After reading the article, *Fertile Minds* respond to the following questions on a separate sheet of paper.

1. What does Shatz mean when she says, “what the brain has done is lay out circuits that are its best guess about what’s required for vision, for language, for whatever”?

   • **Although the brain contains virtually all the nerve cells it will ever have, the pattern of wiring between them has yet to stabilize**
   • it is now up to neural activity – no longer spontaneous, but driven by a flood of sensory experiences to take this rough blueprint and progressively refine it
   • in the 1st year ~ brain undergoes a series of extraordinary changes
   • baby’s brain produces trillions more connections between neurons that it can possibly use
   • through a process that resembles Darwinian competition, the brain eliminates connections or synapses that are seldom or never used
   • the excess synapses in a child’s brain undergo a draconian **pruning**, starting around the age of 10 or earlier, leaving behind a mind whose patterns of emotion and thought are, for better or worse, unique

2. How many neurons are present at birth? What is the role of glial cells?

   • **100 billion (150 billion according to video) ~** roughly the # of stars in the Milky Way
   • also a trillion glial cells (Greek for glue) which form a kind of **honeycomb that protects and nourishes the neurons**

3. What role does touch and contact with loving caregivers play in the size of a baby's brain?

   • **When deprived of a stimulating environment, a child's brain suffers**
   • children who don't play much or who are rarely touched develop brains 20% to 30% smaller than normal for their age
   • in lab, young rats reared in toy-strewed cages exhibit more complex behaviour than rats confined to sterile, uninteresting boxes; the rats with toys have as many as 25% more synapses per neuron
   • **rich experiences really do produce rich brains**
   • the data underscore the importance of hands-on parenting, of finding the time to cuddle a baby, talk with a toddler and provide infants with stimulating experiences

4. Can damage to a child's brain or lack of a stimulating environment early in life be compensated for later in life?
There is a time scale to brain development and **the most important year is the first by the age of three**, a child who is neglected or abused bears marks that, if not indelible, are exceedingly difficult to erase. but, research offers **hope**. the brain during the first years of life is so **malleable** that very young children who suffer strokes or injuries that wipe out an entire hemisphere can still mature into highly functional adults. **Well-designed pre-school programs** can help many children overcome glaring deficits in their home environmental with appropriate **therapy**, even serious disorders may be treatable. while inherited problems may place certain children at greater risk than others, that is no excuse for ignoring the **environment's power to remodel** the brain. **Activity changes the brain**.

5. Is a fetus's developing brain simply a miniature of an adult brain?

- A baby does not come into the world as a genetically preprogrammed automaton or a blank slate at the mercy of the environment's rather than focusing on whether nature or nurture calls the shots, most scientists are more interested in chronicling the myriad ways in which genes and the environment interact. “it's a dance” a **developing babies brain is more like a tadpole that gives rise to a frog**. cells produced in the neural tube must migrate to distant locations and accurately lay down the connections that link one part of the brain to another. the embryonic brain must construct a variety of temporary structures, including the neural tube, that will, like a tadpole's tail, eventually disappear. the instructions are programmed into the genes. **At birth a baby can see, hear, smell and respond to touch, but only dimly**. the brain stem, a primitive region that controls vital functions like heartbeat and breathing, has **completed its wiring**. the connections between neurons in other areas of the brain are wispy and weak. over the first few months of life, the brain's higher centres explode with new synapses as dendrites and axons swell with buds and branches like trees in spring, metabolism soars. by age **2 yrs, a child's brain contains twice as many synapses and consumes twice as much energy as the brain of a normal adult**. this profusion of connections lends the growing brain exceptional flexibility and resilience.

6. What does the case of Brandi Binder teach us about the resiliency of the brain?

- Brandi had developed such severe epilepsy that surgeons removed the entire right side of her cortex when she was 6 yrs old. she lost virtually all the control she had established over muscles on the left side of her body, the side controlled by the right side of the brain. @ 13 yrs old, after years of therapy ranging from leg lifts to math and music drills,
Binder is an A student
- she loves music, math and art (skills usu. Assoc. With the right half of the brain)
- her recovery is not 100%  (i.e. She has not regained the use of her left arm) it comes close
- if there is a way to compensate, the developing brain will find it
- repeated experience wires or re-wires a brain

7. Why are parents considered the “brain's first and most important teacher(s)”?

- they appear to help babies learn by adopting the rhythmic, high-pitched speaking style known as Parentese
- when speaking to babies, moms and dads from many cultures change their speech patterns in the same peculiar way
- faces very close to the child
- use shorter utterances
- speak in an unusually melodious fashion
- the heart rate of infants increases while listening to Parentese, even if delivered in a foreign language
- Parentese hastens the process of connecting words to the objects they denote
- Parentese – exaggerated, vowel-rich sounds appear to resemble the choice morsels fed to hatchlings by adult birds
- **fundamental role parents play in setting up the neural circuitry that helps children regulate their responses to stress**

aside...
- repeated experience wires or re-wires a brain
- each time a baby tries to touch a tantalizing object or gazes intently at a face or listens to a lullaby, tiny burst of electricity shoot through the brain, knitting neurons into circuits as well defined as those etched onto silicon chips
- the results are those behavioural mileposts that delight and awe parents
- around 2 months, the motor-control centres of the brain develop to the point that infants can suddenly reach out and grab a nearby object
- around 4 mos, the cortex begins to refine the connections needed for depth perception and binocular vision
- around 12 mos, the speech centres of the brain are poised to produce what is perhaps the most magical moment of childhood:  the first word that marks the flowering of language
- **when the brain does not receive the right information – or shuts it out – the result can be devastating**
- some children who display early signs of autism, for example, retreat from the world because they are hypersensitive to sensory stimulation, others because their senses are under-active and provide them with too little information
- the treatment must match the underlying causes
- when parents & therapists collaborate in an intensive effort to reach these abnormal brains, sometimes the child can be brought back out of the autistic's limited universe


8. Why is earlier abuse more damaging to brain development?

- parents play a fundamental role in setting up the neural circuitry that helps children regulate their responses to stress
- children who are physically abused early in life develop brains that are exquisitely tuned to danger
- at the slightest threat, their hearts race, their stress hormones surge and their brains anxiously track the nonverbal cues that might signal the next attack
- because the brain develops in sequence, with more primitive structures stabilizing their connections first, early abuse is particularly damaging
- experience is the chief architect of the brain
- because early experiences of stress form a kind of template around which later brain development is organized, the changes they create are all the more pervasive

9. What effect can a new mother's depression have on the developing brain of her young infant?

- Emotional deprivation early in life has a similar effect as physical abuse
- as infants, children of mothers who were d/x with depression showed markedly reduced activity in the left frontal lobe (an area of the brain that serves as a centre for joy and other lighthearted emotions)
- the patterns of brain activity displayed by these children closely tracked the ups and downs of their mother’s depression
- not all children follow this pattern
- the difference seems to be accounted for by the difference in emotional tone of the exchanges between mother and child
- mothers who were disengaged, irritable or impatient had babies with sad brains
- mothers who managed to rise above their melancholy, lavishing their babies with attention and indulging in playful games, had children with brain activity of a considerably more cheerful cast
- *if mother snaps out of depression before child is 1 year old, brain activity in the left frontal lobe quickly picks up
- the ability to rebound declines markedly as the child grows older

10. What are the implications mentioned in this reading concerning early stimulation for later growth and development?

- There appear to critical/sensitive periods or “windows” for development in certain areas
- i.e. The ability to learn a second language is highest between birth and the age of six, then undergoes a steady and inexorable decline
- brain’s greatest growth spurt draws to a close around the age of 10 yrs when the balance between synapse creation and atrophy abruptly shifts
- over the next several years, the brain will ruthlessly destroy its weakest synapses, preserving only those that have been magically transformed by experiences
- this experience seems to be encoded in the genes
• the bursts of electricity that travel through the brain, creating everything from visual images and pleasurable sensations to dark dreams and wild thoughts ensure the survival of synapses by stimulating genes that encode for synapse-destroying enzymes
• by the end of adolescence, around the age of 18yrs, the brain has declined in plasticity but increased in power
• talents and latent tendencies that have been nurtured are ready to blossom
• it is the overproduction of synaptic connections followed by their loss that leads to patterns in the brain
• potential for greatness may be encoded in the genes, but whether that potential is realized as a gift for mathematics, or a brilliant criminal mind depends on patterns etched by experience in those critical early years
• *confirming/providing evidence to support the value of early experiences
• foreign languages should be taught in elementary school, if not before
• remedial education may be more effective at the age of 3 or 4 than at age 9 or 10
• good affordable day care is not a luxury or a fringe benefit for welfare mothers and working parents but essential brain food for the next generation
• while new synapses continue to form throughout life, and even adults continually refurbish their minds through reading and learning, never again will the brain be able to master new skills so readily or rebound from setbacks so easily
• if parents and policymakers don't pay attention to the conditions under which this delicate process takes place, we will all suffer the consequences....