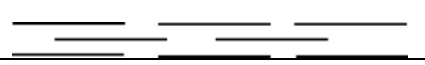
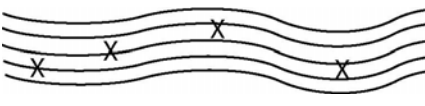
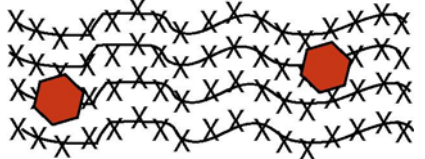




# Metamorphism and Metamorphic Rocks - Chapter Questions

1. \*\*What are the agents of metamorphism?
2. \*\*When metamorphic rocks form, what main factors dictate the rock that will form?
3. \*\*Where does water in hydrothermal (chemically active) fluids come from?
4. Compare and contrast metamorphism, weathering/ sediment lithification, and igneous rock formation.
5. \*\*Be sure you understand the main textural changes that occur as metamorphic grade increases.

How does texture change as grade increases?	Why?
Density increases (volume shrinks)	Grains/crystals pack closer together under confining pressure
Foliation increases	Minerals align when under directed pressure
Crystal size increases	Grain boundaries migrate, enlarging crystal size as pressure (any kind) placed on crystal boundaries.

6. Distinguish among these types of foliation (ensure you know the definition of foliation and can recognize these textures).

Grade	Foliation type	Description	Picture
Low	Rock or slaty cleavage	Microscopic, aligned mica minerals. Planar cleavage. No visible minerals. Dense.	
Low to med	Phyllitic texture	Mostly microscopic, aligned mica minerals. Only a few visible, isolated minerals peeking out of satiny background. Foliation is undulating.	
Med to high	Schistosity	Mostly visible biotite minerals - all aligned, giving rock a scaly look, like a fish. Foliation is undulating and fine. Some large porphyroblasts may peek out.	
High	Gneissic texture	All visible, interlocking crystals, separated into alternating dark- and light-colored layers.	
Very high	Migmatitic texture	Gneissic texture where 1/2 melted, and the high temperatures caused folding of the layers.	

7. How and why do mineral compositions change as metamorphic grade increases?
8. \*\*What is an index mineral?
9. Which of the minerals below are good index minerals? Poor?

General mineral grade stability		
Low	Medium	High
-----Quartz-----		
-----Feldspar-----		
-----Calcite-----		
-----Muscovite-----		
-----Biotite-----		
-----Garnet-----		
-----Hornblende-----		
-----Pyroxene-----		

10. Be sure you can describe each of the major metamorphic settings found on Earth and the P, T, and fluid conditions of each.

**Common metamorphic settings for metamorphism and their characteristics and symbol**

Metamorphic setting	P	T	Chemically active fluids
Contact metamorphism (C)	Low	High: increasing toward magma	High - from magma and from heated surface waters
Regional metamorphism: Deep burial (B)	High: steadily increasing with depth	High: steadily increasing with depth	Low - liberated from hydrous minerals
Regional metamorphism: Converging continents (R)	High: increasing with depth	Low to medium: increasing with depth	Low - liberated from hydrous minerals
Subduction zone metamorphism (S)	High	Low: slowly increasing with depth	High - from hydrous minerals in hydrothermally altered ocean crust.
Fault zones (F)	Shear is high. Overall pressure is low.	Low.	None
Hydrothermal (H) circulation at spreading centers	Low	High because occurs at the Moho.	High - from magmas and from circulating seawater

11. \*\*How are **slate, phyllite, schist, gneiss, and migmatite** formed? (Parent rock, setting, and grade) What are there similarities? Differences?
12. How are **marble, quartzite, hornfels, and skarn** formed? (Parent rock, setting, and grade) What are there similarities? Differences?
13. How are **greenstone** and **eclogite** formed? (Parent rock, setting, and grade) What are there similarities? Differences?
14. \*\*How is **serpentinite** formed? (Parent rock, setting, and grade)
15. The chart below summarizes the parent rock, setting, and grade of common metamorphic rocks. Be sure you understand all of the rock's origins.

**Metamorphic rock names based on parent rock, geologic setting, and metamorphic grade.**

Metamorphic settings	B, R, S	B, R, S	S	B, R, S	B, R, S
Parent rock	Shale	Granite	Basalt	Chert (SiO <sub>2</sub> )	Limestone (CaCO <sub>3</sub> )
<b>GRADE:</b> Low Low - Med Med - High High Very High	<i>Slate</i> <i>Phyllite</i> <i>Schist</i> <i>Gneiss</i> <i>Migmatite</i>	<i>Gneiss</i> <i>Migmatite</i>	<i>Greenstone</i> <i>Blueschist</i> <i>Eclogite</i>	<i>Quartzite (crystals grow larger)</i>	<i>Marble (crystals grow larger)</i>

Metamorphic settings	C	C	C	C	C	H
Parent rock	Chert (SiO <sub>2</sub> )	Limestone (CaCO <sub>3</sub> )	Mixture of minerals	Shale	Basalt	Mantle rock (Peridotite)
<b>GRADE:</b> Low Low - Med Med - High High Very High	<i>Quartzite (crystals grow larger)</i>	<i>Marble (crystals grow larger)</i>	<i>Skarn (crystals grow larger; form new minerals)</i>	<i>Hornfels</i>	<i>Hornfels</i>	<i>Serpentinite</i>