Yoga Anatomy and Physiology for Kids Aged 2-5yrs

There can be no keener revelation of a society's soul than the way in which it treats its children.

- Nelson Mandela

Dedication – This manual is dedicated to the children of the world. May we know them and love them and may we never forget the child that will always live within us.

CHILD ANATOMY & PHYSIOLOGY 2-5 year olds

Lisa Fitzpatrick

PO Box 97 New Brighton, Australia 2483

Created in Australia

INTRODUCTION

I am so excited to present this manual to you. As a registered physiotherapist, mother and experienced yoga teacher, I am passionate about supporting health and wellbeing through the practices of yoga and coaching. My mission is to empower teachers like you with a greater understanding of the anatomy and physiology of children so that you can enjoy a greater level of depth, understanding and fulfilment as you branch into the specialty of children's yoga. With this manual, I am committed to giving you the insights and tools you need to safely and confidently teach younger children.

Whether you are just beginning your teaching journey, or you already have plenty of experience teaching yoga to children, this manual is designed to support you at your current skill level.

INSTRUCTIONS FOR USE:

This Children's Anatomy and Physiology Manual has been created to provide a basic introduction to children's anatomy and physiology, as it relates the practice of yoga with children aged 2-5 years. It is intended that this resource will facilitate its readers to better understand how to practice yoga safely with younger children based on their unique physical capacities and needs. Understanding how yoga can support the positive development of children will help to ensure the benefits of yoga are optimised. This manual supports the view that children's health and wellbeing is holistic in nature and includes their mental, emotional, spiritual and social wellbeing alongside their physical bodies. An understanding of the content of this manual will allow you to tailor your yoga teaching to meet children where they are in their unique development.

Focus: Ages 2 to 5 year olds

DISCLAIMER

The advice contained within this manual is a very basic reference guide only. All care has been taken to ensure the material has been substantiated by the research cited. It does not substitute medical advice, nor should it support the diagnosis or treatment of disease or illness. Please refer students to a qualified medical practitioner if in doubt about a child's health. It takes many years to understand the human body and delegating to a health professional is one of the wisest decisions a yoga teacher can make in the case of a health condition.

TABLE OF CONTENTS

LEARNING OBJECTIVES

- Competently understand the basic physical development of children aged 2-5 years
- To be able to understand skeletal, nervous, muscular, cardiovascular and respiratory development in young children
- To be able to understand specific benefits of yoga to the skeletal, nervous, muscular, cardiovascular and respiratory systems and specific safety aspects to ensure proper care is given.
- To be able to tailor yoga techniques of asana, mindfulness, meditation and pranayama as they apply to children aged 2-5 years.
- How to manage specific physical challenges and understand how to identify certain common conditions when teaching yoga classes to pre-schoolers aged 2-5 years.
- The understanding of how to identify and prevent common injuries in children aged 2-5 years

Introduction to CHILD DEVELOPMENT

Understanding Anatomy and Physiology in the 2-5 year old child

* in this age group, the continuous and consistent growth of the child is marked by periods of rapid and accelerated growth known as 'growth spurts'

* Rapid growth is usually followed by periods of slower growth

* Child development is influenced by multiple factors, which may be both internal and external. It includes a vast range of biological or physical, psychological, mental, emotional, spiritual and social changes

* genetic, social, cultural, emotional, mental, nutritional and environmental influences also play a part in a child's development

* It's important to remember that every child has unique characteristics, just like a fingerprint

* Therefore every yoga class will be different, with a child's individual qualities needing to be considered in each and every class

* This manual will primarily be an outline of the commonalities seen in the developmental stages of a child between the ages of 2 and 5

* Understanding the unique stage and features of a young child's development will support you to tailor your classes and activities to maximise their effectiveness and to make sure your activities are age appropriate

* The most important thing as a teacher, is to remember is to have fun and to stay playful with children of this age

* Trust yourself and keep things as light as possible

* remember the safety rules and enjoy playing within these rules

WHY IS ANATOMY and PHYSIOLOGY IMPORTANT for YOGA TEACHERS?

We can use our knowledge of anatomy and physiology as yoga teachers in a myriad of beneficial ways for pre-school aged children

- It allows you to become a more precise, skillful, knowledge-able and safe yoga teacher for 2-5 year olds
- It deepens your appreciation of the developmental stages of 2-5 year olds and their unique physical, mental, emotional and spiritual capacity to engage in yoga tools
- It helps you to prevent injury specific to this age group and understand the causes of common injuries and challenges seen in pre-schoolers' bodies.
- It supports you to develop and deliver age-appropriate and developmentally-appropriate activities

- To increase your understanding of the health benefits of yoga for children
- To increase your confidence, awareness and compassion towards pre-schoolers and their specific and unique needs enabling you to effectively tailor your classes
- To support you to speak and engage with other health professionals and parents on behalf of your pre-school aged students to ensure their needs are being met. These health professionals may include psychologists, physiotherapists, speech and language pathologists, occupational therapists, podiatrists, specialists, paediatricians and general practitioners who will support the well-being of a child with special requirements
- To support you to teach anatomy and physiology for yoga to your own pre-school aged students to facilitate their own learning and awareness about their own bodies
- To increase your awareness of specific movement patterns in the pre-school aged child
- To understand the anatomical differences that may exist in children of various ages

THE SKELETAL SYSTEM and DEVELOPMENTAL ANATOMY

Over the course of childhood, the skeletal system grows in height, length, and density. At birth, the skeleton has over 270 bones. Over time, smaller bones grow together and fuse into larger bones. The adult human body has only 206 bones.

Purpose of Bone

Bones serve to support and protect the body. They are essential for movement as they provide attachment points for the muscles. Bones are a storage place for minerals, energy and blood cell production, which occurs in the bone marrow.

Growth plates and fontanelles (soft spots in the skull) are two key differences between the child body and adult body. At birth, the human skull is comprised of multiple bones that are separated by fontanelles. Fontanelles are membranous gaps between skull bones that allow for rapid stretching in the skull as the brain expands. The last fontanelle closes at 19 months of age. By two years of age, these are fully closed in normal development.

The Nature of Bone

Bone strength is determined by the skeleton's total bone mass, or the amount of bone tissue in the skeleton. During childhood and adolescence, the skeleton grows in size and density. Bone mass increases in the skeleton until it reaches maximum density around age thirty.

Bone is a dynamic, living tissue, constantly being built, torn down and rebuilt. The skeleton constantly responds to forces placed upon it. In a rapidly developing child, bones need special care in order to develop with symmetry and good postural alignment, otherwise developmental issues may occur in the skeleton related to correct posture and alignment.

The tools of yoga asana provide an opportunity to support skeletal development in the younger child.

Alignment

Alignment relates to how the head, neck, shoulders, spine, hips, knees, ankles, and feet line up in relationship to each other. Correct alignment will create optimum conditions for breathing, major organs, muscle mechanics as well as posture. Yoga increases body alignment and posture by developing core strength and body awareness. Poor habits (like holding a school bag on one side of the body consistently) will adversely influence the developing skeleton.

Early childhood is an important time for bone growth as the bones grow rapidly in both length and width. It is important to start building the strength in bones from a young age. In order for bone growth to develop, preschoolers need to do physical activity and eat a healthy diet. Weight bearing activity such as walking, running and yoga asana, can help the bones to develop in healthy ways when done safely.

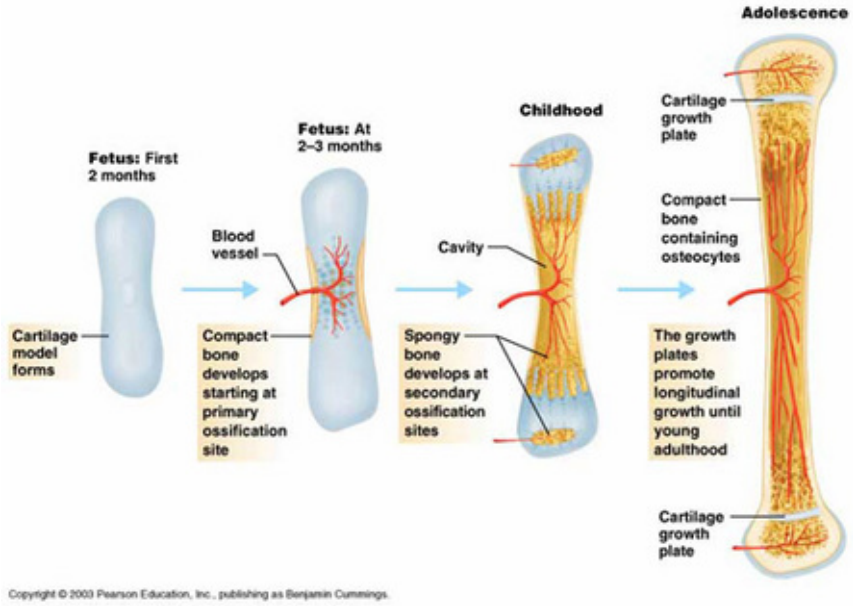
It is important for children to consume enough calcium and vitamin D for bones to grow properly.

For 2- 5 year olds, the recommended daily dose of calcium is 500mgs or two full glasses of milk. Vitamin D recommendations are 600IU per day.

Children's bones contain growth zones at both ends called growth plates. These contain special cells that support rapid and steady growth in the lengths of the bones. Growth plates are softer and appear darker on x-ray as they have less mineral content. As a child gets older, the growth plates eventually disappear as they become 'closed growth plates' which means they have fully developed.

As kids grow, growth plates change in appearance on the X-ray images and become thinner, eventually disappearing hence becoming closed growth plates. Growth plate injuries can occur in young children. Serious injury from a fall or a direct blow to the limb can result in growth plate fractures. Teach from a place of modification to avoid injury as a child's limbs and long bones are more fragile than adults. Girls' bones mature earlier than boys'. Growth plate fractures are

twice as common in boys.



To evaluate how fast or slowly a child's skeleton is maturing, a bone age study can be performed. A paediatrician will conduct a bone age study to diagnose conditions that delay or accelerate physical development. If you are concerned about a child's development, it is prudent to have a discussion with their teacher and/or parent. A referral to a general practitioner who will then have the authority to refer to a paediatrican may be required.

Bone age can be used to predict:
- how much time a child will be growing
- when a child will enter puberty
- what the child's ultimate height will be

Orthopedic or orthodontic problems in which the timing and type of treatment (surgery, bracing, etc.) must be guided by the child's predicted growth are supported by bone age tests. In order to progress and guide treatment of children who may have conditions that affect growth such as hormone deficiency, hypothyroidism (underactive thyroid gland) and growth disorders, then a bone age test may be required.

By the age of three or four, a child is usually double their birth length in height. The major leg bones, of a three-year-old child are half their eventual adult length.

(sources :
1.https://www.niams.nih.gov/health_info/bone/Bone_Health/Juvenile/default.asp
2. http://www.healthofchildren.com/S/Skeletal-Development.html#b)

3. image:
http://www.personal.psu.edu/staff/m/b/mbt102/bisci4online/bone/bone5.htm)

Joints

A joint is formed where bone joins with another bone. There are many different types of joints in the body, which create different types of movement. Not all joints move, such as the joints between skull plates. However, freely moving joints are known as synovial joints. A preschool aged child's joints are not fully developed so will be more shallow and hence capable of a greater range of motion.

All synovial joints have the following structures:

- A joint space
- Cartilage
- Synovial membrane
- Synovial fluid
- Fibrous joint capsule
- Supporting ligaments

Ligaments

Ligaments are the rigid, inflexible structures that attach bone to bone. However, these are more pliable and flexible in pre-schoolers. So ligaments don't provide the same level of stability to the joints as an adult's fully formed ligaments. Being less stable, care must be taken not to push or force children's joints into positions such as asana. A child should be able to comfortably move in and out of asana without placing excessive force on their developing body.

Joint Range of Motion (ROM)

Range of motion at the joints is dependent upon individual flexibility and the genetic structure of joints, which can be hugely varied amongst individuals. For example, the hip socket joint or *acetabulum* is shallow in some bodies allowing for a high range of movement and very deep in others hence limiting hip flexibility.

However in most pre-schoolers, joint ROM will be more flexible than in adults because supporting structures such as bone, ligament and muscle are still developing.

(source: Columbia University Medical Center. (2010, May 10). Pediatric spine—

not just smaller—different. *Columbia University Medical Center.* Retrieved December 15, 2013 from http://www.columbianeurosurgery.org)

Yoga safety tip: a rule of thumb for supporting a child to move in and out of asana is allowing the child to mirror your movement actively without any pressure. They should not require assistance to move their limbs in and out of position and if they can comfortably move their body independently using active muscle control, this indicates their safe range to operate from.

Allow a child to move within his or her natural movement pattern and never push or adjust a child with force.

The Spine

The spine is divided into four sections. The cervical spine (7 vertebrae), thoracic spine (12 vertebrae), lumbar spine (5 vertebrae) and sacrum = sacred (1 bone consisting of 5 fused vertebrae). The coccyx forms the tip of the sacrum or tailbone (4 fused bones) and is shaped like a cuckoo's beak. Thus, there are a total of 33 vertebrae.

Curves

The primary curves of the spine form in utero. The initial curve creates a rounding out towards the back of the body (the spinal position seen in an asana known as child pose). This curve is known as a primary curve or *kyphosis*.

As an infant develops and learns to lift the head (usually by 3 months of age), this creates the inward facing cervical curve known as a secondary curve or *lordosis*.

Later, usually around 6-9 months, the sitting posture develops which introduces the inward facing lumbar curve in the lower back. Both the cervical and lumbar curves are known as secondary curves or *lordosis*.

In the lower back, the inward facing *lordosis* is pronounced in the child aged 2-5 years. This creates the appearance of the 'swayback' and naturally tips the pelvis forward slightly into an anterior tilt. It also increases the prominence of the abdomen, which is why pre-schoolers have their adorable tummy bump.

(source: MacGregor, J. (2008). *Introduction to the anatomy and physiology of children* (2nd ed.). New York, NY: Routledge)

The natural curves of the spine are developmentally important because they provide a clear pathway for the spinal cord and spinal nerves to provide impulses

to the muscles for movement.

The primary role of the spine is to create structure and stability for the upright body and to enclose and protect the spinal cord. However, a pre-schooler's spine is *hypermobile* as ligaments are very elastic. They also tend to have underdeveloped muscles as their skeleton grows. This makes pre-school aged children more at risk of spinal injury, especially at the neck.

(source: Columbia University Medical Center. (2010, May 10). Pediatric spine—not just smaller—different. *Columbia University Medical Center.* Retrieved December 15, 2013 from http://www.columbianeurosurgery.org)

Safety tip: *maintain the natural curves of the spine and do not place excessive force on the spine in either forward or backward bends.*

The cervical spine

In a child aged 2-5 years, there are unique factors, which increase the possibility of a neck injury.

- Their heavy head is based on a weaker neck with muscles that are not as formed as those in adults. Undeveloped muscles create less stability overall.
- They have looser and more pliable ligaments in the higher cervical levels such as C2-3 and C3-4 until they get older
- They have less formed joints in the upper cervical spine which are more vulnerable in rotation and extension of the neck
- The movement fulcrum exists at a higher level in children (C2-3) vs (C 5-6) in adults

A child's head is disproportionately larger than an adults compared to their body's actual size. The brain is growing so quickly that the skull must also grow fast in order to accommodate, and the rest of the body then needs to catch up.

(Sources: 1. MacGregor, J. (2008). *Introduction to the anatomy and physiology of children* (2nd ed.). New York, NY: Routledge

2. Huelke, D.F. (1998). An overview of anatomical considerations of infants and children in the adult world of automobile safety design. *Annual Proceedings / Association for the Advancement of Automotive Medicine, 42,* 93-113.)

Due to the fact that the child's head is large compared to their body, the neck is more prone to injury due to sudden head and neck movements. A child's neck must be treated with more care during yoga.

Safety tip: *when doing forward folds, tuck the chin to the chest to protect the*

neck. When doing back bends, encourage a forward gaze with and don't allow the head to drop back. Avoid yoga poses that put weight on the head like headstands. Their neck is not developed enough at this age to cope with the pressure upon it.

The Thoracic spine

Children aged 2-5 years have thinner chest muscles and their ribs are generally softer and more malleable than adults. It's important to be careful when children engage in high-energy activities that involve jumping or excessive bodily contact. Partner activities need to be well supervised to avoid children jumping on top of one another or having excess body contact.

Proportions and centre of gravity

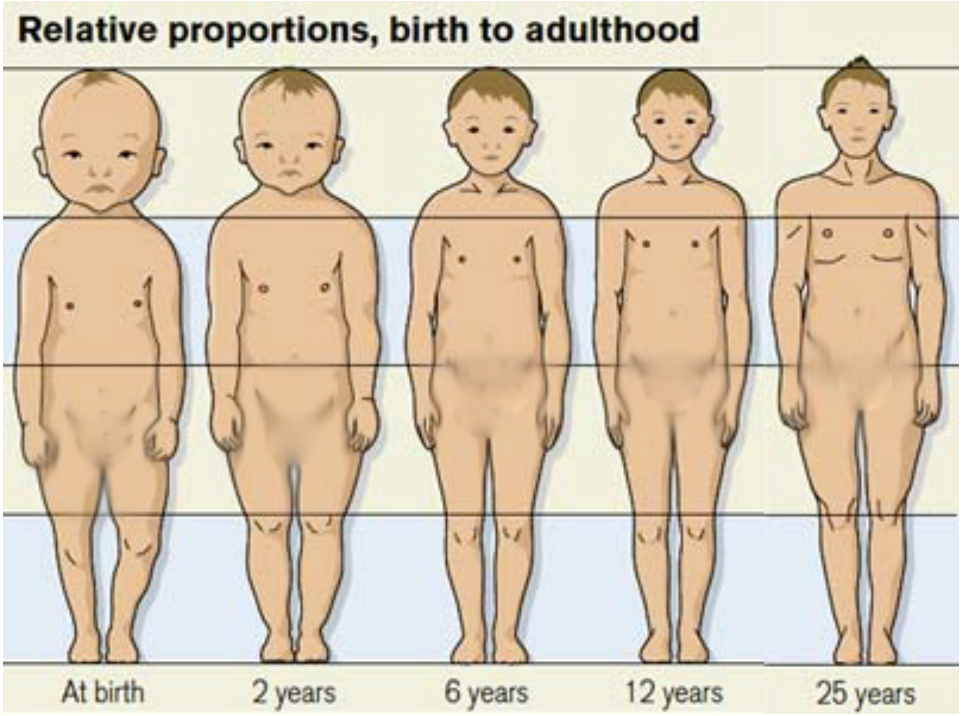
A child's centre of gravity sits fairly high up in the body, around the lower thoracic spine. As the spine develops, a child's centre of gravity will move downwards towards the pelvis. This means that a child aged 2-5 years will be slightly more 'top heavy' than an adult and will lose balance more easily.

MacGregor says: 'When a child reaches adult height, their centre of gravity will have shifted from the 12th thoracic vertebrae to around the 5th lumbar vertebrae, with slight differences between women and men.' Thus, the centre of body mass of a toddler is higher than in an older child. It lies at about the level of the bellybutton.

(source: MacGregor, J. (2008). *Introduction to the anatomy and physiology of children* (2nd ed.). New York, NY: Routledge)

Safety tips: ***when doing standing balancing poses, be aware that a child's centre of gravity sits higher up in the body. This means they may need wall or chair support to assist their balance. Be generous with modifications that help with balance. Avoid high level poses such as high level balancing or inversion asana that may cause them to fall and injure themselves. Direct a child to adopt a wider base of support (ie feet hip distance apart or wider) in standing postures such as mountain pose, in order to support their balance. Do asana that is closer to the ground.***

Body proportions change significantly as a child develops.



(image thanks to http://www.rearfacingdownunder.com)

As the rate of growth of different body segments is varied, it creates change in the body's proportions. A child's physical appearance markedly changes as their head becomes relatively smaller while their leg length increases.

Summary of safety considerations when teaching 2-5 year olds

* The development of the spine affects a child's centre of gravity and balance. Pre-schoolers need support and modifications to ensure you keep their spine and joints safe

* In forward folds, always ask preschoolers to tuck their chin into their chest when transitioning in and out of the forward bend

* In back bends, ask them to keep their eye-gaze looking forward so that they don't extend their neck or drop their head back

* Avoid yoga poses that put weight on the head

* Avoid postures that may cause a child to fall and injure themselves or others, such as high level balancing poses or inversions.

* Create a wider base of support by standing with legs wide

* Do more asana closer to the ground to support less change of falls

Benefits of yoga for the skeletal system

- promotes awareness of head and neck
- strengthens supporting neck and spinal muscles
- starts to develop bone strength and joint integrity
- builds symmetry and alignment in the developing skeleton
- encourages awareness of posture
- promotes spatial awareness of the head and neck
- strengthens the developing muscles that support the neck, when performed safely.
- can help to lengthen and decompress the lower back
- supports flexibility and strength of the muscles surrounding spine
- Weight- bearing activities place mechanical strain and tension on growth plates, which causes the body to increase bone density to respond to the stress (MacGregor, 2008). Bone strength is important in preventing fractures and osteoporosis.

Yoga asana to support growing bones for children aged 2- 5

1. crawling and cat and cow – great for weight bearing through arms and legs
2. dolphin pose (down dog on elbows) – great for upper limb bone strength
3. down dog (for arms and leg bone strength building)
4. locust pose (salabasana) – lovely for building the strength of the muscles supporting the spine and neck. Take care to keep the eye gaze forward to prevent excessive extension of the neck.

THE NERVOUS SYSTEM

The primary role of the nervous system is to maintain balance, harmonizing all the body's systems. This balance is known as *homeostasis*. *Homeostasis* comes from the Greek words – *homeos*, meaning *same* and *stasis,* meaning *standing still*. The nervous system is a complex network of nerves and cells that carry messages between the brain, spinal cord, and the rest of the body in order to maintain balance.

The nervous system is divided into two parts

- the central nervous system (CNS) – the brain and spinal cord which convey information to and from the body.

- the peripheral nervous system (PNS) – any nerves outside the brain and spinal cord as well as the autonomic nervous system (ANS). The enteric nervous system (ENS) is a division of the ANS.

Neurons are the main cells of the nervous system. These are responsible for both *receiving* information from various structures of the body and *sending* impulses to affect the functions of the body.

The Central Nervous System (CNS)

Children in the 2-5 year age group have a rapidly developing nervous system, which is incredibly versatile and dynamic. Brain and nervous system developments during early childhood are extreme.
In fact, **90-95% of brain growth will happen in the first 5 years of life.**

The brain is a complex organism. In the first 2-5 years, there is a dramatic growth spurt. Approximately 90-95% of cells organize and create pathways to more sophisticated brain functions. Not all of these connections are permanent. Brain development occurs by strengthening the connections of nerve cells.

Complexity of movement and function both increase in a direct relationship to the rapid nervous system development that occurs during childhood. The brain (also called the *cerebrum*) is made up of billions of nerve cells (neurons) and support cells. Although the brain is only 2% of the body weight, it consumes 20-30% of the energy supply in adults. However in a five year-old child, 50% of the calories consumed are used to fuel the brain due to a child's high level of activity and rate of development.

(sources: 1. https://www.babycenter.com/0_brain-development-frontal-lobe_6611.bc 2. http://www.teach-through-love.com/child-brain-development.html)

Certain areas of the brain have specialized functions such as speech, hearing, memory, emotion and movement. There are two sides of the brain, or hemispheres, which are able to work almost independently. Lateralization refers to the localization of a variety of skills and functions in either or both hemispheres. Yoga can help to balance the left and right sides of the brain and to promote cross over between the left and right sides.

i)the left hemisphere – relates to the masculine polarity – pertains to intellectual, reasoning, mathematics, spoken and written language, numerical ability, scientific skills and linear thought.

ii) the right hemisphere –relates to the feminine polarity- creativity, imagination, intuition, artistic awareness, space and pattern perception, insight and imagination. This is usually vividly developed in children with rapid growth in early childhood.

The hemispheres are connected by the **corpus callosum**. This structure is a wide bundle of neural fibers that stretches between the two hemispheres. It is responsible for managing and maintaining the integration of the left and right hemispheres. A child's corpus callosum won't become fully insulated for quick functioning until he or she is 7 or 8, making whole brain behaviors challenging.

In fact, the work of integration between hemispheres doesn't stop until a child is 26 years old!

Although the hemispheres have separate functions, these brain masses develop to co-ordinate their functions and work together.

Key concept: The two cerebral hemispheres develop at different rates, with the left hemisphere developing more fully in early childhood (ages 2 to 6), and the right hemisphere developing more fully in middle childhood (ages 7 to 11). The left hemisphere predominates earlier and longer, which may explain why children acquire language so early and quickly.
In a younger child, there is huge growth in the left hemisphere of the brain, tied to language. A three year-old child has learned 500 to 800 words and can speak three- to five-word sentences due to the rapid growth of the language centre.

Handedness

Another aspect of brain development is handedness, or preference for using one hand over the other. Handedness appears to be strongly established by middle childhood. About 90 percent of the general population is right-handed, while the rest of the population is left-handed and/or ambidextrous.

A person is ambidextrous if he or she shows no preference for one hand over the other.

(source: 1. https://medium.com/@galynburke/child-development-post-3-of-3-when-your-kids-become-capable-of-certain-tasks-and-why-1c4e28be26c6

2. http://www.parenting.com/article/brain-development-children)

3. https://www.cliffsnotes.com/study-guides/psychology/development-psychology/physical-cognitive-development-age-26/physical-development-age-26)

YOGA TIPS: children under eight will have difficulty with reciprocal movements and high-level co-ordination and balance of the body because their brain is still developing the ability to multi-task and integrate left and right sided brain function. Reduce the difficulty of balancing poses and any poses that involve high-level co-ordination. Keep things fun and simple!

The younger child's nervous system is enormously pliable and dynamic and may be shaped by the experiences he or she is exposed to. Yoga provides a wonderful way of introducing new movement patterns and movement awareness, which is deeply supportive to the developing nervous system.

Right and left hemisphere cross-over is strengthened in yoga by asana which involve crossing the midline of the body (for example Jathara Parivartanasana - the maltese twist - and Parivritta Parsvakonasana – right angle pose with a twist), rolling left and right and reciprocal actions such as crawling.

Most of a child's neurons (cells that make up nerves) form prenatally. However, nervous system support cells surrounding neurons known as glial cells are responsible for nourishing, insulating and removing waste from neurons. Glial cells don't actually transmit any information but they have an essential role to play in the health of the nervous system. These cells develop most rapidly during infancy, toddlerhood, and early childhood.

During the pre-school years, the myelin sheaths that surround, insulate, and increase the efficiency of neurons also form rapidly.

The developments of glial cells and myelin sheaths help to explain why older children may perform behaviours that younger children are not capable of.

(source: Yoga Ed. Corp (2014) 1st Ed. *Child Anatomy and Physiology Mini Yoga Manual.* Yoga Ed. Corp. Honolulu)

The brain of a 2-year-old has trillions of connections or synapses, which is double the number that an adult has. The brain grows these connections in response to a variety of environmental stimulus.

Over time, certain connections are used again and again while others fall by the wayside and wither away.

This process is called *neural pruning*. It explains why it's easiest for a young child to learn the accent of a language. When the brain isn't exposed to that language

regularly, certain synapses (neural connections) subside and the brain is no longer able to hear or form certain sounds as easily.

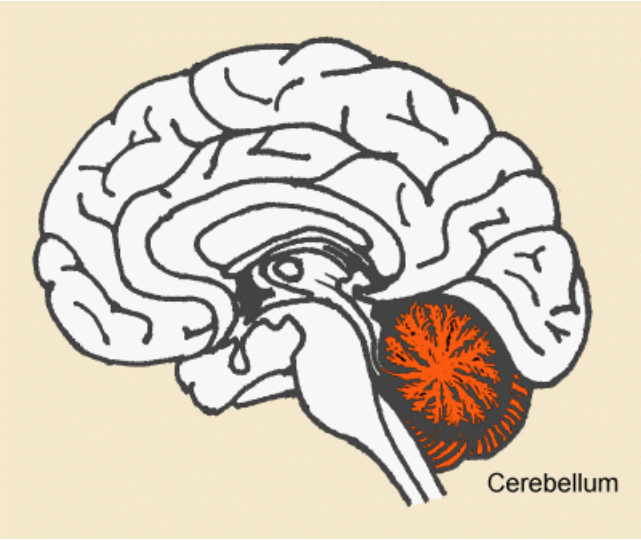
Routine and repetition are important to a young child as they facilitate learning and help to reinforce the synaptic connections to prevent pruning away of essential functional skills.

Although most brain development occurs during the first three years of life, the school years continue to foster the growth of neurons.

(source: https://www.babycenter.com/0_your-childs-growing-brain-ages-5-to-8_3659070.bc)

Yoga Tip: young children require constant repetition and routine to ensure the correct neural pathways are reinforced. Set up your yoga classes with a consistent rhythm and ritual to positively reinforce a child's learning.

The Cerebellum



This is a cauliflower shaped part of the brain located behind the cerebrum at the nape of the neck. It's also known as the 'lesser' brain, and is responsible for balance, smooth integration of movement (co-ordination), posture and regulation of muscle tone. It allows a child to progress from simple to more complex movement patterns as it co-ordinates motor function. This is an essential structure for the deep, automatic responses to asana, which allow children to develop balance and their awareness of where their body is positioned in space.

The cerebellum also helps with higher brain functions, such as learning music and language. And some experts believe the cerebellum has a critical role in helping children process social cues - in fact, research suggests that cerebellar abnormalities play a part in causing social and communication impairments (like

autism).

(source: https://www.babycenter.com/0_brain-development-cerebellum_6624.bc)

Yoga Tip: If you suspect that a child is having difficulty with tasks that are simple to the other children in the class, have a conversation with his or her teacher to ensure developmental delays are detected. A referral to an occupational or physiotherapist may be required to support early intervention. The earlier therapy is implemented, the better the outcome for the child.

The Brainstem

The brainstem is the lowest part of the brain connecting the brain to the spinal cord. Regulates heart-beat, blood pressure, breathing, swallow reflex, vomit reflex and coughing reflex.

The Spinal Cord

The spinal cord is a thin extension of the brain, living inside the vertebral canal (spine). It is 45cm in length on average and carries sensory and motor information to and from the body to the brain.

The Peripheral Nervous System (PNS)

The PNS consists of all the nerves outside the central nervous system (CNS). It exits the spine between the arches of the vertebrae and consists of 31 pairs of nerves. Nerves have many different functions both motor and sensory, leading to skin, muscles, organs and other tissues.

Nerves generate electrical impulses therefore they are wrapped in a myelin sheath and insulated with fat cells.

Nerve impulses send information from the nerve in the PNS to the spinal cord and brain during movement and asana to give feedback about the body's position in space, level of flexibility, alignment and balance.

Movement awareness is rapidly developing in early childhood and is stimulated by the asana offered in yoga.

Developmental milestones

Each stage of development for a child will be signified by increases in his or her capabilities, which normally follow a predictable sequence of achievements known as milestones.

- **Two year-old**

  Can stand on tiptoes

  Kick a ball

  Run

  Throws a ball overhand

  Climbs stairs with help

  Follow simple instructions

  Starts independent thinking (also known as the 'rebel stage')

  strangers can usually decipher only about 50 percent of a 2-year-old's words.

  Language begins to rapidly develop

  Tends to 'parallel play' alongside other children and not with them

- **Three year-old**

  Climbs well

  Runs easily

  Pedals a tricycle

  Walks up and down stairs one at a time

  Makes eye contact and has simple speech

  Play pretend

  Understand 3-step instructions

  Enjoy simple puzzles

  Know their name and age

  Enjoy playmates, although challenged by sharing

  Separate from parents easily

  Have finished toilet training

  Can speak at least 200 words

- **Four year-old**

  Hops and stands on one foot up to 2 seconds

  Catches a bouncy ball most of the time

  Can jump

  Interacts with other children

  Understands 'me' and 'you'

  Can obey a 3-part command

  Loves pretend games

  Improving impulse control

  Has a sense of time

  Uses pretend play to learn about others and bolster social development (according to research in the *Psychological Bulletin*)

  Can say their name and identify basic colours

  Can tell the difference between fantasy and reality

  Can speak in sentences with 5 or 6 words and tell stories

  Enjoy singing songs

- **Five year-old**

  stands on one foot for 10 seconds or longer

  can hop and skip

  can do a somersault

  climbs well

  can focus on an activity for longer than 5 minutes

  can recite first and last name

  become aware that actions will impact others

  find and seek and recognize acceptance

  rapidly developing prefrontal cortex – brain region responsible for self-

awareness and decision making.

Know their address and phone number, most of the alphabet, count to ten, basic understanding of time

Have conversations and use advanced grammar

(sources : 1. http://www.lanekids.org/developmental-milestones-for-children-age-2-5-years/

2. http://www.parenting.com/article/brain-development-children

3. http://www.webmd.com/children/tc/growth-and-development-ages-2-to-5-years-what-to-expect)

The autonomic nervous system (ANS)

A branch of the PNS is the Autonomic Nervous System (ANS). The ANS is divided into the *sympathetic nervous system* (SNS) and the *parasympathetic nervous system* (PSNS). Whilst the rest of the peripheral nervous system is responsible for conscious movement control, all subconscious activities within the body are directed by the Autonomic Nervous System. This includes organ control, heart rate and blood pressure.

The Sympathetic Nervous System (SNS)

The SNS is activated in emergency and stressful situations. It is known as the 'fight or flight' (or freeze) response. When activated, the SNS increases heart rate, blood pressure and respiratory rate. The SNS is responsible for actions requiring quick responses. It initiates a series of physiological changes in the body by releasing stress hormones (i.e. adrenaline and cortisol). Blood, oxygen, and energy are shunted to the arms, and legs to allow the body to fight, flee or freeze. Increased blood flow to the heart, arm and leg muscles will activate them which results in less blood flow to the digestive and abdominal organs. Stress and anxiety can increase the activity of the SNS.

Stress has a widespread negative effect on health and wellbeing due to the chronic changes in blood flow away from important abdominal organs. Stress can adversely affect the body in multiple ways including the increase in blood clotting factors and an increase in negative thoughts, feelings, and behavior.

Stress-related conditions include ulcers, fatigue, headaches, sleep problems, anxiety, lack of motivation, irritability, and sadness. The younger child is no different to an adult in relation to the negative effects of stress. However, due to a child's rapidly developing nervous system

If left untreated, chronic stress can contribute to more serious health conditions such as diabetes, heart disease, and obesity.

(source: Ratey, J. (2008). *Spark: e revolutionary new science of exercise and the brain.* New York, NY: Hachette Book Group)

The Parasympathetic Nervous System (PSNS)

The PSNS relates to a relaxation response, which results in decreased heart rate, blood pressure and respiratory rate. This is also known as the 'rest and digest' response that occurs when the body is at rest or in a relaxed state. Blood flow, oxygen and energy increases to the digestive and reproductive organs and glands, hence digestion, immunity and fertility are enhanced when a child or adult is in the PSNS response.

The rest and digest response is complementary to the SNS. It controls the slower actions of the body to recover from stressful events. Ideally we should spend a majority of our time in the PSNS. Yoga techniques such as meditation, savasana, certain types of pranayama and gentle asana (especially restorative asana and forward bends) greatly promote the PSNS response. The relaxation response is a physical state of rest that counter-balances the effects of stress.

Studies suggest that yoga may relieve stress and anxiety

(source: Li & Goldsmith Li, A.W., & Goldsmith, C.W. (2012). effects of yoga on anxiety and stress. *Alternative Medicine Review, 17*(1), 21-35).

A typical kids yoga class will combine an active practice with relaxation. Research has shown that active practices followed by relaxing practices trigger a deeper relaxation response than simply applying the relaxing practices of yoga alone

(source: McCall, T. (2007). *Yoga as medicine.* New York, NY: Bantam Dell).

Yoga may also combat the physical effects of stress by reducing perceived stress and increasing self-compassion. This may help the mind deal with stress more effectively which will lessen its toll on the body.

(source: Gard, T., Brach, N., Holzel, B.K., Noggle, J., Conboy, L.A., & Lazar, S.W. (2012). Effects of a yoga-based intervention for young adults on quality of life and perceived stress: e potential mediating roles of mindfulness and self-compassion. *Journal of Positive Psychology, 7*(3), 165-175. doi:10.1080/17439760.2012.667144)

The Relaxation Response

Discovered by Herbert Benson (professor at Harvard and founder of the Mind/Body Institute), the relaxation response occurs when the PSNS predominates.

Benson discovered that two factors elicit the Relaxation Response

1. The mind focuses on something repetitive (yantra, mantra, knitting, walking, asana

2. a conscious attempt is made to let go of all other thoughts

Yoga Tip: Teaching a child the repetition of mantra in a song, or watching and counting their breaths, or cat-cow synchronized with the breath, are all great examples of a repetitious activity that can lead to the relaxation response in a yoga class. Be creative. The key is to practice the repetition with full focus on the activity so young children may only be able to sustain a couple of minutes for each activity.

Sleep

Naps count towards total sleep time! Children typically require from eight to ten hours a sleep in a day, but it doesn't have to be in one session. Many children have issues with sleep.

Quality sleep is vital to the repair and healthy development of the cells. During sleep, toxins are cleared from the brain.

(source: Xie, L., Kang, H., Xu, Q., Chen, M.J., Liao, Y., iyagarajan, M., O'Donnell, J., Christensen, D.J., Nicholson, C., Ili , J.J., Takano, T., Deane, R., & Nedergaard, M. (2013). Sleep drives metabolite clearance from the adult brain. *Science, 341*(6156), 373-377. doi:10.1126/science.1241224)

Sleep enhances memory, learning, attention, and emotional regulation. Sleep deprivation in children can result in poor school performance, low motivation, and an increase in injuries

Education experts are finding that naps are important for preschool aged children. Neuroscientists at the University of Massachusetts Amherst taught a group of 40 preschoolers a game similar to Memory. Then the kids took a nap (averaging 77 minutes) one week and stayed awake the other week. When they stayed awake they forgot 15 percent of what they'd learned, but when they napped they retained everything. The kids scored better on the game not only after they'd just woken up but the next day too.

(source: http://www.parents.com/health/healthy-happy-kids/why-your-kid-needs-sleep/)

"Children with sleep disorders have excessive brain arousal during sleep, which can trigger the fight-or-flight response hundreds of times each night," says Jeffrey Durmer, M.D., Ph.D., a sleep specialist and researcher in Atlanta. The repercussions can range from creating disturbances with weight gain, hormones, immunity, learning and attention.

how much sleep is enough for your child?

Some kids may be wired to operate on a little less sleep than others, but the National Sleep Foundation suggests these guidelines:

WHEN KIDS ARE ...	THEY NEED ...
up to 2 months	10.5 to 18 hours
3 to 12 months	9.5 to 14 hours
1 to 3 years	12 to 14 hours
3 to 5 years	11 to 13 hours
5 to 12 years	10 to 11 hours

image thanks to http://www.parents.com/health/healthy-happy-kids/why-your-kid-needs-sleep/ and the National Sleep Foundation)

Yoga can influence and support a child's ability to fall asleep and stay asleep. By improving a child's ability to move into the relaxation response and to self soothe as you guide them through the stages of a yoga class. Yoga improves the quality of sleep by tiring the body and mind with asana and then supporting the child with a variety of relaxation tools.

Studies have shown that a regular yoga practice can support sleep quality by decreasing sleep onset time and the number of times the child wakes, whilst also increasing total sleep time, which is essential for neuro-developmental growth.

(source: Khalsa, S.B., Hickey-Schultz, L., Cohen, D., Steiner, N., & Cope, S. (2012). Evaluation of the mental health bene ts of yoga in a secondary school: A preliminary randomized controlled trial. *Journal of Behavioral Health Services & Research, 39*(1), 80-90. doi:10.1007/s11414-011-9249-8)

The Enteric Nervous System (ENS)

Also known as the 'second brain' the ENS is another part of the ANS. This system lives inside the abdomen where large numbers of nerve cells co-ordinate digestive functions. If a child is chronically stressed, the ENS is affected and will reduce the efficiency of digestion. Supporting a child with exercise or asana followed by relaxation tools, is the most effective way to ensure a deeper relaxation response.

Benefits of Yoga: To The Nervous System

- encourages neurological and endocrine development
- encourages neuro-motor development
- decreases stress response which reduces anxiety and depression
- improves quality and quantity of sleep

Yoga tip: Dristhi

The optic nerve is the largest nerve entering the brain aside from the spinal cord. The eyes are prone to being very stimulated by bright lights and colours. A more restful and meditative yoga practice is achieved when the lights are low and when the eyes are kept as still as possible throughout the yoga practice. Candle gazing or *trataka* (focus on a single point) can also be a wonderful tool for keeping the gaze still to induce relaxation. Be particularly safety conscious if you are introducing candles or use a faux candle with younger children.

A note on screens

Research is mounting about the light generated by computers and tablets. Two hours of screen time right before bed is enough to lower levels of melatonin -- a chemical that occurs naturally at night and signals sleep to the body -- by 22 percent. Support children and their parents to say no to screens after dinner-time and discuss why sleep is so important for well-being.

THE MUSCULAR SYSTEM & MOTOR DEVELOPMENT

The muscular system develops rapidly alongside the nervous system in early childhood. The rate at which a child develops motor skills is dependent upon the rate of maturation of the nervous system.

The muscular system has the following functions – to provide movement, to support and stabilize joints and regulate organ volume and to generate heat in the body (a process known as *thermogenesis*). Muscles also act as powerful agents for generating pressure gradients in the body, which assists the circulatory system to deliver oxygen, nutrients and important hormones to the cells.

Muscles have the characteristics of excitability, contractility, extensibility and elasticity, which are all controlled by the nervous system.

Tendons

Tendons are made of strong fibrous cords of connective tissue which extend out from the ends of muscle to attach muscle to bone.

Ligaments

Ligaments are inflexible bands of connective tissue, which attach bone to bone around joints. They are joint structures not connected to muscle and do not have any contractile or movement ability. Ligaments in preschoolers are more flexible and require care in order to preserve the integrity of joints.

What is a soft tissue injury?
Soft tissue injuries may include injuries to the skin, muscles, tendons, ligaments or the tissue capsules that surround certain joints.

Sprains and strains
Sprains are injuries to the ligaments when they are overstretched. **Strains** are injuries to muscles and/or the tendons that attach or connect the muscles.

Safety Tips: ensure children are never forced or pushed into a position in class. Be extra careful with partner work to ensure children don't jump upon each other's bodies when they get enthusiastic in your class! The most common time for an injury is when a child is coming out of the pose so instruct and demonstrate this with care and never rush the teaching process. It is better for children (and their muscles) to have less instruction and more demonstration as they are great imitators. It is also more desirable to have less content in a class to ensure you have a spacious delivery.

Motor skills

Motor skills are physical abilities or capacities.

Gross motor skills are larger muscle actions such as standing, running, jumping, hopping, turning, skipping, throwing, balancing, dancing and walking. These develop at the earlier ages.

Fine motor skills such as drawing, tying shoelaces and writing develop later than gross motor skills. Girls tend to develop faster than boys in their fine motor skills.

Gross and fine motor skills are refined during early childhood; however, fine motor skills develop more slowly in preschoolers. There is a striking difference between the fine motor skills of a 2 year old and a 5 year old. For example: a 2 year-old will have trouble to even grasp the concept of tying shoelaces.

Yoga tip: be prepared for a wide variation in gross and fine motor skill level in preschoolers. Older preschoolers will be far more developed than younger ones.

Development of motor skills will be influenced by both biological (internal) and environmental (external) factors.

Balance, coordination and mobility improve as a child's nervous system develops. A process known as *myelination* occurs in muscle fibres, affecting reaction times, skillfulness and strength. This process goes on until puberty hence, fine motor skills take many years to refine and reach full potential.

Fact: Good body control and motor skills are important for children's knowledge development, social skills, language development and well-being, because young children use their bodies to learn.

(source: http://sciencenordic.com/girls-have-better-motor-skills-boys-do)

Yoga offers many different opportunities to observe, explore and practice motor skills and this supports motor development. Opportunities to practice movement, balance, and coordination are all part of a good yoga class.

Fact: Eurythmy was developed by Rudolph Steiner (1861-1925) in order to 'make visible speech and visible song' and came from the scientific theory that in early childhood, observational learning is the best form of learning.

(source: http://journals.sagepub.com/doi/abs/10.1177/002246697601000312?journalCode=seda)

Albert Bandura's theory of observational learning can be applied to a child acquiring gross and fine motor skills. Bandura states that once children are biologically capable of learning certain behaviors, children must do the following in order to develop new skills:
1. Observe the behavior in others.
2. Form a mental image of the behavior.
3. Imitate the behavior.
4. Practice the behavior.
5. Be motivated to repeat the behavior.
(source: https://www.boundless.com/psychology/textbooks/boundless-psychology-textbook/learning-7/cognitive-approaches-to-learning-48/bandura-and-observational-learning-203-12738/)

Yoga provides an opportunity for children to observe skills and imitate the skills in order to practice and reinforce the positive effects of tools such as asana, breathing and meditation. To become competent, children must be engaged and interested.

Yoga Tip: remember the power of demonstration so that a child may observe the yoga tools you are teaching first, rather than relying upon language alone. Demonstrate asana whilst making them fun and engaging. Don't be afraid to repeat asana 3 times in a row (or more) to reinforce the benefits.

Benefits of yoga to the neuro-muscular system

- develops mind-body awareness
- increases spatial awareness
- develops balance
- supports development of muscle strength
- strengthens learning and focus

The Respiratory System

In a resting child, breathing should be quiet and effortless. The respiratory system is responsible for supplying all the cells of the body with oxygen through the breath, so healthy breathing is essential for the wellbeing of all other functions. In pre-schoolers, the respiratory system is still developing (and will continue up until 8 years of age).

Air sacs that increase the lung's surface area are known as *alveoli*. Research has shown that the number of alveoli will continuously increase throughout childhood and teenage years.

(source Narayanan, M., Owers-Bradley, J., Beardsmore, C.S., Mada, M., Ball, I., Garipov, R., Panesar, K.S., Kuehni, C.E., Spycher, B.D., Williams, S.E., Silverman, M. (2012). Alverolarization continues during childhood and adolescence: New evidence from helium-3 magnetic resonance. *American Journal of Respiratory Critical Care Medicine, 185*(2), 186-191. doi:10.1164/rccm.201107-1348OC)

Physiology of the Breath

The breath is made possible by the mechanical action of the diaphragm, which is a sheet of muscle that separates the abdomen from the thorax (chest).

inhalation

Upon inhalation, air enters the respiratory system through the mouth and nose, larynx, trachea and bronchi and the diaphragm descends. As this important muscle descends, it increases the lung volume and draws oxygen into the lung where it passes into the alveoli and surrounding capillaries and alveoli. It is then distributed to the body's millions of cells via the circulatory system.

Exhalation

As the diaphragm relaxes upon exhalation, it ascends. Lung volume is naturally

decreased. Carbon dioxide is pumped out of the lungs as waste matter, exiting the body through the same pathway as the inhalation.

Respiratory Development

Younger children have a higher respiratory rate than adults at any level of exercise and at rest. More oxygenated blood is delivered to a child's muscles because they generally have an excellent high level of distribution of blood throughout the body during exercise.

Yoga safety tip: Instruct students to breathe through their noses so that their nose will naturally humidify the air on an inhalation to prepare their lungs for the breath.

Exercise-Induced Bronchoconstriction (EIB)

Some children with asthma experience an increase in their symptoms with exercise. A certain amount of children will only experience symptoms of asthma during prolonged exercise. This is known as Exercise-Induced Bronchoconstriction (EIB). Symptoms arise after 5-10 minutes and include coughing, tight chest, shortness of breath, wheezing, and unusual fatigue.

Yoga safety tip: To prevent EIB, ensure you have a warm up before the asana and a cool down at the end of class. This allows their body's to slow down any rapid changes in temperature, which will affect the lungs. Always allow a child to rest if symptoms such as coughing, wheezing and shortness of breath appear. They may need their inhaler if they have one. Allow them to rest until symptoms subside. Check the temperature of the room you are teaching in and regulate it to a comfortable temperature if possible.

Deep breaths support physical relaxation and reduce nervous system stress. Deep breathing lowers stress in the body and increases relaxation. Physical effects include lower breath rate, lower heart rate, and lower blood pressure

(source: Joseph et al., 2005). (Joseph, C.N., Porta, C., Casucci, G., Casiraghi, N., Ma eis, M., Rossi, M., & Bernardi, L. (2005). Slow breathing improves arterial barore ex sensitivity and decreases blood pressure in essential hypertension. *Hypertension, 46,* 714-718. doi:10.1161/01.HYP.00000179581.68566.7d)

Shallow breaths

Shallow or rapid breathing can trigger the fight or flight response and increase feelings of stress and anxiety in the brain. When relaxed, the brain signals the body to take slow and even breathes.

Conscious deep breathing affects the brain. Taking deep breaths sends a soothing message to your brain to calm down and relax. The brain can then signal the body to relax.

Yoga uses a range of breathing exercises to support the relationship between the

body and the mind. Consciously breathing in a quiet, gentle and even way produces healthy physiological changes in the body. Yoga breathing exercises are capable of reducing stress, improving oxygen and energy levels.

Benefits of Yoga to the Respiratory System

- increases the endurance and strength of the muscles of respiration (including the diaphragm).
- Supports a child to gain control over respiration
- Increases awareness of respiratory structures
- mobilises the lungs (hence preventing secretions from building up which increases risk of chest infection)
- empowers children to control their stress, anxiety and inner state by controlling the depth of the breath. Deeper, longer breaths can help to induce therapeutic relaxation and reduce stress.

The Cardiovascular System

The cardiovascular system consists of the heart, blood vessels, and blood. With every heartbeat, the heart pumps the blood to deliver oxygen and nutrients to every cell in the body and remove waste from the body.

Yoga can promotes heart health in children through physical exertion of asana.

(source: Woodyard, C. (2011). Exploring the therapeutic effects of yoga and its ability to increase quality of life. *International Journal of Yoga, 4*(2),

49-54. doi:10.4103/0973-6131.85485).

By reducing stress, yoga may improve cardiorespiratory health and fitness.

(source: Galantino, M.L., Galbavy, R., & Quinn, L. (2008). Therapeutic effects of yoga for children: A systematic review of the literature. *Pediatric Physical Therapy, 20*(1), 66-80. doi:10.1097/PEP.0b013e31815f1208).

While not all yoga is aerobic, yoga practices that do not increase heart rate can improve cardiovascular health. Research suggests that yoga can reduce blood pressure, lower cholesterol levels, mediate blood sugar, and/or increase heart rate variability.

(source: McCall, T. (2007). *Yoga as medicine.* New York, NY: Bantam Dell)

A regular yoga practice can have significant effects on the management of obesity, a strong risk factor for heart disease

(source: Rioux, J. & Ritenbaugh, C. (2013). Narrative review of yoga intervention clinical trials including weight-related outcomes. *Alternative Therapies in Health & Medicine, 19*(3), 32-46).

Benefits of Yoga to the Cardiovascular System

- Increases blood flow
- Lowers blood pressure
- Lowers cholesterol levels
- Normalizes blood sugar
- Increases heart rate variability
- Lowers risk of heart disease

(source: Williams, C.L., Hayman, L.L., Daniels, S.R., Robinson, T.N., Steinberger, J., Paridon, S., & Bazzarre, T. (2002). Cardiovascular health in childhood. *Circulation, 106,* 143-160. doi:10.1161/01.CIR0000019555.61092.9E)

The Urinary system

Before continence is developed, the bladder is controlled by a pressure sensitive reflex the bladder will empty when stretched to a certain volume. The ability to control urination is a process learned in early childhood through "potty training." Potty training teaches a child to consciously override the messages from the bladder to their brain and stop the bladder from emptying until a desirable time. Nervous system maturation is required for bladder

(source: MacGregor, J. (2008). *Introduction to the anatomy and physiology of children* (2nd ed.). New York, NY: Routledge)

Yoga exercises increase metabolism, which stimulates activity in the urinary system. Have children use the restroom before class to avoid accidents

About the Author – Lisa Fitzpatrick

http://www.LisaFitzpatrick.com.au

I am an experienced and certified Professional Business Coach, Intuitive Healer, certified Yoga Teacher, Workshop Facilitator, Entrepreneur, Writer, Speaker, Registered Physiotherapist since 1993 and Mother of two sons. I live in a beautiful sub-tropical paradise near Byron Bay, Australia. I'm passionate about bridging the gap between modern science and spirituality to bring transformation and empowerment to conscious women around the planet.

After working with thousands of women around the world in the areas of business, health, wellbeing and transformation, I have found that there are simple keys that explain why so many women are stuck in survival mode when it is their natural birthright to thrive. When a woman finds her True North, the calling that utilises her unique set of talents and abilities, she is able to harness her physical, mental, emotional, financial and spiritual selves into a healthy alignment and union with the divine. She becomes the powerful Goddess she has always been destined to be. Her passion ignites, she feels re-energised and revitalised by her work in the world rather than depleted and exhausted. Her unique contribution brings her deep joy and fulfilment and soul wealth.

My true calling has lead me establish Sacred Women's Business Coaching, a coaching business which supports women to find their True North and to use their unique and authentic voice sustainably in the world of service-based women's business.

Other books by author

‘Healing the Heart of Your Business – sustainable success for heart-centred women’ – by Lisa Fitzpatrick – available from all good online bookstores

‘Manifesting in High Heels – secret rituals to achieve success’ – an best-selling anthology – available at Amazon.

‘The Complete Guide to the Pelvic Floor - 7 Keys to Awakening Your Inner Goddess’ [Kindle Edition] – by Lisa Fitzpatrick