Punnett Square Practice Problems Part 1 - Key

1. For each genotype below, indicate whether it is heterozygous **(He),** homozygous dominant **(Ho D)** or homozygous recessive **(Ho R)**

AA Ho D	DD Ho D	Gg He	Jj He	Mm He	Pp He
Bb He	Ee He	HH Ho D	kk Ho R	nn Ho R	QQ Ho D
Cc He	ff Ho R	Ii He	LL He	oo Ho R	rr Ho R

2. For each of the **genotypes** below determine what **phenotypes** would be possible.

Purple flowers are dominant to white flowers.

PP Purple Flowers

Pp Purple Flowers

pp White Flowers

Brown eyes are dominant to blue eyes

BB Brown Eyes

Bb Brown Eyes

bb Blue Eyes

Bobtails in cats are recessive.

TT Normal Tails

Tt Normal Tails

tt Bobtails

Round seeds are dominant to wrinkled seeds

RR Round Seeds

Rr Round Seeds

rr Wrinkled Seeds

3. For each **phenotype** below, list the **genotypes** (remember to use the letter of the dominant trait) (Any letter)

Straight hair is dominant to curly. SS, Ss straight ss curly

Pointed heads are dominant to round heads. PP, Pp pointed pp round

4. Set up the Punnett squares for each of the crosses listed below.

Round seeds are dominant to wrinkled seeds.

RR x rr

What percentage of the offspring will be round? 100%

	R	R
r	Rr	Rr
r	Rr	Rr

Punnett Square Practice Problems Part 1

Name:_____
Date: _____

SIMPLE DOMINANT & RECESSIVE TRAITS

Let's say that in seals, the gene for the length of the whiskers has two alleles. The dominant allele (W) codes long whiskers & the recessive allele (w) codes for short whiskers.

1) What percentage of offspring would be expected to have short whiskers from the cross of two long-whiskered seals, one parent is homozygous dominant and the other one is heterozygous?
2) If one parent seal is pure long-whiskered and the other is short-whiskered, what percent of offspring would have short whiskers? (Pure = homozygous)

1)

	W	W
W	WW	WW
w	Ww	Ww

0%

2)

	W	W
w	Ww	Ww
w	Ww	Ww

0%

In purple people eaters, one-horn is dominant and no horn is recessive.

3.) Draw a Punnett Square showing the cross of a purple people eater that is hybrid for horns with a purple people eater that does not have horns. (Hybrid = Heterozygous)
4.) Summarize the genotypes & phenotypes of the possible offspring

3)

	H	h
h	Hh	hh
h	Hh	hh

4) 0 : 2: 2 (0% Ho D, 50% He, 50% Ho R)
2: 2 (50% Horns, 50% no horns)

A green-leafed fuzzywhatsit (*I made this plant up*) is crossed with a fuzzywhatsit with yellow-striped leaves. The cross produces 185 green-leafed fuzzywhatsits.

5.) What were the genotypes of both parents? **(Green must be dominant as seen in offspring)**
6.) Summarize the genotypes & phenotypes of the offspring that would be produced by crossing two of the green-leafed fuzzywhatsits obtained from the initial cross.

5) Green must be dominant because green and yellow crossed, and all offspring are green.
Parents must be GG, and gg
6) Offspring has a genotypic ratio of 1:2:1, and a phenotypic ratio of 3:1

5)

	G	G
g	Gg	Gg
g	Gg	Gg

6)

	G	g
G	GG	Gg
g	Gg	gg

Mendel found that crossing wrinkle-seeded plants with pure round-seeded plants produced only round-seeded plants.

7.) What genotypic & phenotypic ratios can be expected from a cross of a wrinkle-seeded plant & a plant heterozygous for this trait (seed appearance)?

7)

	G	g
g	Gg	gg
g	Gg	gg

Genotypic: 0: 2: 0
Phenotypic: 2: 2

Punnett Square Practice Problems Part 1

Name:_____
Date: _____

SIMPLE DOMINANT & RECESSIVE TRAITS

Let's say that in seals, the gene for the length of the whiskers has two alleles. The dominant allele (W) codes long whiskers & the recessive allele (w) codes for short whiskers.

1) What percentage of offspring would be expected to have short whiskers from the cross of two long-whiskered seals, one parent is homozygous dominant and the other one is heterozygous?
2) If one parent seal is pure long-whiskered and the other is short-whiskered, what percent of offspring would have short whiskers? (Pure = homozygous)

1)

	W	W
W	WW	WW
w	Ww	Ww

0%

2)

	W	W
w	Ww	Ww
w	Ww	Ww

0%

In purple people eaters, one-horn is dominant and no horn is recessive.

3.) Draw a Punnett Square showing the cross of a purple people eater that is hybrid for horns with a purple people eater that does not have horns. (Hybrid = Heterozygous)
4.) Summarize the genotypes & phenotypes of the possible offspring

3)

	H	h
h	Hh	hh
h	Hh	hh

4) 0 : 2: 2 (0% Ho D, 50% He, 50% Ho R)
2: 2 (50% Horns, 50% no horns)

A green-leafed fuzzywhatsit (*I made this plant up*) is crossed with a fuzzywhatsit with yellow-striped leaves. The cross produces 185 green-leafed fuzzywhatsits.

5.) What were the genotypes of both parents? **(Green must be dominant as seen in offspring)**
6.) Summarize the genotypes & phenotypes of the offspring that would be produced by crossing two of the green-leafed fuzzywhatsits obtained from the initial cross.

5) Green must be dominant because green and yellow crossed, and all offspring are green.
Parents must be GG, and gg
6) Offspring has a genotypic ratio of 1:2:1, and a phenotypic ratio of 3:1

5)

	G	G
g	Gg	Gg
g	Gg	Gg

6)

	G	g
G	GG	Gg
g	Gg	gg

Mendel found that crossing wrinkle-seeded plants with pure round-seeded plants produced only round-seeded plants.

7.) What genotypic & phenotypic ratios can be expected from a cross of a wrinkle-seeded plant & a plant heterozygous for this trait (seed appearance)?

7)

	G	g
g	Gg	gg
g	Gg	gg

Genotypic: 0: 2: 0
Phenotypic: 2: 2

In dogs, there is a hereditary deafness caused by a recessive gene, "d." A kennel owner has a male dog that she wants to use for breeding purposes if possible. The dog can hear, so the owner knows his genotype is either DD or Dd. If the dog's genotype is Dd, the owner does not wish to use him for breeding so that the deafness gene will not be passed on. This can be tested by breeding the dog to a deaf female (dd).

8.) Draw the Punnett squares to illustrate these two possible crosses. In each case, what percentage/how many of the offspring would be expected to be hearing? Deaf?

9.) How could you tell the genotype of this male dog?

10.) Also, using Punnett square(s), show how two hearing dogs could produce deaf offspring.

8a)

	D	D
D	DD	DD
d	Dd	Dd

8b)

	D	d
d	Dd	dd
d	Dd	dd

If any offspring are deaf, then male must be heterozygous. Unless male dog has a lot of kids, we cannot tell if it is homozygous dominant.

10)

	D	d
D	DD	Dd
d	Dd	dd

In humans, brown eyes (B) are dominant over blue (b). A brown-eyed man marries a blue-eyed woman and they have three children, two of whom are brown-eyed and one of whom is blue-eyed.

11.) Draw the Punnett square that illustrates this marriage.

12.) What is the man's genotype?

13.) What are the genotypes of the children?

11)

	B	b
b	Bb	bb
b	Bb	bb

12. The man is Bb.

13. The children brown eyed children are Bb, and the blue eyed is bb

<u>Directions</u>: **For each of the following problems 14-18,**

1. **List the genotypes of the parents.**
2. **Diagram and complete a Punnett square**
3. **Give the phenotype percentages of the offspring.**

In garden peas, round seed coats (R) is dominant over wrinkled seed coats (r).

14.) What will the results be of a cross between a homozygous dominant male and a recessive female?

	R	R
r	Rr	Rr
r	Rr	Rr

Parents are RR and rr

Phenotypic ratio is 4:0

In peas, yellow color (Y) is dominant to green (y).

15.) What will be the results of a cross-pollination of a heterozygous female and a heterozygous male?

	Y	y
Y	YY	Yy
y	Yy	yy

Parents are Yy and Yy

Phenotypic ratio is 3:1

In humans, straight toes (S) are dominant over curled toes (s).

16.) What would be the result of a cross between a recessive male and a heterozygous female?

	S	s
s	Ss	ss
s	Ss	ss

Parents are Ss and ss

Phenotypic ratio is 2:2

In dogs, erect ears (E) are dominant over droopy ears (e).

17.) What are the results if two heterozygous dogs have a litter of puppies?

	E	e
E	EE	Ee
e	Ee	ee

Parents are Ee and Ee

Phenotypic ratio is 3:1

The ability to roll the tongue (R) is determined by a dominant gene while the recessive gene results in the inability to roll the tongue (r). A man and his wife can both roll their tongues and are surprised to find that their son cannot.

18.) Explain this by showing the genotypes of all three persons. (Note: You do not need to do a Punnett Square for this problem).

Parents must be heterozygous for the trait. If one was homozygous dominant, then the son would only get a dominant gene from one the parents.

Mom: Rr, Dad Rr, Son rr

Appendix: Who's My Daddy Key

Baby 1: Mom and Dad Doe

The only couple with A and B is Mom and Dad Doe. Baby 1 as type AB.

	I^A	I^A
I^B	$I^A I^B$	$I^A I^B$
I^B	$I^A I^B$	$I^A I^B$

Baby 2: Mom and Dad Smith

The only couple with O alleles is Dad and Mom Smith Baby 2 has type O blood.

	i	i
i	ii	ii
i	ii	ii

Baby 3: Mom and Dad Jones

While Mom Jones has type O blood, Dad Jones has type A. A heterozygous I^AI is type A blood.

	I^A	I^A
i	I^A i	I^A i
i	I^A i	I^A i

Appendix: Midterm Review Key

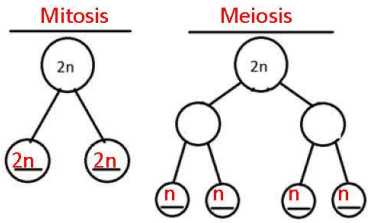
Word versions of these keys are found on canvas course

Name_____ Date_____ Period_____

Mid-Term Review - Key

1. What is the difference between phenotypes and genotypes? Give an example of a genotype and a phenotype using the using, A- Tall and a-small. Phenotypes: physical traits ex: tall, short Genotypes: genetic makeup: Aa

2. Identify which diagram to the right that represents mitosis and the one that represents one, meiosis. Fill in the blanks to the left with (2n and n)

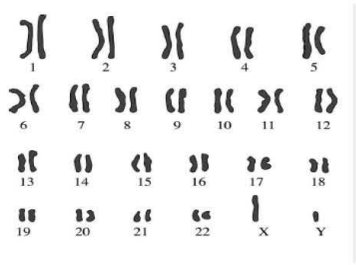


3. What gender is the person to the right? Why?

Male, has X and Y chromosome

How would I know, when looking at a karyotype, if a fetus has Down syndrome?

Ther would be three 21 chromosome



4. How does the process of crossing over occur? What part of meiosis does crossing over occur in?

Crossing over mixes homologous chromosomes in prophase I

5. If a dark-haired person were to bleach his hair blonde, what would his biological kids have blond hair too? Why or why not? Bleaching someone's hair does not change their Genotype. Moreover, changes must happen to gametes to be passed on to offspring. Hair is not a gamete.

6. What body organs would a mutation have to take place for people to have genes different from their own?

Reproductive organs (Testis and Overies)

7. In a genetic experiment, the original generation is called the _P___ generation. What are the next 3 generations called? F_1, F_2, F_3

8. The terms below could stand for a homozygous organism or a heterozygous organism. Identify which one is heterozygous and which one are homozygous.

Hybrid _Heterozygous___ Pure Bred __Homozygous_____Carrier ___ Heterozygous ___

HH_ Homozygous ____ Hh____ Heterozygous _____ hh ___ Homozygous ___

9. Fill in the chart:

	Diploid	Haploid
Abbreviation (2n, n)	2n	N
Type of cells	Somatic	Gametes
Amount of DNA (Half or all)	All	Half

10. How many chromosomes are in human somatic cells? How many are in gametes?

46 (23 pairs) of chromosomes are in human cells. 23 chromosomes are in gametes

11. Compare and Contrast Meiosis and Mitosis (at least 4 differences)
Meiosis has 2 divisions, creates haploid cells/gametes, happens in reproductive cells, and creates unique cells
Mitosis has 1 division, creates diploid cells/somatic, happens in all cells, and all cells are the same

12. Define the following:
Nondisjunction – When chromosome pairs are not divided evenly in meiosis

Gamete- Sperm/egg cells

Zygote- When sperm/egg cells come together

Somatic- normal body cells

13. Which term below are diploid, and which one is haploid?

Somatic Cells __Diploid___ Gametes ___Haploid___ Zygotes _Diploid__ Eggs__Haploid_ Sperm __Haploid__

14. How Is it possible for two parents who have a dominant phenotype and yet have a kid with a recessive trait? When explaining, use ***A- Tall*** and ***a-small.*** When both parents are heterozygous, they both parents can pass recessive allele leading to a child with a recessive phenotype

15. Compare and contrast codominance and incomplete dominance. How are they both different than complete dominance? In complete dominance, the dominant trait completely covers the recessive phenotype. In incomplete dominance heterozygous phenotypes that are blended together. Codominance is when both alleles of a heterozygous genotype are expressed, but not blended (ex spotted cow)
16. If a gene is found on the 23 X chromosome, how does that affect inheritance? In sex linked inheritance, males are more likely to get a recessive allele phenotype because males only get one X chromosome. Females get 2
17. A family has 3 boys? What are the odds of the next child will be a female? If the family has 4 boys, does this violate Mendel's laws? There is a 50/50 chance that the next child will be a male. It does not violate Mendel's laws because these are probabilities.
18. In a genetic experiment if is best to have as __Large___sample size as possible? Why? So that the chances that low probability outcomes are unlikely. Example, it is possible to flip 4 coins and get four heads. It is unlikely that you flip 1000 coins and all of them end up as heads.

Show all work, use Punnett squares

19. In dogs, erect ears (E) is dominate over droopy ears (e). What are the results if two hybrid dogs have a litter of puppies? Both parents are heterozygous because they are hybrids Ee, Ee

Genotypic ratio: 1:2:1

Phenotypic ratio: 3:1

	E	e
E	EE	Ee
e	Ee	ee

20. The ability to roll the tongue (R) is determined by a dominant gene while the recessive allele results in the inability to roll the tongue (r). A man and his wife can both roll their tongues and are surprised to find that their son cannot. Explain this by showing the genotypes of all three people.

Both parents must heterozygous. Because both parents can hand over a recessive allele their child can have recessive phenotype. Genotypic ratio: 1:2:1, Phenotypic ratio: 3:1

	R	r
R	RR	Rr
r	Rr	rr

21. In humans, wavy hair (CS) results by the co-dominant situation of curly hair (C) and straight hair (S). What are the possible results if a curly-haired man and wavy-haired woman have children.

50 percent of kids will be Curly hair, 50 percent wavy.

50 percent CC, and 50 percent CS

	C	S
C	CC	CS
C	CC	CS

22. In crocus flowers, white (W) and purple (P) colors are co-dominant, and result in a purple and white striped flower when both genes are present. What are the possible results from the cross-pollination of a striped crocus with a white crocus?

	W	P
W	WW	WP
W	WW	WP

50 Percent of flowers WW (White), and 50 percent striped (WP)

23. During the process of meiosis, the number of chromosomes is Half__ from the number of original chromosomes.
24. During the process of mitosis, the number of chromosomes_____are the same___as the number of original number of chromosomes.
25. A duck has 36 chromosomes in its feather cells. How many chromosomes are in its sex cells_18
26. How many chromosomes will the duck above have after two mitotic divisions?_____36_____
27. A fish has 10 chromosomes in its egg cells. How many chromosomes are in its eye cells? 20
28. A female horse has 26 chromosomes in her egg cells. How many chromosomes will her zygote have in its muscle cells? 48

Appendix: Protein Synthesis Worksheet

Word versions of these keys are found on canvas course

Name _____ Date_____ Period _____

Transcription/Translation Student Activity - Key

1. Where does transcription occur? Nucleus
2. What organelle does translation occur? Ribosome
3. Why is mRNA known as "messenger" RNA? It carries information from the nucleus to the Cytoplasm
4. In RNA, which base replaces Thymine? Uracil (U)
5. Transcribe the following DNA strand into mRNA.

DNA:	**T**	**A**	**C**	**G**	**A**	**C**	**T**	**T**	**A**	**C**	**G**	**A**	**C**	**A**	**G**
mRNA:	A	U	G	C	U	G	A	A	U	G	C	U	G	U	C

6. Three letters of mRNA are called a Codon.
7. Explain the job of a codon. A codon's job is to code for a specific amino acid in protein synthesis_____
8. What is the role of tRNA in translation? Carries the amino acid to the ribosome/mRNA

---

9. Practice codons (use your personal copy of the decoder chart):

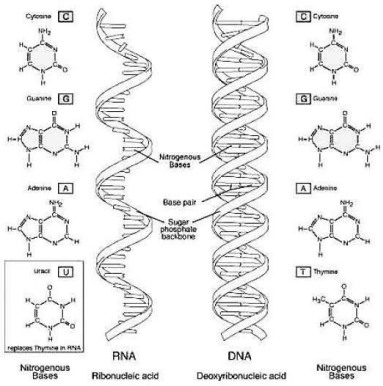
   1. CAU = __GUA___ 2. GGC = _CCG__ 3. UGG = ___ACC__

10. Using the strand of mRNA from problem 5 identify the amino acids that are coded in the strand.

mRNA: AUG CUG AAU GCU CAG

Amino acids: Met (start) Leu Asn Ala Gln

Asparagine (Asn) is a separate amino acid from aspartate (Asp) Student get the two confused, and usually I give the student points for Asp. The same goes for Glutamine (Glu) and glutamate (Glu)



Compare the structure of RNA to DNA

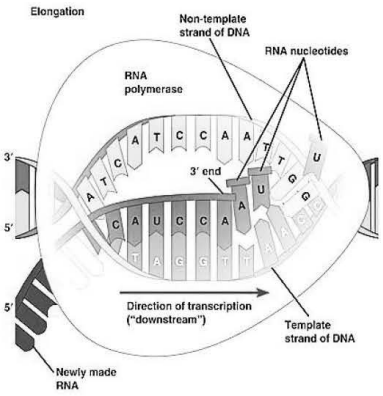
1. What is the sugar found in RNA?
Ribose

2. How many strands does RNA have?
1

3. What nitrogen base is found in DNA but NOT RNA?
Uracil

4. What nitrogen base is found in RNA that pairs with adenine in DNA?
Uracil

5. A RNA Nucleotide_is made up of ribose, phosphate and a nitrogen base.



Transcription is ……

6. What process is being shown in the middle picture?
Transcription

7. Find the template strand of DNA-write it on your foldable-
CAUCCAAAU (students might place in it reverse)

8. What base pair is different in mRNA than found in DNA?
Thymine

9. Why is mRNA needed?
Transfers genetic information from the DNA to the ribosome to make a protein

10. What does mRNA carry the instructions for? Creating a protein

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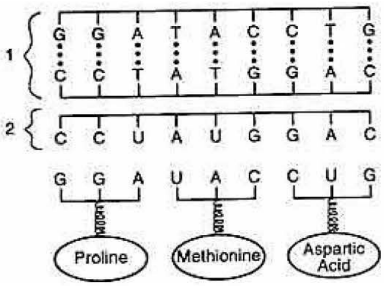


Translation is.. . .

11. What process is being shown in the picture to the right
Translation

12. Name the strand labeled 1 DNA

13. Name the strand labeled 2-What part of strand #1 is #2 copied from (old or new?) Template strand

14. The three letter portion GGA is called a __Codon__.

15. Name the type of RNA shown in the bottom strand. mRNA

16. Proline is an example of one of the twenty _Amino acids___.

Practice Problems

1. DNA: TAC CCC GTC ACC

   mRNA AUG GGG CAG UGG

   Amino Acids Met Gly Gln Trp

2. DNA: TAC GTT CCG TAT

   mRNA AUG CAA GGC AUA

   Amino Acids Met Gln Gly Ile

   (Ile = Isoleucine – students my put iso)

3. DNA: TAC CTA TTA TCA

   mRNA AUG GAU AAU AGU

   Amino Acids Met Asp Asn Ser

4. DNA: TAC CAT CAC ACA

   mRNA AUG GUA GUG UGU

   Amino Acids Met Val Val Cys

5. DNA: TAC GAT ACC GGG

   mRNA AUG CUA UGG CCC

   Amino Acids Met Leu Trp Pro

6. DNA: TAC GAA GAT AAC

   mRNA: AUG CUU CUA UUG

   Amino Acids Met Leu Leu Leu

7. DNA: TAC GCC CCC GAC

   mRNA: AUG CGG GGG CUG

   Amino Acids Met Arg Gly Leu

8. DNA: TAC CTC TCC GAC

   mRNA: AUG GAG AGG CUG

   Amino Acids Met Glu Arg Leu

9. DNA: TAC GGC ATA AAA

   mRNA: AUG CCG UAU UUU

   Amino Acids Met Pro Tyr Phe

10. DNA: TAC TAA TAT ATC

    mRNA: AUG AUU AUA UAG

    Amino Acids Met Ile Ile Stop

Appendix: Final Review Key

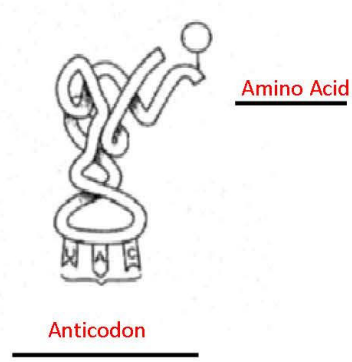
Word versions of these keys are found on canvas course

Name_____ Date_____ Period_____

Final Review (note please look over the mid term review) - Key

1. What are the two major phases of protein synthesis? What do these phases do?
   Transcription and Translation

2. A eukaryotic cell's DNA is found in the __Nucleus___. Describe the process that allows DNA to pass information from the nucleus to the rest of the cell?
3. The diagram on the right represents a __tRNA molecule. Label the parts
   (Transfer RNA is also acceptable)



4. What phase is this molecule used in?
   Translation

5. Where is this molecule located?
   Cytoplasm/Ribosome

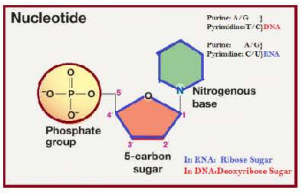
6. What is the function of the molecule on the right?

   Carry amino acid to ribosome, and properly place them in correct location

7. Compare and contrast DNA and RNA. Include types of bases, location, and type of sugar

	DNA	RNA
Type of bases	A, T, G, C	A, U, G, C
Location	Nucleus	Nucleus and the Cytoplasm
Type of Sugar	Deoxyribose	Ribose
Function	Contains genetic code	mRNA carries genetic information from nucleus to the cytoplasm tRNA carries amino acid to correct location rRNA Part of Ribosome
Single or double stranded	Double	Single

8. What is the function of the ribosome? Where is it located?
   Ribosomes are where proteins are assembled. It is in the Cytoplasm (and the Rough ER- not tested)
9. How many bases code for one amino acid? What is this called?
   3, codons
10. What are the parts of an DNA and RNA nucleotide? Draw both and label its parts.



11. What is the function of mRNA? What process creates it? Where is it created?

Carries genetic information to cytoplasm. Transcription, Nucleus

12. Circle the nucleic acid strand that is directly used with the chart below. Translate the sequence into its protein sequence.

mRNA –	AAGGCCUGUCCCUGA
DNA –	TTCCGGACAGGGACT

Lysine, Glycine, Cysteine, Proline, Stop

First Letter	Second Letter				Third Letter
	U	C	A	G	
U	phenylalanine	serine	tyrosine	cysteine	U
	phenylalanine	serine	tyrosine	cysteine	C
	leucine	serine	stop	stop	A
	leucine	serine	stop	tryptophan	G
C	leucine	proline	histidine	arginine	U
	leucine	proline	histidine	arginine	C
	leucine	proline	glutamine	arginine	A
	leucine	proline	glutamine	arginine	G
A	isoleucine	threonine	asparagine	serine	U
	isoleucine	threonine	asparagine	serine	C
	isoleucine	threonine	lysine	arginine	A
	(start) methionine	threonine	lysine	arginine	G
G	valine	alanine	aspartate	glycine	U
	valine	alanine	aspartate	glycine	C
	valine	alanine	glutamate	glycine	A
	valine	alanine	glutamate	glycine	G

13. Complete the chart below

DNA	GGG	CGA	**ACC**	ACG	**TAC**	**TAA**
mRNA	**CCC**	GCU	**UGG**	**UGC**	**AUG**	**AUU**
Anticodon	**GGG**	CGA	**ACC**	**ACG**	UAC	UAA
Protein	PRO	ALA	TRP	CYS	Met	ILE

TRP = Tryptophan

14. Define these key terms
    a. Codon – 3 letter mRNA- one codon = one amino acid
    b. Anti-codon – tRNA codon match. Used to find correct codon to place amino acid
    c. Transcription Process where DNA information is copied
    d. Translation Process where mRNA information is converted to protein
15. Mutation- Show an example of these mutations:
    Original Strand : AATTCC
    a. Insertion AATT**T**CC
    b. Deletion AAT_CC
    c. Substitution AAT**G**CC
16. Which one/ above is a frameshift mutation? Insertions and deletions
    What makes frameshift mutations dangerous? Not only do they affect the original codon, but they affect all codons after it
17. Which of these changes to the DNA triplet GAA will affect the protein produced?
    Must convert to mRNA codon first
    A. GAA – AGG - Arginine
    B. GAG - CUC - Leucine
    C. CGT – GCA - Alanine

18. What is the function of rRNA?

Part of ribosome

19. Describe what the following are below. Then, from smallest to largest, put the following in order.
    - Chromosomes Complete strand of DNA
    - Codon Three mRNA basepair sequence that codes for single amino acid
    - Genes codes for a single trait/protein
    - Nucleotide single base, monomer of nucleic acids

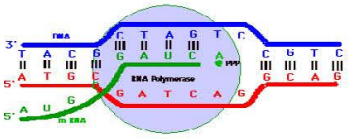
    Order: nucleotide, codon, gene, chromosome.

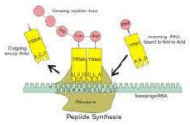
20. If I had 6 amino acids how many codons do I need?
    18 (6X3)

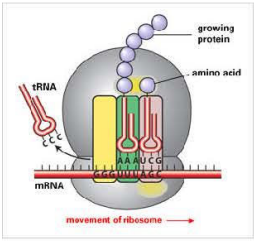
21. If I have 4 amino acids, how many nucleotides do I have?
    12 (4X3)

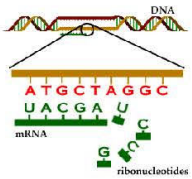
22. Identify the following images as Transcription or Translation

_____Transcription_____ _____ Translation _____ ____ Translation _____ __ Transcription _









23. What happens when one nucleotide is lost from the middle of a gene
    A. no change to the protein
    B. everything in front of the loss is changed
    C. everything downstream from the loss is changed
    D. it is called a silent mutation

24. Look at the drawing of a normal strand of mRNA and a mutation that takes place in the strand of mRNA.

25. What type of mutation has occurred

A.	A deletion of a base has caused the strand of mRNA to code for a different nucleotide
B.	A substitution of a base caused the strand of mRNA to code for a different nucleotide
C.	A deletion of a base has caused the strand of mRNA to code for a different polypeptide
D.	An insertion of a base has caused the strand of mRNA to code for a duplicate polypeptide

---

27. A plant with completely dominant alleles has two genes of interest.
The first gene has two alleles: H- Purple , h- white
The second gene has two alleles: D- Dark wood, d- light wood

The first generation we cross two pure breeding parents, one, parent 1, is purple with light wood, and the other white with dark wood.

What is the genotype of parent 1, ____HHdd_____ and the genotype of parent 2? ___hhDD_____

28. Assume that that the next generation has a genotype of ***HhDd***, and ***HhDd***. Cross these two organisms using the dihybrid cross to the right.

What is the phenotypic ratio of the this cross?

__9:3:3:1____

	HD	Hd	hD	hd
HD	*HHDD*	*HHDd*	*HhDD*	*HhDd*
Hd	*HhDd*	*Hhdd*	*HhDd*	*Hhdd*
hD	*HhDD*	*HhDd*	*hhDD*	*hhDd*
hd	*HhDd*	*Hhdd*	*hhDd*	*hhdd*

29. If I had 32 plant offspring from the previous cross, how many should I expect to be purple and have dark wood.

18, The Punnett square shows the outcome of 16. 9 of them are purple dark. This question asks for 32, double of 16. Thus, 9 * 2 = 18

30. How Is it possible for two parents who have a dominant phenotype and yet have a kid with a recessive trait? When explaining, use ***A- Tall*** and ***a-small.***

Yes, if both are heterozygous, but can give a recessive trait and thus child can have recessive phenotype

	A	a
A	AA	Aa
a	Aa	aa

31. Compare and contrast codominance and incomplete dominance. How are they both different than complete dominance?

In complete dominance, the dominant trait completely covers the recessive phenotype. In incomplete dominance heterozygous phenotypes that are blended together. Codominance is when both alleles of a heterozygous genotype are expressed, but not blended (ex spotted cow)

32. Label the type of chromosomal mutations in the diagrams below?

Deletion

Duplication

Inversion

Translocation

33. Janet is breeding rabbits for two traits, fur color, and ear position. Their alleles are as follows

F- Brown fur	E – for upright ears
f- white fur	e- for floppy ears

Suppose Janet mates two rabbits. One that is a **brown carrier with floppy ears** and the other has **white fur but is heterozygous upright ears**. Predict the phenotypic ratios of the offspring. Parents: Ffee, ffEe

	Fe	Fe	fe	fe
fE	FfEe	FfEe	ffEe	ffEe
fe	Ffee	Ffee	ffee	ffee
fE	FfEe	FfEe	ffEe	ffEe
fe	Ffee	Ffee	ffee	ffee

25% (4) Brown upright, 25% (4) Brown floppy, 25% (4) white upright, 25% (4) white floppy

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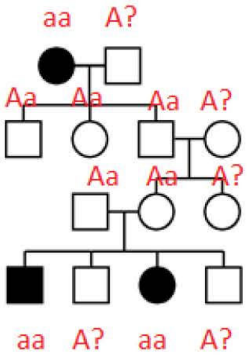
34. Assume that the pedigree to the right represents the trait attached earlobes. Is this an autosomal recessive or dominant trait? Why?

Recessive, females and males have trait, and it skips generations.

35. Assuming it is a recessive trait Fill in the genotypes of all family members.



Assume that the pedigree to the right represents the disease Huntington's disease. Is this an autosomal recessive or dominant trait? **Why?**

Trait does not skip generations.

36. Assuming it is a dominant trait Fill in the genotypes of all family members.